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Multicrop Harvesting Machine

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Abstract: Overall the world, India is not only the largest producer of many crops like wheat, rice, pulses but also exporter of many crops. The Indian economy finds its roots in agriculture. In farming, crop cutting is an essential part of farming as well as a very time consuming process. Harvesting is an important part of the agriculture industry. Nowadays modern harvesting technology is increasing but its cost is very high and skilled laborers are required to operate the machines. To minimize the lengthy process of harvesting and reduce the cost of skilled laborers to operate machines. We have designed the "MULTICROP HARVESTING MACHINE" so it can eliminate skilled laborers as well as it saves the time of farmers so they can focus more on good crop production. This machine uses the solar panel to power the drive cutter from the wheels of the vehicle itself. This project targets the small field crop cutter machine for small height & small stream crops. This machine is economical and helps the farmers to achieve higher productivity.

Keywords: Small Scale, Solar Panel, Wheels

I. INTRODUCTION

In a country like India where the primary element of income is agriculture it needs to concentrate on some aspects of farming like how to increase productivity and profit, how to reduce cost and how to solve and ease the problems of the workers. To overcome a physically operated cutter it has been constructed for cutting multiple types of crop during harvesting and named as "Multi Crop Cutter". It possesses four criteria: ease in manufacturing, ease in handling, low cost and light weight. The fabrication of this device involves some procedures such as fabricating prototypes, material & component selection, etc. It is a process of cutting the crops close to the ground or pulling the plants when they are ripped out. It includes chopping of the trunks of coral crops like tuar, javar, bajara, maize grass etc. close to the ground. In India it is generally done by a sharp sickle. On the basis of a large number of this crop harvester is in use today's date, which are available at different shapes and sizes and on various power supplies. Some of them are pneumatic crop harvester, hydraulic crop harvester and crop harvester running on a tractor engine. Since they are costlier keeping into consideration the economic ability of the farmer it should be simple and fulfill the same intention which is achieved by the farmers.
This machine aims to be economical and efficient. Farmers will be able to afford this machine and use it for small scale production. We are aiming for small scale production because most of the farmers who face problems of insufficient labor and their cost are producing the crops at small scale.Harvesting of MULTICROP at a right time i.e., peak maturity, by adopting the apt technique is necessary to realize maximum weight of the mill-able canes (thus sugar) produced with minimal possible field loss under the given growing environment.

A. Objective

1) To design and develop economical and compact harvester which lessen overall cost of harvesting underground crops in the form of labor and harvesting them
2) To provide actual usage of wastage which can be beneficial for farmers and saves their money.
3) To lower overall harvesting time as that of long-established harvesting time

II. LITERATURE REVIEW

A. Manual Harvesting

In this method, harvesting is done manually with the help of humans. Manual harvesting is dominant in developing countries. In this, the land is first set on fire. The fire burns dry leaves without harming the stalks and roots, then laborers cut the cane just above the ground level using the canes or machetes. The manual harvesting is more intensive as compared to machine harvesting. Further, the manual harvesting method is tedious and efficient work may not be done also the cost required is also more. Majority cereals, pulse and oilseed crops are harvested using sickle whereas tuber crops are harvested by country plough or spade. All these traditional methods involve drudgery and consume a long time.

B. Machine Harvesting

In this method, harvesting is done with the help of a machine. It is fully automated and requires very less time for cutting sugarcane around a large area. The machine harvesting has high initial cost, high operating cost, applicable for only large scale farmers, skilled labor required to operate the machine and area required for operation is also more. Systems are planned to achieve the mass removal of the commodity during the harvesting season at once. The application of this method is done by shaking the trunks, limbs, and canopies of plants.

C. Existing System

Atul R. Dange et. al. [1], (2011), this research work was made to investigate the cutting energy and force required for the pigeon pea crops. The commercially available blade has been attached to the lower end of the arm of pendulum type dynamic tester which cut the stalk at 900 to the stalk axis with knife velocity ranging between 2.28m/s to7.23 m/s the diameter of stem at 42.6 % (wb) moisture content investigated the cutting energy and cutting force were directly proportional to cross-sectional area and moisture content at the time of harvesting of pigeon pea crop. In view of this a tractor operated front mounted pigeon pea stem cutter was design and developed in Department of Farm Machinery and Power [1].

Adarsh J. et. al.[2], proposed a fabrication design for small scale sugarcane harvesting machine consists of petrol engine and mechanisms are used in this machine to differentiate to manual harvesting. This machine has reliability to cut sugarcane in faster rate and economical.It design and fabricate small scale sugarcane harvesting machine for sugarcane harvesting to reduce farmers strive and to increase production of agricultural items.

This project consists of petrol engine and different mechanisms are used in this machine. While comparing to manual harvesting by using this machine has a capacity to cut canes in faster rate and it is economical. The machine is helpful for both whom having small or big farms.[2]

Dr. Sharad S. Chaudhari et al. [3] proposed that designing and fabricating small scale MULTICROP harvester for MULTICROP harvesting to reduce farmer's effort and to increase production of agricultural products. Machine consists of petrol engine and different mechanisms.

When compare to manual harvesting by using this machine has capacity to cut canes in faster rate and it is good in all aspects. The machine is helpful for unskilled labor or farmers so they can use it. [3]

Abhay Singh et al. [4] proposed that to inspect the performance of solar energy operated crop cutting machine (SEOCCM). During the harvesting of crops, farmers face harsh climatic conditions such as summer (for cutting crops of wheat, sugarcane, corn, mustard, etc.), and winter (for cutting crops of rice, sunflower, herbs, etc).

It is a general to monitor that to evade such harsh conditions of weather, the farmer used to cut the crop during the night (in summer especially) and sometimes face accidents such as snakebite, insect bite, or wild animal's attacks which lead to the death of several farmers. As manual cutting (i.e. utilising by manpower) takes several hours, sometimes a farmer loses his crop due to a sudden change in weather such as rain. There are various machines available such as harvester which consumes either conventional fuel (Diesel) or electricity which leads to air pollution. Hence, there is a requirement of a machine which consumes no conventional energy, saves both times, and cost.

Getaw Ayay Tefera et al. [5] proposed that design and prototype were achieved by following a method of reviewing literatures, collecting data, synthesizing and analysing the mechanism and structure at a preliminary and detail design stage (using manual and CATIA), making drawings, manufacturing a prototype and testing. The prototype of solar grain harvester has one hp DC motor, 2.4 m2 solar panel, four-wheel vehicle and cutter assembly.

It can harvest 600 mm width of grain at a speed of 500 mm/s i.e., it can harvest 0.108 ha/hr. or 18.73 times more than a single person can do. Therefore, small-scale solar grain harvester will become preferable means of harvester because it is none pollutant and freely available.

Chavan P. B. et al., (2017), [6] various approaches have been proposed for improving mechanized type of crop cutter in agriculture field. Designing a reaper machine to harvest grains more efficiently. The research work focusing on harvesting operation to the small land holder to cutting varieties of crop in less time and at low cost by considering the factor as power requirement, ease of operation, field condition, time of operation and climatologically condition[6].

Siddaling S and Ravikiran B. S. et al [7] (2015), proposed that fabrication and plan to implement this project for small scale sugarcane harvesting machine for harvesting to reduce farmer's effort and to increase the output of the agriculture products. The comparison was made with the manual method but the proposed machine can cut the lower and upper part of the sugar cane containing leaves, simultaneously by setting the ideal movement of the rotary blades. [7]

III. METHODOLOGY

The intention of the project is to design a crop harvesting machine which is productive and affordable to farmers. The design is so simple that it's easy to disassemble and reassemble if required. The machine takes a power from a solar panel and charge the battery with help solar energy. The motion from the wheels is utilized by the shaft for the free movement also drives the cutters which are powered by pushing force of the operator. A DC motor drives the system. The power is supplied into the DC Motor either from DC batteries or direct solar panels. As the DC motor starts, the power is transmitted to intermediate shaft through battery and automates drive start. We give the battery power to the wheel as well as to the the cutter through the D.C.Motor. Due to this the machine is start to move in the forward direction and also all the cutter is started rotate. There are two switches who operate front and rear direction of wheel and give the power to rest wheels. While working on this machine DC motor will get charge at the same time due to solar energy convert into Mechanical energy.

A. Material Selection

1) DC Motor 12V, Geared Motor, 150rpm,Torque upto 1.5Kg-cm.DC motor with metal Gear head generally used in various robotics application.

Specifications:

Motor Type	DC with Gear Box, Metal Gears
Shaft Type	Circular 6mm with internal hole for coupling,23mm shaft length
Maximum Type	1.5 kg at 12V=0.14715N-m
RPM	150 at 12V
Weight	130gms
Max Load	-330mA at 12V

B. Main Frame

This frame is constructed in rectangular shape on which the whole assembly is mounted.

C. Bearing

It is type of ball bearing of rolling elements that uses balls to maintain the separation between the bearing races. It is also used to reduce rotational friction and radial and axis load.

D. Shaft

It is the component of mechanical device that transmits the rotational motion as well as power. An intergral to any mechanical system in which power is transmitted from a prime mover.

E. Blades

This cutter blade has a good sharpness that affect on power requirements .It has leading edge were thickness is less than 0.127mm requires 35% less energy. Velocity of blade is depends upon the diameter of blade & no. of rpm.We are changing the blades according to crop also checking strength, diameter of stem and thus the cutting force also change.

F. Storage Battery

It is an essential part of the system. Solar radiation intensity varies from season to season as per the atmospheric condition. It protects the spray pump from over the voltage by providing Constant voltage of 12V. We are using the dry battery which is small in size and this battery consists of Nickel Cadmium material for electrical energy. It has an output voltage of 12v and an output current of 14Amp.

G. Wheels

In this machine, It is ring shaped component which is made from iron where the radius of wheels is 18 inch. A wheel rim to transfer the load from the axle through the traction on the surface over the which the wheel travels. The axle of wheel is made from iron so in mud and rough surface it can easy to move as the size of wheels is small threads are provide traction.

IV. DESIGN CALCULATION

A. *Motor*

Motor power

$$P = \frac{2 \Pi N T}{60}$$

$$T = \frac{2 \times 3.14 \times 150 \times 0.14715}{60}$$

P =2.310255 w

Power is transmitted from the motor shaft to the input shaft of wheel and four shaft vertically is mount on the body of the four motor which is attached to the four gear drive,

Torque at IP_shaft = 0.14715 N-m

B. *ASME Code for Design of Shaft*

The loads on most shafts in connected machinery are not constant, it is necessary to make proper allowance for the harmful effects of load fluctuations According to ASME code permissible values of shear stress may be calculated form various relation.

fs_{max} = 0.18 fult
= 0.18 x 900
= 162 N/mm^2

OR

fs_{max} = 0.3 fyt
= 0.3 x 700
= 210 N/mm^2

Considering minimum of the above values:

$\Rightarrow$ fs_{max} = 162 N/mm^2

Shaft is provided with key way; this will reduce its strength. Hence reducing above value of allowable **stress by 25%**

$\Rightarrow$ fs_{max} = 121.5 N/mm^2

Force required in cutting the MULTICROP by shearing.

Shearing strength of MULTICROP: 3.03 to 4.43 MPa (AVG 3.64 MPa)

- Area of MULTICROP stalk cutting at a time = Diameter of stalk × length of serration = 40mm × 1mm = 40 mm2
- Shearing force required = Shear strength × Cutting area = 4.43 × 40 (Taking maximum shear strength) = 177.2 N

Power required cutting the MULTICROP: The optimal combination of parameters was: blade cutting velocity of 13.8 m/s,

Diameter of Cutting Disc = 200mm

- Optimal rpm for cutting Multicrop = 1317.8 ~ 1318 rpm
- Power Required for Cutting = $\tau \times \omega$
- Cutting force × radius = 177.2×0.1 ×P= 244.57Watt

C. *Wheels Specification*

Let we select the wheel having specification given below,

Diameter of wheel D=30cm=0.3m.

Radius of wheel r =15cm=0.15m.

Let to find Linear Velocity of wheel is, V=r ω

V= Linear Velocity of wheel (m/s)

r = Radius of wheel (m)
ω= Angular Velocity of wheel.
N = Speed of wheel.(Assume 15 rpm)
V= r* ω
V= (2 x 3.14 x N)/60 x 0.15 = 0.235 m/s

D. Selection of Bearings

Input shaft bearing will be subjected to purely medium radial loads; hence we shall use ball bearings for our application.
Selecting ; Single Row deep groove ball bearing as follows
$P = X F_r + Y F_a$
Neglecting self-weight of carrier and gear assembly
For our application $F_a = 0$
$\Rightarrow P = X F_r$
where F_r = Pt = Maximum load at dyno-brake pulley
Maximum load = Torque / Radius of dyno-brake pulley
$= 1.36 \times 10^3 / 30 = 45$
Max radial load = F_r =45 N. (Tension in belt)
$\Rightarrow$**P= 45N**
Calculation dynamic load capacity of brg
$L = \left(\frac{C}{P}\right)^p$, where p= 3 for ball bearings
For m/c used for eight hr of service per day;
L_H = 4000- 8000hr

$$L = \frac{60\, n\, L_H}{10^6}$$

$$L = \frac{60 \times 5000 \times 4000}{10^6}$$

L= 1200 mrev

$$\text{Now;} 1200 = \frac{(C)^3}{(45)^3}$$

$\Rightarrow$C= 478N
As the required dynamic capacity of brg is less than the rated dynamic capacity of brg;

E. Torsional Shear Failure of Shaft

Assuming minimum section diameter on input shaft= 16 mm
d = 16mm
$Td = \Pi/16 \times fs_{act} \times d^3$

$$fs_{act} = \frac{16 \times Td}{\Pi \times d^3}$$

$$= \frac{16 \times 0.2943}{\Pi \times (16)^3}$$

fs_{act} = 3.66 N/mm^2
As, $fs_{act} < fs_{all}$
$\Rightarrow$ I/P shaft is safe under torsional load

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Check for torsional shear failure:-

$$T = \frac{\Pi \times fs_{act} \times}{16} \left(\frac{D0^4 - Di^4}{D0} \right)$$

$$1.36 \times 10^3 = \frac{\Pi \times fs_{act} \times}{16} \left(\frac{36^4 - 16^4}{36} \right)$$

$$\Rightarrow fs_{act} = 0.154 \text{ N/mm}^2$$

V. RESULT

After Fabrication and assembling all parts of the machine that Multicrop harvesting has great potential to increase productivity of crops. This machine is tested by some of farmer and unskilled labors it is convenient for all also its reduces the cost of harvesting & time as differentiate to traditional methods. Therefore, Cost of production is less. This Multicrop harvester can increase the growth of farmer because design and fabrication of machine at affordable price also its customizable. It is favorable to small scale farmer who cannot afford expensive equipment of farming and one person can easily operate this machine .This machine can reduce the load of the farmers from all aspects.

Fig: Multi-Crop Harvester

VI. CONCLUSION

This is the affordable machine for the agriculture purpose for increasing the production rate as well as save the man power. This machine does not require any electricity for operating it is self-driven machine. The increase of labor demand for Multicrop cutting labor, farmers have started using mechanical techniques for Multicrop cutting. 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 after using such small machine. Our project is now manually operated machine for Multicrop cutting, but in future we can make it semi/fully automatic with large scale machine. We can use tractor drive to fully automatically actuated Multicrop cutting machine with high speed blades for its future working.

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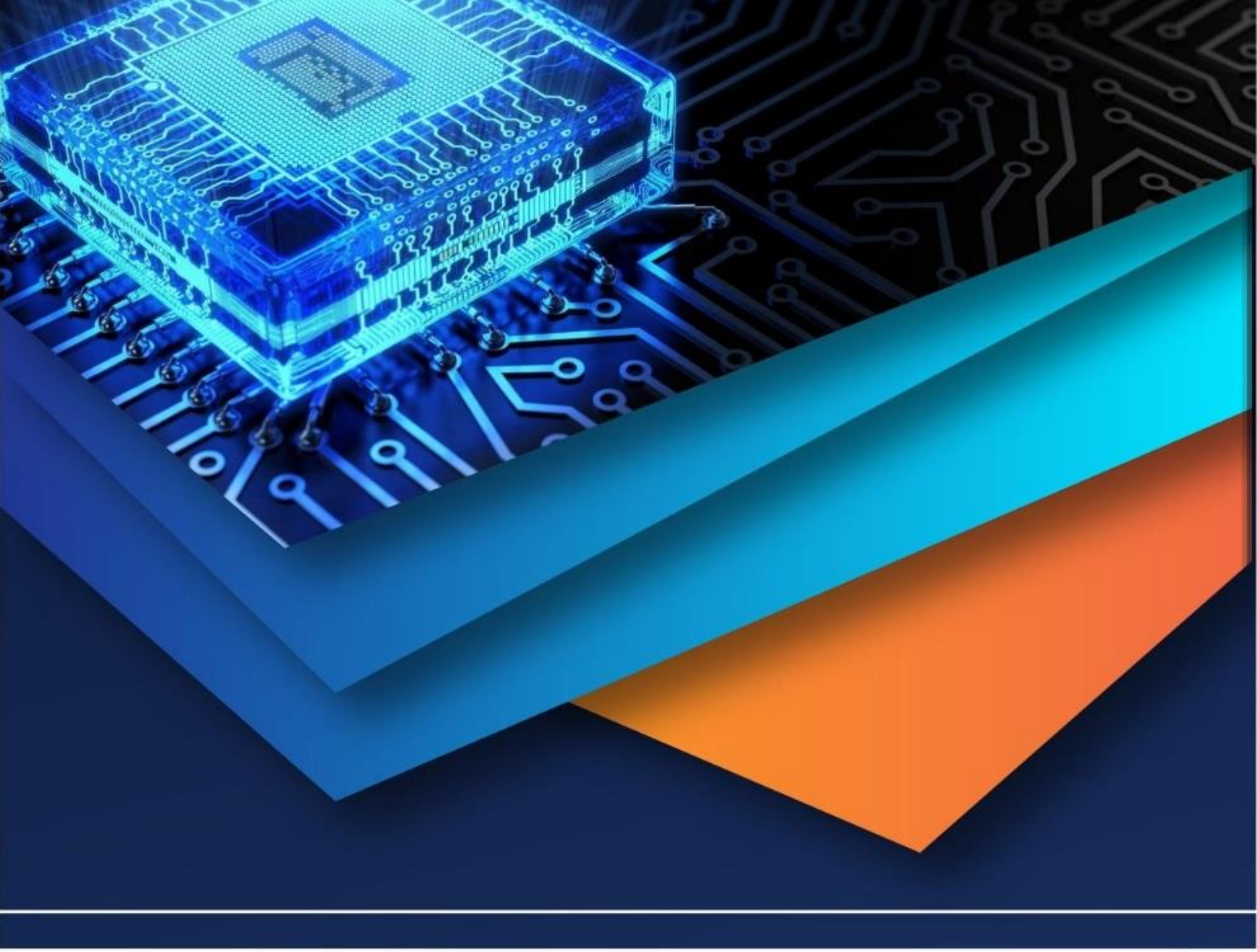

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