

UNIVERSAL MULTIPURPOSE CULTIVATOR

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Abstract – Now a days there is a rapid development in all the sectors in which agricultural sector plays a major role. It also plays a vital role in the economic development of a country. Due to increase in population in both underdeveloped and developing countries, the demand for the food is also increasing at a faster rate. As India is also referred as a agricultural country which cultivates a wide range of crops like rice, wheat, barley, corns, etc. in the village areas. Generally, the strength factor for the soil varies from region to region so in order to meet the food demands, thereby it is required to implement the new methods which will not affect the texture of the soil which results in a high crop productivity yield. Since the present seed sowing cultivators are too costly as well as bulky which is not affordable for the farmers who are having small scale farms.

This paper suggests the design and re-development of the Universal Multipurpose Cultivator (MPC) for agricultural operations. In this paper the field analysis is to done for various agricultural operations, the design and development of MPC is done by using the analysis tool. The machine is able to perform various agricultural operations such as seed sowing, ploughing, fertilizing and cutting through power generation in the respective order. We can use insecticide instead of fertilizer. The main objective of the multipurpose cultivator is to put the seed in the desired depth and provides particular spacing between the seeds and further it covers the seeds with soil by the help plougher. We can achieve optimum yield by proper spacing within the seed and can provide a particular row spacing with the help of implementing various mechanism. The research is to be done to provide farmers which minimizes the labour hours required in multiple agricultural activities by implementing various operations. This paper provides an alternative method to the existing farming system on agricultural field at effective cost.

Key Words: Seed sowing, Ploughing, Fertilizing, Cutting MPC.

1. INTRODUCTION

In India, almost 75% of the population are dependent on agricultural for economic growth. So the agricultural system in our country should be changed to reduce the manual efforts of farmers required while farming. It includes the various operations is to be performed in the agricultural field like sowing, ploughing, cutting, fertilizer spraying in a manual manner by the farmers. One of the basic and significant operation is seed sowing which is a lot time consuming process. So the traditional equipment used for sowing is very difficult and inconvenient to handle. So there is a need to re-develop the machine which will minimize the

manual efforts of farmers such as Broadcasting and Dribbling. To overcome these difficulties, in this paper, efforts had been taken to develop an Universal Multipurpose Cultivator. This technology in the farming system minimizes the efforts taken by the farmers, saving their time, labor cost and their energy as well.

2. LITERATURE REVIEW

2.1. Mahesh Pundkar and A. Mahalle (Volume 3, Issue 03/ ISSN: "2249."), [Research paper citing] – 2017

He presented the information about the different innovations done in seeding machines available for farming and plantation purpose. The seed sowing machine is one of important key factor in an agriculture field and their performance makes a remarkable influence on their cost and yield productivity. Presently there are many ways to determine the performance of seed-sowing machine.

2.2. L. P. Raut and, S. B. Jaiswal (International journal of Research and studies), [Research paper] – 2013

He presented to meet the various food requirements for the increasing population, industrialization, modernization of agriculture is unable to be avoided. In this paper, it enables the fact of being exact and accurate distribution, reducing the quantity needed for better results and prevention of losses of inputs applied. Due to this it reduces the unit cost of production and results into the better productivity.

2.3. Dr. Ramesh and H. P. G. Kumar (Review journal on seed sowing equipment) , 2014

He presented information regarding the various types of innovations done in the sowing equipment. In this the main aim of seed sowing operation is to put the seed in rows and at desired depth and having a particular spacing between seed to seed with soil and provides a proper exertion of a force over the seed. So it shows proper row spacing within the seeds, their seed rate and their depth associated with different agro-climatic conditions to achieve optimum yields.

2.4. P. V. Sawalakhe and Amit, Sontakke, (global journal of solar seeding machine), [Cited on research paper]- 2016

They investigated that there is a rapid development in all sector including the agricultural sector as well. So in order to meet the future food requirements, the farmers need to change their techniques to overcome the traditional method of farming. This Paper describes the various sowing methods implemented in agriculture for seed placements.

3. PROBLEM STATEMENT

There are many developments in the existing cultivating machineries but it is too costly. It is not affordable for each and every farmers in India as It has a complex design and inconvenient to handle. Basically, it is not compact in size and their weight is a major factor for handling purpose and hence, it requires a much effort to accomplish its transportation cost from one place to another place.

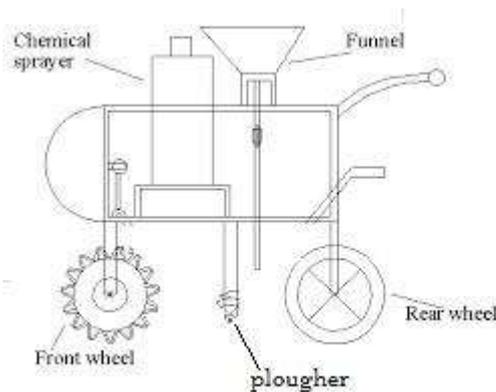
Due to these reasons, the design and development of “Multipurpose Cultivator” has been taken up. Taken care to ensure that the cost of the machine, operational cost and maintenance cost are low. Also to reduce the weight of the machinery to increase the productivity of crop. Various health problems can be minimized. This product is easy to use and less effort required as compared. It is helpful for small scaling farming.

Along with these several factors, the traditional way of farming is time consuming and can lead to a lots of labour work and their energy consumption as well. So by implementing this design it is going to be simple and easy to handle and more convenient. Hence, the size of the machine, its production and transportation cost, everything will be reduced.

4. OBJECTIVES

- To study the farming process.
- To Design and development of Multipurpose Cultivator.
- To perform the field testing and Design Finalization.

5. CONCEPT DIAGRAM



MAJOR COMPONENTS IN THE PROPOSED MACHINE:

- HOPPER
- SPROCKET
- CHAIN DRIVE
- SEED BUCKET

- PUMP
- PLOUGH WITH SHANK
- WHEELS
- SHAFT AND BEARING
- BATTERY
- SOLAR PANEL
- TANK
- GENERATOR

6. COMPONENT DETAILS

Hopper:: It is used to store the seeds and their delivery for the further use. The capacity of the Hopper varies as per their design and various customers demands ie, from 25kg - 85kg. Due to this hopper the seeds can be sown from smaller to larger rate as per the requirement. Here, in our design the hopper is rectangular in shape in order to prevent the wastage of the seeds. Hence the weight and cost of sowing machine can be reduced.

Sliding-Plate:: The sliding plate consists of two brackets with holes spacing in equal distance. The sliding plate rotates as per the given drive to the cultivator.

Seed Metering Mechanism:: This mechanism uses metering of the seeds for the proper distribution of the seeds. It comprises the seed buckets aligned at 180 degree or 90 degree based on the various demands. As it gets the primary drive, the main shaft also rotates and it receives the seeds from the hopper through the holes present in the sliding plate.

Ground Wheel:: Ground wheel is the primary drive given by the driver to generate the power in the device. The ground wheel consists of a circular disc having a number of teeth provided on their periphery ie, at their outer circumference and it provides a fine grip with the land.

Power Transmission System:: It consists of a Belt drive which is connected in between the front wheel through the shaft. Hence the is generated initially by the primary drive and then it transmits from the front wheel to the sliding plate through the belt drive.

Seed Distributor:: It consists of flexible pipe which is used as a seed distributor. Seed distributor receives the seeds from the hopper. After receiving the seeds, the distributor leaves the seeds on the cultivating ground in a well spaced manner.

Battery: It is a device which produces electrons through electrochemical reactions, and contains positive (+) and negative (-) terminals for power distribution for fertilizing and cutting operations.

Solar Panel: Solar panel make use of solar thermal radiations which converts solar energy into electrical energy. For this we can make use of photovoltaic cell or the concentrated solar power or the combination of both which consists of mirrors focusing number of solar radiation and further used for the power generation.

Generator: A generator is a device which converts mechanical energy into electrical energy.

7. DESIGN AND ANALYSIS

7.1 Design Calculations:-

Selection Of Soil -

SOIL TYPE	RESISTANCE OF SOIL (KGF/CM ²)
Light	0.13
Medium	0.16
Heavy	0.21
Very Heavy	0.26

7.1.1 Design of Plough:

Now,

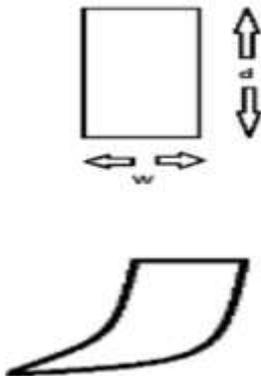
Taking Very Heavy Resistance of soil. ..0.25kgf/cm² By using Draft Force formula,

$D = K_o \times w \times d$ from research paper

Where,

K_o = Soil Resistance, kg/cm²

W = Width of the plough



d = depth of the plough

D = Draft force, Kgf

Take $K_o = 3$FOS

So,

$K_o = 0.25 \times 3 = 0.75$

Take, $w = 2.5$ cmcommonly available

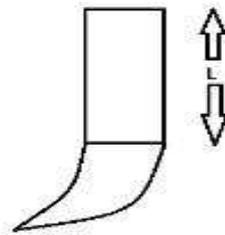
Taking, $W/d = 1/4$ ratio

$D = 2.5 \times 4 = 10$ cm

Therefore, $D = 0.75 (2.5 \times 10) = 18.76$ kgf

Again taking FOS = 3

D (Force exerted) = $18.76 \times 3 = 56.28$ kgf



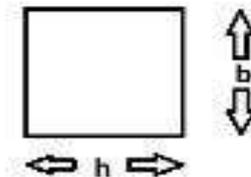
Length of the shank = 25mm

\therefore Bending moment = Draft force x Shank length

= 56.25×25

= 1412.5 kgf/cm

For Shank,



Where,

B = Thickness

H = Width

Considering, $b:h = 1:2$

Taking $b = 16$ mm available in market

$b/h = 1/2$

$\therefore h = 32$ mm

Then to find deflection ,

$Y_{max} = Wl^3 / 3EI$

$I = M.I$ of rectangular section(mm⁴)

$\therefore I = bh^2 / 12 = 16 \times 32^2 / 12$

$I = 13653$ mm⁴

Now, by using formula,

$Y_{max} = 56.25 \times 250^3 / (3 \times 2.1 \times 10^5 \times 1365.3)$

$Y_{max} = 1.02$ mm

Hence, there is a less deflection present within the shank for a length of 25mm.

7.1.2 Design of Shaft

Bending: A bending moment is the measure of the bending effect within the element which occurs due to external force or a moment applied to the element.

Torsion:

Torsion is an important action which measures the shear strength of an element. It occurs due to the twisting force acting on the member commonly known as torque.

Combined Bending And Torsion: The combined bending and torsion case arises when shaft is subjected to thrust action in addition to the bending moment and torsion action. On the other hand, this action can be possible due to direct or indirect twisting. So that the cross-section of the shaft is subjected to both bending and torsional stresses simultaneously.

Power of Shaft = P = 17 watt

Power transmitted by shaft,

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

Where,

N= Rpm of motor shaft = 24

T= Torque transmitted

$$T = 21.25 \times 10^3 \text{ Nmm}$$

Torque transmitted,

$$T = \pi/16 \times \tau \times d^3$$

Selecting, shear stress (τ) from PSG.

$$\tau = 70 \text{ N/mm}^2$$

Therefore, $21.25 \times 10^3 = \pi/16 \times d^3 \times 70$

$$D = 11.56 \text{ mm.}$$

Taking, FOS = 2

$$D = 2 \times 11.56 = 23.12 \text{ mm}$$

Taking Dia = 24mm

We select dia. Of shaft = 24mm.

7.1.3 Design of Bearing

Here ball bearing are selected for radial load of transportation along with the self weight of plate including friction being 10 kg. during 90% of time & 30 kg load during remaining 10%. The shaft rotates maximum at 50 rpm. We have to calculate the value of dynamic load capacity for 5000hrs of operation.

$$W1 = 10 \text{ kg}$$

$$W2 = 30 \text{ kg}$$

$$N = 50 \text{ rpm}$$

Therefore no. of revolution during 90% of time,

$$L1 = 0.9 \times 50 \times 60 \times 5000$$

$$L1 = 13.5 \times 10^6 \text{ min}$$

Number of revolution during 10% of time

$$L2 = 0.1 \times 50 \times 60 \times 5000$$

$$L2 = 1.5 \times 10^6 \text{ min.}$$

Basic dynamic load rating = C

$$C = \left(\frac{L1W1^3 + L2W2^3}{10^6} \right)^{1/3}$$

$$C = 37.79 \text{ kgf.}$$

Now using reference table, for static load of 38.86 kgf bearing SKF 6203 is suitable.

7.1.4 Design of Bolt

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-25 steel $f_t = 420 \text{ kg/cm}^2$. Std nominal diameter of bolt is 10mm. From table in design data book, diameter corresponding to M12 bolt is 8.160mm

Let us check the strength:-

Also initial tension in the bolt when belt is fully tightened.

P = 30 kg = 300 N is the value of force applied by hand

Also, $P = \pi/4 d c^2 \times f_t$

$$300 \times 4$$

$$f_t = \frac{300 \times 4}{\pi/4 (12 \times 0.84)^2} = 3.76 \text{ N/mm}^2$$

The calculated f_t is less than the maximum f_t hence our design is safe.

7.1.5 Design of Welded Joints

A welding joint is a edge or it can be a point where it make use of two or more pieces of metal or plastics are fused or joined together with the help of with or without application of the pressure by using a filler material.

Checking the strength of the welded joints for safety.

The maximum load which carries the transverse fillet weld is given by -

$$P = 0.707 \times S \times L \times f_s$$

Where,

S = weld size,

L = contact length = 30mm (5 mm for starting & stopping of weld)

The load of shear along with the friction is 45 kg = 441N
Hence, $441 = 0.707 \times 5 \times 30 \times fs$

Hence let us find the safer value,

$$\text{Therefore, } fs = \frac{441}{0.707 \times 5 \times 30}$$

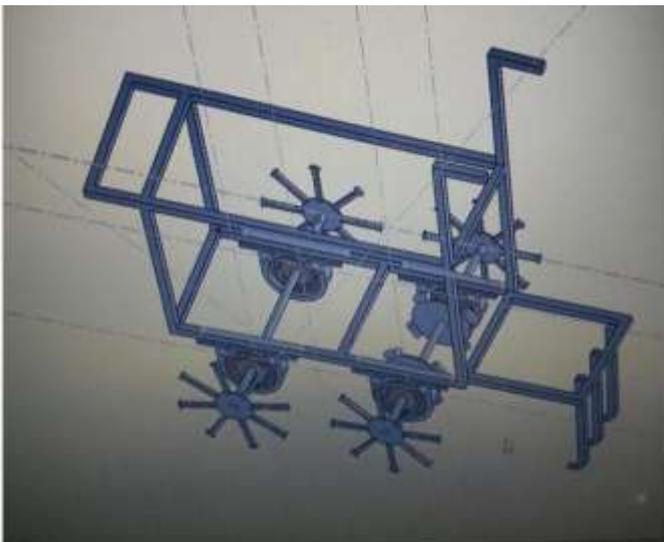
$$fs = 4.15 \text{ N/mm}^2$$

Since the calculated value =4.15 permissible value as $fs=56 \text{ N/mm}^2$.

Hence welded joint is safe.



8. CAD MODEL



9. CONCLUSIONS

We can infer that our planned mechanical machine is beneficial over the current machines in the accompanying ways:

It is of minimal effort similarly and accounts less than 50% of the current expenses.

- The method of task is extremely basic even to the layman.
- We can obtain a better productive yield over the traditional machines.
- This equipment consist of a low maintenance cost which does not consist of a fine texture which can be easily broken or damaged.
- By using this machine, we get a good quality in seeding.
- It utilizes as a part of a fertilizer sprayer.
- Proper expertise not required for working this machine and simple to exchanged.

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