

Design and Fabrication of Sugarcane Trash Removal Machine

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Abstract: *Sugarcane, known as one of the most important and commercialized crops of India, is a renewable, natural agricultural resource producing mainly sugar and bio-fuel along with other by-products like, fiber and fertilizer, etc. But, the production cost of sugarcane is increasing year after year. Many reasons are there for increased production cost, like increased prices of fertilizers, unexpected weather change, shortage of skilled labours, day-by-day reducing capability of a lands' crop growing strength, etc.. This reduces the profit margin of both the sugarcane growers and the sugar industry. Most of the frequent intermediate cultivity actions, which are necessary, are delayed or not taken up at all for want of sufficient skilled labour at reasonable wages, which results in low weight, production and overall productivity of sugarcane and other by-products. Harvesting of sugarcane is the laborious operation, which involves many efforts, starting from on-field individual sugarcane's base cutting, de-trashing, de-topping, bundle making, loading on vehicle and transport of sugarcane to the sugar mill. Labours' strength requirement of sugarcane harvesting range varies from 800 to 1500 human hours per Hectares, which is the highest of other agricultural operations. Mechanization of sugarcane harvesting is essential for reducing the sugarcane production cost, drudgery involved in manual harvesting operations, saving valuable time, to ensure quality produce, etc. Mechanical combine harvesters that are presently available are of high capacity, but they also require high capital investment. Thus, neglected by small and medium scaled farmers. Our Sugarcane de-trasher, using Engine as power source, would be less expensive and suitable for small and medium scaled farmers. Among the high costed sugarcane harvesters currently available in the markets, this machine would be the cheaper option, forming less deterioration of the sugarcanes on storage. An Engine de-trasher suitable for small and medium scaled farmers, is an essential requirement for mechanizing the harvesting of sugarcane to tide over the labour scarcity.*

Keywords: De-Trashing, Sugarcane Harvesting, Sugarcane Trash Remover, Engine Operated De-Trasher.

I. INTRODUCTION

Sugarcane crop plays a vital role in nation's economy, being one of the most commercialized crops in India. It provides income to the sugarcane grower, and employment for numerous farm workers or labours, throughout the year. Sugarcane occupies near to 2.5 % of the gross cropped area in India, which supplies raw material to more than 450 sugar mills. About 45 million Indian sugarcane farmers, their dependents and a large mass of agricultural labourers are involved in cane cultivation. Also, about half a million skilled and semi-skilled workers, mostly from rural areas, are directly or indirectly engaged in the sugar industry. Normal categorisation could be, pre-production of sugarcane, post-production of sugarcane, production of products from sugarcane, post-production sale, export, usage etc. of sugarcane. Sugarcane is grown in two distinct agro-climatic regions: the tropical - Maharashtra, Tamil Nadu, Karnataka, and Gujarat, being the important cane growing states in tropical region while Punjab, Uttar Pradesh, Haryana and Bihar are the four important states growing sugarcane in North India.

Sugarcane harvesting is a critical step that must be well managed to maintain good quality and quantity of sugarcane production. Farmers harvesting sugarcane have a dry leaves-removing step and cut the stem closing to the soil, then cut the top of sugarcane stem. Leaves and leaf sheaths of sugarcane caused delay of harvesting. Moreover, the sugarcane crop that has not been fully leaves-removed could carry some soil, sand and mud, thus damaging the downstream

sugarcane process machine and reduced sugar yield. Farmers who are workerless cannot do sugarcane harvesting during factory operation time. They burn sugarcane in order to eliminate the leaves to speed up the sugarcane harvesting. The burning sugarcane have disadvantages such as overall weight reduction, helpful pathogens get destroyed easily, rapid decrease of sweetness, that organic material and structure in soil get destroyed, high production cost of plant and ultimately decreased sugar production.

Thus, Sugarcane leaf-removing machinery can solve the problems of need of sugarcane burning and reduce contaminants, help speed up sugarcane harvest process, reduce contamination, saving valuable time. However, this also results in, increased sugarcane harvest production.

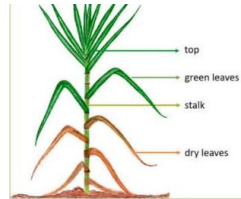


Fig. 1 - Trash content

1.1 Problem Statement

Nowadays agriculture facing a shortage of manpower, need for automating the various activities in the field arises or it is becoming the necessity. For removing the sugarcane dry leaves, traditional practices are very lengthy process. It requires more cost as well as more time, as it takes minimum 2 days to remove all dry leaves of sugarcane in 1 acer of land with 7-8 workers working full day. Now a days, major problem of labour shortage in agricultural sector can be seen. Hence it is essential to manufacture a machine which optimizes the labour cost and time.

1.2 Objectives

1. To design and develop an engine operated Sugarcane de-trashing machine which is universal for all farm conditions.
2. Cost effective solution for sugarcane de-trashing

II. METHODOLOGY

2.1 Product Concept

The basic idea behind the concept to manufacture the sugarcane trash removal machine is to reduce the labour cost, increase accuracy in work and saving of time, during the actual work. For this requirement, we discussed on the product idea, which is easy to operate, cost efficient and time saving. This is done by thinking, discussing, rectifying on concept, which to and how to apply any mechanism to do such work. Once the mechanism was finalised, which was impact friction method, then basic and initial drawing or sketch of the machine is done.

2.2 Farm Survey

In India there are many types of soil and farm arrangements which can be seen in different locations as per their requirements. To made this machine universal form all types of farm arrangements farms survey is very important aspect. Before designing the machine, we visited 5-6 farms all at different places and different size. We also had a discussion with the farmers about their requirement from the machine and the problems facing currently with all that data we calculated the average distance of row (sari) which is about 3.5 - 4 foot and made the design accordingly.



Fig. 2 - Farm survey

2.3 Research

For us, there were two important things to research at research stage: firstly, demand or requirement. If the product solves a problem, are a lot of people looking for a solution to the same problem? For this, research was done by meeting the sugarcane farmers directly, listening the related problems they are facing to do such work, machine tool and asking them that, is there any need of such type of machine. Secondly, are there any products out there already available that are similar to ours? Even if available, is there any unique way to enhance the product or tool?

2.4 Product Design Development

At this stage, development of product design begins. There are a number of things must be considered here:

1. Have a firm idea of product's function.
2. Thinking about how strong and long-lasting the product will be
3. How reliable is the product. What will the manufacturing costs be?
4. Thinking about complexity in manufacture, factoring in how many parts each unit is made from.
5. What are the materials needed for production.

2.5 CATIA Modelling

This process uses advanced 3D rendering software in order to produce and visualise a computer model of final design. This can help to reveal and eliminate any potential or unexpected issues that weren't harmful from the product design, for itself. Thus, the Catia modelling of the sugarcane trash removal machine is done.

2.6 Manufacturing

1. First the MS steel bars are cut into required dimensions. According to primary and secondary members.
2. The basic frame structure is done by welding the bars i.e. primary and secondary members according to the design of machine.
3. The main drive shaft is fitted with the gear and is its end is fitted with arrangement of PTO shaft to connect with Engine.
4. The four shafts are then fitted on outer frame with help of bearings.
5. The ends of shafts are then connected with rollers by means of nut and bolts. The ropes are tied with rollers.
6. Main driving shaft and rotating shafts are then connected by V-belts and pulleys.
7. The entire assembly is the sugarcane trash removing machine.

2.7 Testing and Analysis

The machine is then tested in the required region i.e. in the sugarcane farms. The mechanism and the proper working of machine is analysed, required changes and improvements are done accordingly.

III. DESIGN AND MATERIAL

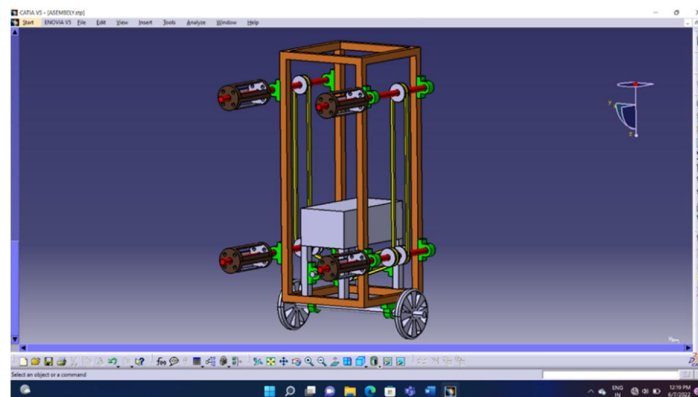


Fig. 3 - Catia Design

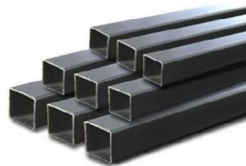
The one driving shaft is connected to engine (prime mover). The power transmitted to shaft from engine which results in rotation of shaft. The Gear is mounted on the main shaft of machine which meshes with another gear on other shaft which is fixed on the frame of machine. Two pulleys are mounted on these shafts one is on main shaft and other on another shaft. There are four shafts mounted on outer frame of machine by using of bearing. Four pulleys are mounted on shaft, one on each shaft is arranged. V-belts are attached connected via pulley between shafts which are interconnected and lower shafts which are mounted on outer frame of machine.

Another two v- belts are attached between outer shafts each for power transmission same as other. At the end of every shaft is attached with rollers which rotate along with shafts which are attached to outer frame of machine. Flexible wire or ropes are attached to these rollers for cutting purpose. Rotation of rollers results in rotation of flexible wires, which are doing impact on leaves to remove the dry leaves of sugarcane. Together this the impact friction method works for de-trashing of sugarcane. Flexible wires attached to rotating rollers that provide a large impact force by the centrifugal force in sugarcane. During this leaf cleaning procedure, the cleaning element works in the situation of large deformation and is subjected to a periodic and dynamic load. Therefore, it is easy to fatigue breakdown.

Rotation of the cleaning shaft in a direction such that the plurality of flexible members contacts a cane stalks and force leaves on a cane stalk in the direction to the base of a sugarcane stalk to remove the leaves from the sugarcane stalk. The equipment separates the top of mature cane, breaking it and removing the dry leaves. It is powered by a petrol engine. This machine has been tested for different varieties of sugarcane farms and for different speeds of rotation of the rollers.

3.1 PARTS LIST

3.1.1 M.S. Square Pipe



Square steel Pipe combines durability, strength and economy, and it is easy to cut, bend or even shape. It has a wide range of sizes and lengths, welded or seamless styles, as well as various finished products and alloys.

Specifications

- Square Pipe Size: 1 inch
- Material: Mild steel

3.1.2 Bearing



A pillow block bearing or Plummer block bearing is a pedestal used to provide support to a rotating shaft with the help of compatible bearings & various accessories.

Specifications

- Bearing Type:- Pillow Block Bearing
- Bore size:- 19 mm
- Material:- Cast Iron

3.1.3 Shaft



Shaft is a rotating machine element is usually circular in cross section, which is used to transmit power from one part to another as same.

Specifications

- Shaft:- Round
- Material:- Mild steel
- Shaft Diameter:- 19 mm

3.1.4 Pulley



V Grooved Pulley also called as v belt sheaves are devices which transmit power between axles by the use of v belt. A mechanical linkage with trapezoidal cross section. These devices offer a high-speed power transmission

Specifications-

- Pulley Type:- V Grooved Pulley
- Size:- 2-inch, 4 inches
- Material:- Cast Iron

3.1.5 V- Belt -



V Belts are made up of rubber with fabric cords to transmit power and it's covered with a protective layer. It Ttransmit the force from the driver to the driven pulley, thereby transmit the power.

Specifications-

- Belt Type:- V Belt
- Type used:- A, B
- Size:- A29, A34, A69, B49

3.1.6 Spur Gear -



Spur gears or straight-cut gears and it is simplest type of gear. This gear is used to transfer power in anticlockwise direction.

Specifications-

- Gear:- Spur Gear
- Size:- 3 inches = 76.2mm
- Material:- Mild Steel

3.1.7 Engine -



Bajaj Platina 100 bike is powered by 102 cc engine. This 102 cc engine generates a power of 7.9 PS @ 7500 rpm and a torque of 8.3 Nm @ 5500 rpm

The output of Engine is transmitted to Shaft via chain drive. After that the power is given to ideal shaft via pulley and belt drive. The output of the ideal shaft is given to the main shaft of the machine. This main shaft rotates in clockwise direction. This motion of the shaft is reversed by using gear train and after that the power is given to the output shaft. The wire holder is mounted on the output shaft. The polypropylene wires are attached on the wire holder. And these wires give impact on the dry leaves of sugarcane.

3.1.8 Wire Holder



Wire holder can be seen in above fig. This is a custom-made wire holder/ roller made up of Mild Steel. Main purpose of this wire holder is to hold polypropylene wires which will be rotating at high speed. 4 rectangular plates were attached to the circular metal plates. This whole component is being rotated with respect to the output of the machine shaft. Speed of this component can be changed using gear arrangement which is same as to output of the machine.

3.1.9 Polypropylene Wire



Polypropylene material is in many aspects similar to polyethylene in both physical and electrical characteristics. Polypropylene is reasonably economical. It is used for cutting grass and leaves. These wires will be fitted on the wire holders which will act as cutter. And this is used for dry leaves of sugarcane.

3.1.10 Sprocket -



The sprocket is used to transmit the output power of engine.

3.1.11 Chain -



These are the most commonly used chains. These chains are used to connect and transfer power from engine shaft output to idle shaft sprocket.

3.1.12 Tyre -



A tyre is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface on which wheel travels.

3.2 Final Model



3.3 Result

Once the manufacturing is completed, the machine was tested in required region i.e. in the sugarcane farm and proper working was analysed in 3,4 lanes of sugarcane. 90% of dry leaves were separated from the sugarcane and was lay downed on the ground. Sometimes dry leaves can get stuck in wire holder which can be removed manually. For covering 1 acer of land, approximate 12 litres of petrol are being required and the time of 3-4 hrs is being required considering all the parameters i.e., human capacity, farm structure, amount of trash, etc. Maximum two workers are enough to manhandle this machine. It optimizes the cost of labour and time required

IV. CONCLUSION

The Sugarcane Trash removal machine is smartly designed and fabricated, as per need. After the test, it is found that the 90% of leaves are lay downed in small pieces without harming sugarcane. By using this mechanism, problem of the leaves de-trashing from sugarcane is reduced. For the entire operation, only two labours are required, when compared with manual de-trashing. Hence it reduces most of the de-trashing time and labour required to operate the machine is also less. This reduces the labour cost and process becomes easier and faster. The productivity is also increased. If the machine is used by maximum number of farmers, definitely farmer can overcome the labour shortage problem.

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