Design And Fabrication Of Portable Sugarcane Harvesting Machine

S. Shankar, C. Maheswari, R. Gowtham, P. Kiruba, K. Mohansrinivas

Abstract: In today's world, the human population is increasing a lot. Due to this, there is a need for large-scale production of agricultural products. There is a huge demand of sugar and its by product. For the cultivation of sugar, the human daily wages are more than the total profit of the cultivation. The major sugarcane growing states are Maharashtra, Uttar Pradesh, Tamil Nadu and Karnataka. This work aims to design and fabricate a small scale portable sugarcane cutting machine for harvesting sugarcane's to reduce farmer's effort and to increase the production of agricultural goods. Compared to manual harvesting, this machine has a capacity to cut canes in faster rate and in economical way. This work helps in laying design foundation for any aspiring user to fabricate a machine for application in their farms. Agricultural harvesting requires maximum man power, ample money and also more time- consuming process. In cutting process, it faces various problems and these are not easily solved. The design of this machine is very simple also easy to implement. Sugarcane Cutting Machine is designed to reduce effort and time. This is user friendly cutting machine; anyone can handle this machine in any working condition. Skilled persons aren't required for operating this machine.

Index Terms: Agricultural need, impact on modern machines, cultivation and harvesting techniques.

1 INTRODUCTION

In India, Agriculture becoming a serious challenge due to water scarcity and labour issues in peak seasons as well as in normal periods. Most of the people are not willing to work in the agriculture field due to several reasons. This is mainly because of non-uniform employment opportunities with low salary, higher salary package induces the people to shift into cities and the society consider the farmers and farming status as low status. Sugarcane is one of the largest crop productions in the world declared by Food Agricultural Organization (FAO). The total cultivation of sugarcane is about 23.8 million hectares in more than 90 countries and it is about 1.69 billion tons in the worldwide. According to the recent survey, Brazil was the largest producer of sugarcane among the world and India secures second position in sugarcane production. Harvesting is the process of removing the crops from the soil and gathered the mature crops from the soil. The machine which is used for harvesting process is called harvester. There are various types of harvesting machines available in the world market namely potato harvester, paddy harvester, wheat harvester and tea harvester. The above types are mainly used for small scale production and the harvesting machines are also available except the sugarcane harvester. Most of the foreign nations are practicing agricultural machineries (Sánchez 2011, Caryn Elizabeth Benjamin 2002, Price et al. 2011) but the survey says that only about 30% of the machines are used by the Indian farmers (Sharma and Prakash 2011). Usually Indian farmers are practicing manual method for harvesting the sugarcane (Jain et al. 2013). This work aims to change this situation by introducing low cost sugarcane harvester to Indian farmers.

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2 LITERATURE REVIEW

Siddaling and Ravaikiran (2015) proposed a theoretical concept about a sugarcane harvester with an economical and efficient. Their work used the gasoline engines for power supply to drive the front blade. The machine can harvest up to 3 tone sugarcane per hour. Moontree et al. (2012) developed a sugarcane harvesting machine which can be operated on 180 HP (134.28kW) at 2500 rpm. The result reveals that the investor can payback his money within 2 years compared to the normal methods. Akash Chougule et al. (2013) discussed about the various sugarcane harvesting process and also explained the advantages and limitations of using sugarcane harvesting process. This work clearly explains the challenges faced in harvesting process. Joby Bastian and Shridar (2014) explains about the physical properties of sugarcane. This work clearly ensures the basic dimensions such as diameter, length and row spacing of sugarcane plantation and how the real field would be with sugarcane. Several others worked on fabricating low cost device and none of them available in the market effectively for farmers. From the literature review, it reveals that many of them are working in the sugarcane harvesting machine development. Also, there were many new techniques and developments in the design, quality and efficiency. There are some drawbacks in each research in the proposed sugarcane harvesting system. Till now, no advancements made in producing a portable sugarcane harvesting machine. The primary objective of this work is to design an effective and portable sugarcane harvesting machine to increase the harvesting rate and reduce the required man power. The secondary aim of the project is to reduce farmer's effort and to increase production of agricultural products.

3 SUGARCANE HARVESTING METHODS

In India, there are two types of sugarcane harvesting methods normally are in practice. Both of these methods having several advantages and disadvantages. Figure 1 represents the manual harvesting method. In this method, the harvesting process is done with the help of human labors. This method starts with the flame process. The fire catches only the dry leaves, the remaining part of the sugarcane remains safe. Then the workers start to cut the sugarcane slightly above the ground level. The cutting process is done with a help of knives. The survey says that the skilled labor can cut approximately about 500 kilograms in one hour. Therefore, it is concluded

that manual harvesting process takes 3 days to cut the one-acre land completely and it cost about 30,000-40,000 INR. Limitations of the manual harvesting process are as follows.

- Time consumption
- Shortage of labor
- Efficient work is not done
- Labor fatigue

Figure 1 *Manual harvesting methods*

Figure 2 represents the mechanized harvesting method. In most of the foreign countries, sugarcane harvesting is practicing mainly by mechanized harvesting method. This process will be more effective for large scale production. The cost of this production will be more and it is about 3500-4000 Rupees per hour. The time to harvest one-acre of land is 6-7 hours. This method requires some specification and it follows.

- High initial cost
- High operating cost
- Applicable only on large scale production
- Skilled labors required

Figure 2 *Mechanized sugarcane harvesting*

4 PROPOSED SYSTEM

The proposed project is to make the mechanization of small-scale Sugarcane harvesting machine. It is mainly concentrated for small scale production with low investment. There are huge demands for labour in agricultural field and the proposed methodology will replace the man power completely. The design of this work is more compactable and it looks like a trolley in shopping complex. Controllers such as Arduino and linear actuators are mainly used to fabricate. In the electrical part, the ultrasonic sensors and 4 channel relays are used. The ultrasonic sensor senses the ground level. There are two ultrasonic sensors. One measures the ground level and the other sensor measures the height of the linear actuator. The ground level measuring sensor sends the feedback signal to the Arduino. The Arduino controls the linear actuator. The DC motor which has the capacity to run with 600 rpm and also has the torque of 4.5 kg. The motor is coupled with the linear actuator. A circular cutter which is of 220mm diameter is attached to the DC motor. A 24v battery is used as a power source for the complete set up. The battery has the current value of about 7Amps. When the machine is taken into the field, the ultrasonic sensors starts to send the signals to the Arduino and the linear actuator varies its height depend upon the ground level. Figure 3 represents the electrical and mechanical set up and also the programming sequences of the model. It clearly explains the overview of the work and describes the key features of the harvesting machine. Figure 3 shows all the basic accessories used in fabricating the product. Even an illiterate can be used to operate the portable machine, which will increase the productivity. It consists of controller part, sensor part, mechanical structure and electrical part. All the components will be incorporated and this product will be an new mechatronic system design work.

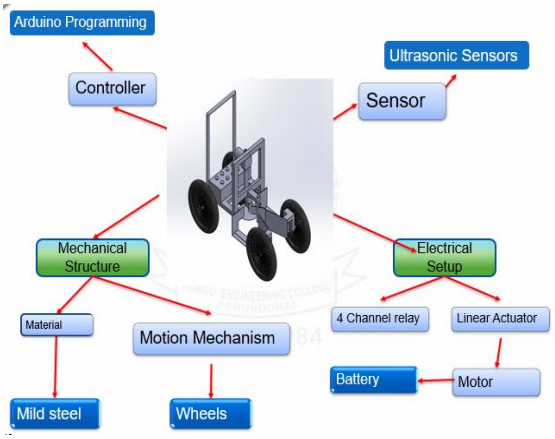

Figure 3 *Basic components of the* ***model***

5 FEASIBILITY STUDY

Feasibility aim to objectively and rationally uncover the strengths and weaknesses of the existing business or proposed venture, opportunities and threats as presented by the environment, the resources required to carry through, and ultimately the prospects for success. The feasibility studies that have done on the work are provided below. From the below cost estimation table 1, it can be determined that the development will be feasible to implement the proposed design in small scale production. Approximately Rs. 7670 will be projected cost to fabricate the portable Sugarcane harvester with all its accessories.

Table 1 *Cost Estimation*

S No	Components	Description	Cost
1	DC motor	12V, 4.5kgcm, 600 rpm	850
2	Arduino UNO	-	350
3	Ultrasonic Sensors (2)	12V	180
4	Circular cutter	-	330
5	Linear Actuator	Voltage : 24v Max load : 12000N Max speed : 6.5mm/s Line length :750mm	3000

6	4 Channel relays	5-12V	350
7	Wheels (4)	-	1000
8	Battery	24V, 7Amps	700
	TOTAL		7670

6. DESIGN CALCULATIONS

Torque is the force that produces rotation. It causes an object to rotate. Torque consists of force acting on distance. Torque, like work, is measured is N-m. However, torque, unlike work, may exist even though no movement occurs. The torque required for the motor is calculated using the specifications available (Lingaiah 2017). Approximately 0.26 Nm torque is required and it can be varied for different future size requirements.

Voltage = 12V
Speed of the motor = 600RPM
Radius of the motor = 14.75mm
Torque = Force x Radius
Mass = 180gm
Force = Mass x Acceleration
= 0.18 x 9.81
= 1.7685N
= 1.7685 * 0.01475
Torque = 0.2599Nm

Thickness (t) = 40mm
Length and Breadth = 800mm × 400mm
Vertical height = 600 mm
Handle of length = 400 mm
Vertical support =400 mm
Horizontal support =400 mm

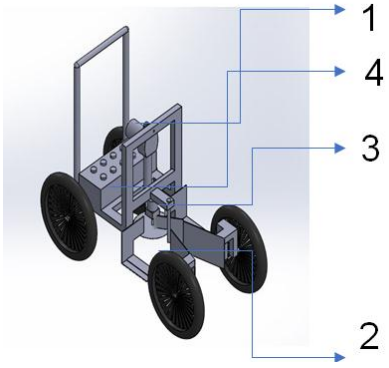

Figure 4 *3D model of the Harvestor*

The 3D model of the proposed work is shown in Figure 4. It consists of 1. Linear Actuator, 2. Circular Cutter, 3. DC Motor and 4.Battery. The components which are used in this fabrication are given below:

- MOTOR
- LINEAR ACTUATOR
- ARDUINO UNO
- RELAYS
- CIRCULAR CUTTER
- MILD STEEL PLATE
- ULTRASONIC SENSORS

The electrical section consists of interfacing ultrasonic sensor, 4 channel relay, DC series motor with Arduino UNO. The sequence of operation to be performed is programmed in Arduino UNO through Arduino IDE (Figure 5).

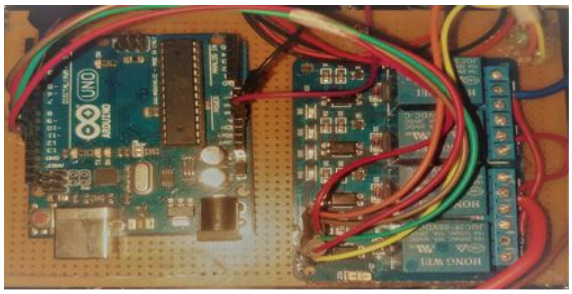

Figure 5 Electrical Setup

The mechanical section consists of wheels, linear actuator, metal plate cutter and mild steel. The process of making the mechanical consists of
drilling process and welding process(Figure 6).

Figure 6 *Fabricated Harvester*

7 CONCLUSION

The developed model reduces the cost of the existing system and also provides eco-friendly harvesting operation. It will reduce human fatigue and increases the harvesting rate in small-scale production. Thus, this system proves to be a low-cost harvester in sugarcane crop production. As the fabrication of the system has been considered with at most care for its simplicity and economy. This prototype cost nearly about Rs. 9000 to 10000 as per the calculation and the payback period for the investors will be 3 months. The designed gasoline operated can be modified with some improvement in the future for system advancement. The main principle working of harvesting method is the cutting process. To increase the harvesting rate motor torque should be increased as well as the dimension of the circular blade.

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