

## DESIGN AND FABRICATION OF SMALL SCALE SUGARCANE HARVESTER

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### Abstract

This project aims to design and fabricate small scale sugarcane harvesting machine for sugarcane harvesting to reduce farmer's effort and to increase production of agricultural products. Machine consists of petrol engine and different mechanisms are used in this machine. When compare 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

**Keywords:** *Harvesting , harvesting methods, harvesting machines, methodology*

#### 1. Introduction

In many countries, sugar cane harvesting is a very labor-intensive activity in which workers usually become fatigued after manually cutting the cane for a few hours. They need frequent pauses for rest, and they experience sustained injuries from excessive stress on the joints and muscles of the body. The cutting tool and motion involved directly influence the stresses created. A cutting tool that has not been designed by taking into consideration

occupational biomechanics can lead to unnecessary strains in the body's muscle system, resulting in injuries. India is a country which is dependent on Farming as a main source of income for many families. Farmers are thus primly important for us. In our state i.e. Maharashtra, crops like Rice, Wheat, Sugarcane grow in majority.

Sugarcanes are important part of it. Nearly 35 to 45 % of field is under Sugarcane only. Thus it is mostly needed to be focused on it. Hand knives, cutting blade or hand axes are used for manual harvesting. It requires skilled labors as improper harvest of cane leads to loss of cane and sugar yield, poor juice quality and problems in milling due to extraneous matter. Aim behind this project is cutting this sugarcane at ground level. Because labor can't cut sugarcane properly at ground level .They cut

sugarcane above the ground level with distance 6" to avoid the strike of the knife with soil. Because of this, it required to cut remaining sugarcane stem after sugarcane harvesting/cutting. It requires extra labor. Cutting of the remaining sugarcane stem is necessary, because its affects the next crop generation.

## 1.2 Sugarcane Cultivation

Sugarcane cultivation requires a tropical or temperate climate, with a minimum of 60 centimeters (24 in) of annual moisture. It is one of the most efficient photo synthesizers in the plant kingdom. It is a C4 plant, able to convert up to one percent of incident solar energy into biomass. In prime growing regions, such as Puerto Rico, India, Pakistan, Peru, Brazil, Bolivia, Colombia, Australia, Ecuador, Cuba, the Philippines, El Salvador and Hawaii, sugarcane can produce 20 lb (9 kg) for each square meter exposed to the sun.

In our region, the Soil is hard and it is Black Soil. The general size of a farm is 1 to 3 acres on an average for each farmer. Some farmers are having more than that. But the land under sugarcane crop is limited. Sugarcane farming has its own methodology. The farm is having alternate peaks and valleys. The peak is known as Ridge while valleys are Furrows. The crop is grown on Ridges. The distance between the successive ridges is called as Pitch and it is generally 2.5 to 4 feet. The sugarcanes grow in a group or bunch. The no. of canes in each group is generally 8 to 12. The distance between two successive groups is kept 3 feet.

Although sugarcanes produce seeds, modern stem cutting has become the most common reproduction method. Each cutting must contain at least one bud, and the cuttings are sometimes hand-planted. In more technologically advanced countries like the United States and Australia, billet planting is common. Billets harvested from a mechanical harvester are planted by a machine which opens and recloses the ground. Once planted, a stand can be harvested several times; after each harvest, the cane sends up new stalks, called ratoons. Successive harvests give decreasing yields, eventually justifying replanting. 2 to 10 harvests are usually made depending on the type of culture. In a country with a mechanical agriculture looking for a high production of large fields like in North America, sugar canes are replanted after 2 or 3 harvests to avoid a lowering in yields. In countries with a more traditional type of agriculture with smaller fields and hand harvesting, like in the French island la Reunion, sugar canes are often harvested up to 10 years before replanting.

## 1.3 Sugarcane Harvesting Methods

There are two main methods of sugarcane harvesting

1. Sugarcane harvesting by manual
2. Mechanical harvesting by sugarcane harvester

### 1.3.1 Manual Harvesting:



Figure 1.3.1.1 : Manual harvesting

Work is done by harvesting sugarcane manually with the help of human labors. Sugarcane is harvested by hand or manually. Hand harvesting accounts for more than half of production, and is dominant in the developing world. In hand harvesting, the field is first set on fire. The fire burns dry leaves, and kills any lurking venomous snakes, without harming the stalks and roots. Harvesters then cut the cane just above ground-level using cane knives or machetes. A skilled harvester can cut 500 kilograms (1,100 lb) of sugarcane per hour. But manually sugarcane harvesting is more labor intensive and as compare to machine harvesting the cutting speed is very slow.

Steps to be taken in Cut and Windrow methods

- (a) It will be detracted
- (b) The base will be cut
- (c) Topped
- (d) Sticks will be placed in a row. Usually 4-6 rows in a single row and put at right angles to the line.

Advantages:

1. Low cost
2. Low soil compaction
3. Low damage to cane roots mostly for use in relatively large cane fields.

### 1.3.2 Mechanical Harvesting

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Figure 1.3.2.1 : Mechanical Harvester

Now days in many countries mechanical sugarcane harvester is used for

sugarcane harvesting. It is fully automated. It requires very less time for cutting sugarcane around large area. Many foreign companies are involved in sugarcane manufacturing like John Deere, New Holland.

1. Harvesting is done by using large mechanical harvester, which cuts the harvest sugarcane in a minimum time.
2. They are applicable only in large areas.

Mechanically Sugarcane harvesting:

Factors which cause sugar cane harvesting done mechanically are as follows:

1. Difficulty in obtaining sugar cane cutters.
2. Cane cutting labor can only work for 8 hours during the day while the sugar cane harvesting machine can work for 24 hours
3. Capacity of sugarcane harvesting machines is much greater than manual cane cutting

(4) The maximum time for sugarcane harvest is relatively short so that the use of sugar cane harvesting machines (Sugarcane harvester), especially in areas with limited manpower, will be able to resolve the harvest activities at a given time, so that losses can be reduced.

Factors generated in the fields where sugar cane harvesting machines operated which affect the efficiency of time and cost of harvesting are the following:

- (1) Slopes
- (2) Shape of the field
- (3) Ridge height and width

- (4) Cleanliness of land from foreign objects.

Mechanical harvesting of sugar cane can be done in two ways:

#### (1) Using Whole stalk Harvester

Whole stalk Harvester cutting the sugar cane in the base of the stem near the soil surface, then brought back and arranged into a windrow for subsequent loading.

#### (2) Using Chopper Harvester

Chopper Harvester's cut the sugar cane at the base and then it is fed into the harvester where the cane is cut again into shorter pieces called billets with a size 20-40 cm.

Each cane harvester has some advantages and disadvantages. Harvesting using a Chopper Harvester will be more profitable than whole stalk Harvester under certain conditions.

The process for a single unit of sugar cane chopper harvester generally be described as follows,

1. Arrange the sugarcane stem in a row into the cane cutters
2. Cut the cane top
3. Shake the sugarcane cut stems to separate the sugar from the soil and sand
4. Cutting the cane into billets
5. Move the billet with conveyor
6. Throw away the trash and light material  
Load the billed for transport.

#### 1.4 Problem Identification :

1. Major problem of sugarcane harvester is soil compaction
2. High initial cost i.e. Rent of this machine is also not affordable in small farmer
3. High operating cost
4. Area required is more for application i.e. it requires more space at starting of cutting and also it doesn't work in small area of farm
5. Size of the machine is very big
6. Time consuming
7. Less profit
8. More labor problems
9. Labor fatigue.
2. Another thing is that the cutting must be very sharp cutting. The cane must be cut quickly and very sharply.
3. The eye should remain below ground level. It should not be damaged.
4. Along with these, there is a situation that the cane should not squeeze while it is being cut.
5. The machine should not damage the crops near to the stem to be cut. The size should be according to this.
6. The cost of a machine satisfying these objectives should be optimum. It should be affordable for a middle class Farmer.
7. Space occupied by the machine should not be so large. It should be kept within the land.
8. The machine should not have excessive weight. It should be such that a single man can operate it very easily.

### 1.5 Aims and Objectives:

The designing of the machine is carried out with some basic objectives. The minimum requirement is to fulfill maximum of them with this machine successfully. Satisfactory performance of this will result into the success of machine. The Objectives are-

1. The main and basic objective is to cut the sugarcane stem at ground level. It is the basic need of cutting as the sugar content in the cane is more at its base.

### 2 Literature survey:

During the 1950s the sugar industries boomed and dramatic changes were taking place within Queensland. In 1954, bulk handling of raw sugar was introduced into Australia replacing bagged sugar and mechanical cane harvester gradually

began to replace manual labor in fields. By late 1960s more than 80% of Australia sugar crops were mechanically harvested. In 1979, Australia achieved 100% conversion to mechanical cane harvesting (Queensland sugar Ltd). Mechanical cane harvesters were developed in a number of countries over the year of Austoft in Australia was one of the 1<sup>st</sup> markets. Austoft is no longer an Australian company and its harvesters are now made in Brazil by case IH. While whole stick system still exist, a more typical harvester tops the crane stalk. Chops the stalks into 25-30 cm billets, separates the billets from the remaining leaves and other trash, and delivers them into a bin or in field transporter for delivery to a nearby rail line or mill.[5]



Figure 2.1:Austoft harvester

Adarsh J Jain designed and fabricated small scale Sugarcane harvesting machine which on testing in the field it is found that the front wheels are struck in mud, due to that the machine was not moving. The machine has a capacity to cut 3.75 ton of sugarcane per hour. Comparing with manual harvesting 50% of harvesting time and 60%

of labors are reduced (in manual sugarcane harvesting 15-16 labors are required).The cost of harvesting is reduced by 34% when compare to manual harvesting. When comparing with the large scale, though the harvesting time and fuel consumption is less in large scale, but the cost machine is very high (1.85 crore) and the cost of the small scale machine is Rs. 30000. So it will be helpful to our farmer. By comparing with manual harvesting, Rs. 10,000 for an acre can be saved by small scale harvesting machine. [1]



Figure 2.2 Sugarcane Harvesting Machine

### Methodolgy

In this project the idea is to make the mechanization of small scale Sugarcane harvesting machine. Different parts of a machine will be mounted on strong chassis. The wheels will be attached to this chassis so that it can be moved in the farm. The petrol engine is mounted on the chassis which provides the power to the wheels to move by means of a gear and chain mechanism and it also provides the power to the cutter. The shaft of the gear box and the shaft which is connected to the wheels are inter connected by means gear and chain mechanism to provide variable speed.

### Materials required

The material for each operations are selected and description of these selected materials are given below

**L-Shape Angle:**

Thickness ( $t$ ) = 7 mm

Section = 35 mm × 35 mm

Section = 35 mm × 35 mm

Total required length = 1.5 m

**Engine:**

2-stroke petrol engine (Bajaj Chetak)

150 cc

**Bevel Gear:**

Two Set of Bevel gears are used

Driver gear teeth = 50

Driven gear teeth = 50

**Shaft :**

Shaft of 40mm

Total length = 840mm

**Cutter:**

Cutter of 300 mm Diameter

**Sprocket:**

a) Driver Sprocket of teeth = 14

b) Driven Sprocket of teeth = 54

**Actual Working:**

The machine is used for cutting stems of the sugarcane. The machine is operated with help of the engine which is basically gasoline engine. Petrol is added with oil. To start the engine first we have to on the petrol switch, after that we have to pull the cable to start the engine. Engine has three shoes that are driven by the centrifugal force, when engine gets started shaft of engine is rotated and the centrifugal force is generated within the shoes. Due to the centrifugal force the shoe get expanded and it will

grips the drum tightly because of this the drive of the engine is transmitted to the cutting shaft through chain and bevel gear and thus cutter will rotated. The bevel gear is converting the drive at 90 degree angle. The speed of cutter is varying with the help of accelerator which is provided on the handle. Then we grip the machine handle take away into the actual field of sugarcane where we want to cut the sugarcane stem then we select a row of sugarcane stems and machine move on this row. After cutting of canes they are taken by worker and leafs are separated with the help of knife. So our machine is fully manual due to that we can adjust the cutting feed of the machine manually. The motion transmission between engine drum and internal transmission shaft is done with the help of splines, after that the cutter is rotated with the help of internal transmission shaft which transmits its motion by using bevel gears. With help of accelerator speed of cutter is controlled.

Figure 2.3 Actual Model

**Results analysis**

The Result is analyzed by comparing manual, small scale harvesting machine and large scale harvesting machine.

SMALL SUGAR HARVESTER	SCALE OTHER CANE HARVESTER	TYPES OF HARVESTER
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This harvester cuts These type of cutters sugar cane system at cuts the stem above ground level. ground level that is 5-6 inches

Only single operator Numbers of labor

can operate the required are more.  
machine easily.

There is less labor There is more labor  
fatigue. fatigue.

No special skill is Skilled operator is  
require to operate the required for operating.  
machine

Initial cost of machine Initial cost of machine  
is very less comparatively more

Operating cost is Operating cost is  
minimum maximum

#### Conclusion

The small scale sugarcane harvesting machine is designed and fabricated. After testing small scale sugarcane harvester in the field it is found that stems can be cut at ground level. The cost of the machine is about Rupees 28,000 and if the farmer buys this machine, farmer can recover the invested money back by harvesting two and half acre. By using this machine problem of the labor crises can be reduced. Comparing with manual harvesting only 3 labors are required. It makes the process faster hence reduces most of the harvesting time and labor required to operate the machine is also less So, it reduces the labour cost. The machine will be used by maximum number of farmers definitely farmer can overcome the labour crises problem. This reduces the labour cost and process become faster and easy. The productivity is also increased.

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