

Design and Fabrication of Small Scale Sugarcane Harvesting Machine

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ABSTRACT- In today's world consisting of huge population due to this there is a need for large scale of production of agricultural products. Agriculture is the backbone of India. In India there is scarcity of labours in agriculture. Day by day labour wages are increasing and in the same way demand of agriculture products are also increasing and today's world need large scale of production of agriculture products due to huge population.

In today's world there is a heavy demand for sugar and it's byproducts. The major states growing sugarcane are Maharashtra, Uttar Pradesh and Karnataka. Now India is the leading producer of sugarcane in the world.

This project aims to design and fabricate small scale sugarcane harvesting machine for sugarcane harvesting to reduce farmer's effort and to increase the output of agricultural products. When compared to manual harvesting, this machine can cut the lower and upper portion of the suger cane containing leaves, simultaneously by setting the optimum movement of the rotary blades.

The advanced technology machines are very costlier and cannot be purchased by a middle class farmers. The maintenance cost of these machines are very high and requires skilled labours to operate. Hence this project work overcomes these problems and aims to develop a small scale sugar cane harvesting machine. And this machine is easy to operate, low cost with more efficiency and having less maintenance. The machine is helpful for farmers and it is economical.

Keywords: agriculture, labors, sugarcane, products, manual harvesting, farmers, machines, low cost

INTRODUCTION:

In India agriculture is facing serious challenges like scarcity of agricultural labour, not only in peak working seasons but also in normal time. This is mainly for increased nonfarm job opportunities having higher wage, migration of labour force to cities and low status of agricultural labours in the society. Sugarcane is the world's largest crop 2010 Food Agricultural Organization (FAO) estimates it was cultivated on about 23.8 million hectares in more than 90 countries, with a worldwide harvest of 1.69 billion tons.

India is the largest producer of sugarcane in the world and Brazil in second position. Harvesting is a process of cutting and gathering of mature crop from the field. Harvester is a machine is used for harvesting. Different types of harvesting machines are available in the market namely paddy harvester, Tea harvester, Potato harvester, Wheat harvester and sugarcane harvester as mentioned above all are available in small scale except sugarcane harvesting machine. Sugarcane harvesting is an agricultural machinery use to harvest and process sugarcane.

Sugar cane is a hardy crop that is cultivated in tropical and sub-tropical regions for its sucrose content and by-products such as molasses and bagasse (the waste fibrous residue). The plant grows in clumps of cylindrical stalks measuring from 1.25 to 7.25 cm in diameter and reaching 6 to 7 m in height. The cane stalks grow straight upward until the stalk becomes too heavy to hold itself up. It then lies on its side and continues to grow upward. This results in a mature cane field lying on top of itself in a mesh pattern. The sugar cane stalks contain a sap from which sugar is processed. Sugar cane is grown throughout the Caribbean, Central and South America, India, the Pacific Islands, Australia, Central and South Africa, Mauritius and the southern United States.

Under favorable conditions and the appropriate use of pesticides and fertilizers, cane grows rapidly. To ensure the maximum sugar content of 1 to 17% of total weight, the cane must be harvested immediately after it reaches its final growth period.

In world the usage of agriculture equipment is increasing. In the usage of agriculture equipment's, India contributes only 10% as shown in Figure 1

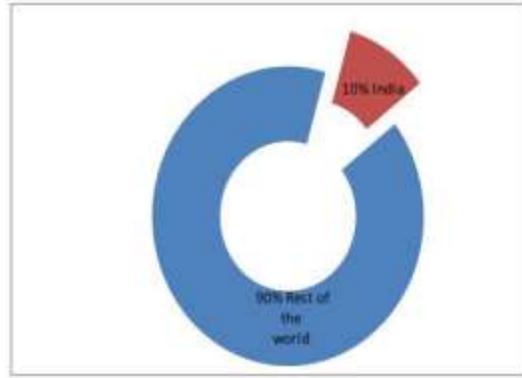


Fig1 : World Agriculture Equipment Market

In areas where hand harvesting prevails, many of the injuries are machete related. These injuries can range from minor cuts to the severing of body parts. Also, the machete is the tool that is most commonly used by the less skilled workers on the farm or plantation. Keeping the machete sharp aids in reducing injuries, since with a sharp machete the worker does not have to swing as hard and can maintain better control over the machete. Working with cane also can very easily produce injuries and cuts to the eyes.

Since cane is grown in tropical and sub-tropical locations, workers also need to be concerned about heat-related health problems. This can be exacerbated due to use of the necessary protective clothing. These regions are also areas of high levels of sun exposure, which can result in various types of skin cancer conditions. Precautions need to be taken to limit or protect against sun exposure.

Pesticides and other chemicals may involve toxic risks that can lead to poisoning through skin absorption or inhalation.

LITERATURE REVIEW

MANUAL METHOD:

In Manual Harvesting to cut one acre of sugarcane 15-16 labours are required they take 3 days to cut one acre and involves harvesting of 60-70 tons per acre with labors being paid 500-550 Rupees per ton of harvest hence total cost of harvesting per acre comes up to 30,000-35,000 Rupees.



Fig2 : Manual Harvesting

DISADVANTAGES OF MANUAL HARVESTING ARE:

- Harvesting time will be more
- Efficient work is not done
- The cost will be more
- Shortage of labour

MECHANIZED TYPE OF HARVESTING:

In mechanization now by using large scale harvesting machine takes about 6-7 hours for harvesting one acre averaging about 60-70 tons with labour costing around 3,500-4,000 Rupees per hour hence the total cost of harvesting per acre comes up to 20,000-25,000 Rupees. The cost of this machine is around 1.2 crore it is not possible to buy the small farmers.



Fig 3: Mechanized harvesting machine

DISADVANTAGES OF MECHANIZED HARVESTING ARE:

- The cost of the machine is high
- The machine is meant for large scale farms
- Requires skilled labour to operate

SUMMARY OF THE LITERATURE REVIEW

After reviewing various journal papers it was found that the existing machines was not economical, having less efficiency and the mechanism involved is complex. To overcome these problems this project work aims to develop low cost sugarcane harvesting machine which is more efficient and having simple mechanism for cutting the sugarcane at a faster rate.

OBJECTIVE OF PROPOSED CONCEPT

To design and fabricate small scale sugarcane harvesting machine which is economical, more efficient and cuts the sugarcane at faster rate. And it will be helpful for small scale formers, unskilled labours can also operate without difficulty.

PROPOSED MODEL



Fig 4: 3D Model of Sugarcane Harvesting Machine

WORKING PRINCIPLE:

The Fuel from the tank is supplied to the Engine and the power is generated to the shaft inside the engine. The driver sprocket which is attached to the engine shaft rotates the driven sprocket through chain drive mechanism. The driven sprocket that is connected to the longer shaft will transmit the power to the either sides of the Bevel gears through the shaft. The longer shafts will be mounted between the two plumber blocks which provide support to the shaft. The rotating Bevel gears are in turn connected to the cutters through vertical rods which rotates the cutters. By this way the small scale sugarcane harvesting machine works. The operations involved are simple and easy to operate.

DESIGN AND CALCULATION

CALCULATIONS OF BEVEL GEARS:

Referred from Bevel Gears of data hand book Gear Design by k Lingaih(old) and Gltln M Maitra Second Edition.

- Shaft angle(Σ) = 90^0
- Pressure angle(α) = 20^0
- Number of teeth on pinion(z_1) = 10
- Number of teeth on Gear(z_2) = 16
- m = module
- i = Gear ratio
- δ_1 = Pitch angle of the driver gear
- δ_2 = Pitch angle of the driven gear
- R_e = Cone distance
- d_1 = Pitch diameter of driver gear
- d_2 = Pitch diameter of driven gear

Pitch diameter of pinion(d_1) = $z_1 m = 10 \times 4 = 40$ mm

Pitch diameter of Gear(d_2) = $z_2 m = 16 \times 4 = 64$ mm

1. Gear ratio = 1.6
2. Pitch cone angle of pinion = 32^0
3. Pitch cone angle of Gear = 58^0
4. formative number of teeth in a bevel gear = 30
5. Dedendum of pinion = 4.912 mm
6. Dedendum of Gear = 6.592 mm
7. Outside diameter of pinion = 38.32 mm

CHAIN AND SPROCKET

1. Length of the Chain, $L = 800$ mm
2. Torque, $T = 18.41$ N-m
3. Power, $P = \text{Engine power} \times \text{Service factor} = 7.46$ KW

SHAFT DESIGN

1. Torque = 9.73 N-m
2. Force = 14.8 N

3. Momentum = 8.8280 N-m

4. Twisting moment $T_e^2 = 12.77 \text{ N-m}$

5. Diameter of shaft = 13 mm

6. Force required to cut the sugarcane by lower cutter

$$F = 78 \text{ N}$$

7. Force required to cut the sugarcane leaves by upper

cutter

$$F = 39 \text{ N}$$

FABRICATION DETAILS



Components required

- Two stroke petrol engine : Selected 98 C.C Kinetic Honda engine with power of 5.741 KW,2000 rpm
- Chain and sprocket : Overall Length 800 mm,driver sprocket 18 teeth and driven sprocket 24 teeth .Distance between two sprocket is 290mm
- Plummer block : 6 units
- Bevel gears : Pinion 10 teeth diameter 40mm,gear 16 teeth diameter 60mm
- Upper cutters: Diameter 500mm,4 blades
- Lower cutters: Diameter 250mm,60 teeth.

RESULTS ANALYSIS

The machine has a capacity to cut 3 ton of sugarcane per hour. Comparing with manual harvesting 50% of harvesting time and 70% of labours are reduced (in manual sugarcane harvesting 15-16 labours are required). The cost of harvesting is reduced by 18% 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. 16000. So it will be helpful to our farmer. by comparing with manual harvesting, Rs. 10,000 acre can be saved by small scale harvesting machine

CONCLUSION

The cost of the machine is about Rupees 16,000 and if the farmer buys this machine, farmer can recover the invested money back. By using this machine problem of the labour crises can be reduced. Comparing with manual harvesting only 18% of labours are required. It makes the process faster hence reduces most of the harvesting time and labour required to operate the machine is also less. This machine is helpful for both small and big farms.

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