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Research Paper

DESIGN AND FABRICATION OF SMALL SCALE SUGARCANE HARVESTING MACHINE

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In today's competitive world there is a need for faster rate of production of agricultural products. Agriculture is the backbone of India. In India almost all farmers facing problems of labour shortage. Day by day labour wages are increasing and in the same way demand of agriculture products are also increasing and today's world need faster rate of production of agriculture products. 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: Design and fabrication, Harvesting machine, Sugarcane

INTRODUCTION

In India agriculture has facing serious challenges like scarcity of agricultural labour, not only in peak working seasons but also in normal time. This is mainly for increased non-farm 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. Brazil was the largest producer of sugarcane in the world and India 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

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sugarcane. Sugarcane is harvested by hand and mechanically.

Disadv antages of manual harvesting are:

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

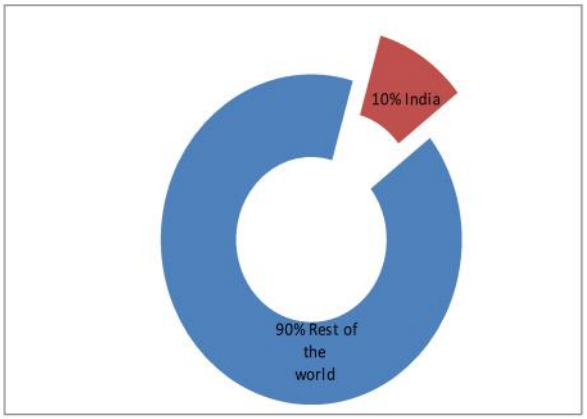
Advantages of machine harvesting are:

- Harvesting time will be less
- Efficient work is done by using machine harvester
- Limited number of labours are required
- Cost of harvesting is comparably less as manual harvesting

LITERATURE REVIEW

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 Conducted survey inyear 2012.

Figure 1: World Agriculture Equipment Market (2012)



Two types are harvesting methods are there:

1. Manual method
2. Mechanized type of harvesting

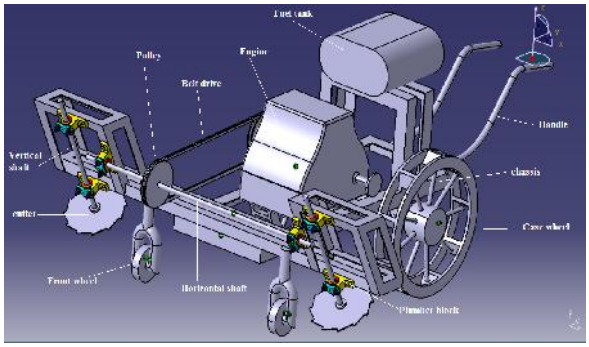
In Manual Harvesting to cut one acre of sugarcane 15-16 labours are required they take 3 days to cut one acre and involves harvesting of 60-70 tons per acre with labors being paid 500-550 Rupees per ton of harvest hence total cost of harvesting per acre comes up to 30,000-35,000 Rupees.

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.

METHODOLGY

In this project the idea is to make the mechanization of small scale Sugarcane harvesting machine.

Figure 2: 3D Model of 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. The pulley is connected to the output shaft of the engine which intern connected to the front pulley which is mounted on the shaft by using belt then by using bevel gear the power is transmitted to the cutter shaft.

DESIGN FOR HARVESTING MACHINE

- Design for power requirement

  $T = F \times r$

  T = Torque of the cutter

  F = Force required to cut sugarcane

  r = radius of the cutter

  T = 18.41 N-m

  P = 3.85 KW

- Design of pulley and belt drive

  v = 31.416 m/s

  A = 125 mm^2

  $d_1 = d_2$

  T_c = 125.75

  T_1 = 289.04 N

  T_0 = 207.459 N

- Calculation for speed of cutter

  $I = n_1/n_2 = Z_2/Z_1$

  $I = n_1/n_2$

  $0.625 = 3000/n_2$

  n_2 = 4800 rpm

- Calculation for speed of wheels

  $i = Z_4/Z_3 = 42/15 = 2.8$

  $i = n_3/n_4$

  $2.8 = 173/n_4$

  n_4 = 61.7857 rpm

- Design for horizontal shaft of cutter frame

  $T_1 + T_2 + W_P = 289.04 + 139.375 + (2 \times 9.81) = 448.035$

  where, T_1 = Tension on Tight side

  T_2 = Tension on slack side

  W_P = Weight of pulley

  $M = F \times L$

  where, M = Moment N-mm

  F = Force in Newton

  L = Perpendicular distance

  R_C = 321.23 N

  R_A = 126.805 N

  M_b = 96371.8 N-mm

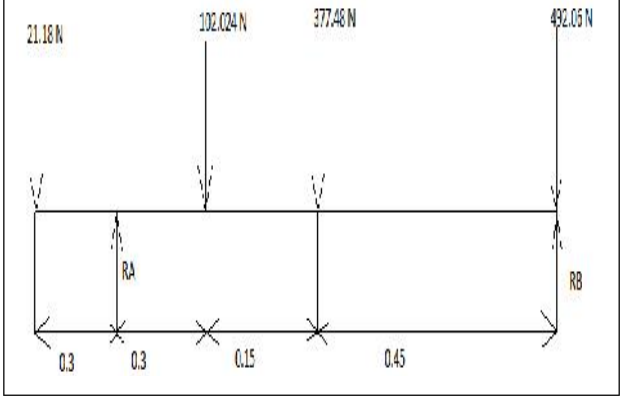
  D = 23.74 mm

- Design for vertical shaft of cutter frame

  R_A = 107.99 N

  R_C = 576.4693 N

Figure 3: Loads Acting on Chassis Frame



M_b = 14038.7 N-mm

D = 20.1521 mm

- Design of chassis

± = 20.23 × 10^6 N/m^2

Z = 3.1cm^3

R_A = 311.67 N

R_B = 681.07 N

- Design of cutter frame

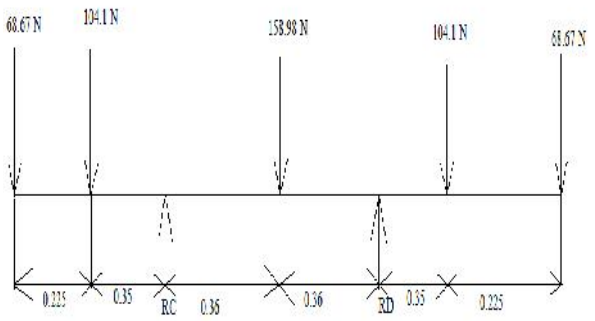
± = 11.21 × 10^6 N/m^2

Z = 3.1cm^3

R_D = 203.944

R_C = 300.57

Figure 4: Loads Acting on Cutter Frame



MATERIALS REQUIRED

After the design calculations the material for each operations are selected and description of these selected materials are given below

L-Shape Angle:

Thickness (t) =5 mm

Section = 55 mm × 55 mm

Total required length = 8 m

Engine:

2-stroke petrol engine (Bajaj Chetak)

150 cc

Bevel Gear:

Two Set of Bevel gears are used

Driver gear teeth = 16

Driven gear teeth = 10

Pulley:

Two pulley each having 200 mm Diameter

Shaft:

A) Shaft of 25 mm

Total length = 1400 + 800 + 800 = 3000 mm

B) Shaft of 30mm

Total length = 75 cm

Plumber Blocks:

a) 2 Plumber blocks of 30 mm diameter

b) 6 Plumber blocks of 25 mm diameter

Cutter:

Two cutter of 250 mm Diameter

Steel Pipe:

Inner Diameter = 18 mm

Outer Diameter = 20 mm

Total length = 120 mm

Fuel Tank:

Capacity = 6 liters

V-Belt:

Length = 81 inches

Thickness = 11 mm

Width = 17 mm

Sprocket:

a) Driver Sprocket of teeth = 15

b) Driven Sprocket of teeth = 42

FABRICATION OF DIFFERENT PARTS OF MACHINES

Chassis frame is the main base of the vehicle on which body is mounted with wheels and machinery. As per the design, marking has done on each angle. As per the marking, angles are cut by cutting machine and holes are drilled on angles by using drilling machine for fixing cutter frame assembly and plumber blocks.

Figure 5: Fully Assembled Sugarcane Harvesting Machine

On the cutter frame cutters are mounted at 20° inclination for efficient cutting. As per the marking, angles are cut by using cutting machine and holes are drilled on the angles by using drilling machine for fixing cutter frame to the chassis by using nut and bolts.

Two mild steel plates are cut as per the dimension and are weld to the chassis frame as per the marking to provide the support. Four plates of 150 mm length are bent to 'L' shape by hammering and hole is drilled on it as per the marking using drilling machine. These 'L' shape bent plates are welded on the previous weld plates as per marking and finally engine is mounted on the chassis frame by inserting the bolt into the 'L' shape bent plate.

A shaft of 30 mm diameter and 750 mm length is inserted to the plumber blocks which is attached to the bottom of the chassis and are fixed by anal key. Two spokes wheels of 60 mm diameter are welded to the end of shaft.

A 25 mm diameter steel pipe is drilled at one end by drilling machine and a case wheel is attached to it by using nut and bolts and another end of the pipe is drilled for connecting it to the chassis frame by nut and bolts.

A shaft of 800 mm length and 25 mm diameter is faced on both side by using lath machine and tapping operation is done on one face of the shaft by drilling 5 mm hole by lathe machine and tapping is made into the hole by tapping tool. The cutter is fixed to the shaft by screwing the bolt through the cutter hole into the tapped hole.

As per design L-angles are cut by cutting machine and are welded on the chassis frame by machine according to the machining. 20 cm steel plates are cut and drilling operation is done on it and it is welded on the previously welded L- angle and finally fuel tank is fixed by nut and bolts.

There are two pulleys, driver pulley is attached to the engine output shaft and the driven pulley is attached to the horizontal shaft of the cutter frame. The driver pulley is attached to the engine shaft by tapping, drilling and screwing operation. Driven pulley is attached by the welding operation. The v-belt is mounted on these pulleys and belt having the specification of 17 mm width, 11 mm thickness and B-section.

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RESULTS ANALYSIS

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

Figure 6: Number of Hours Required to Cut One Acre

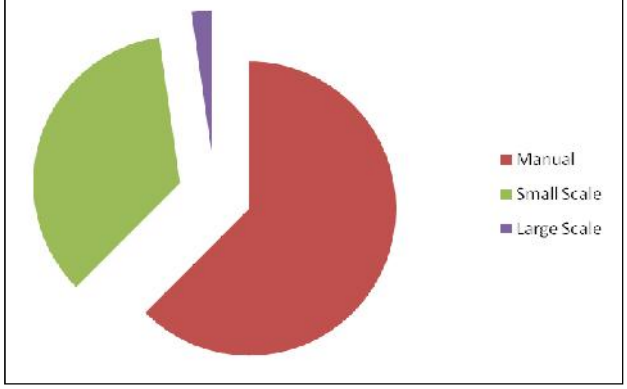


Figure 7: Total Cost of Harvesting / Acre in Rupees

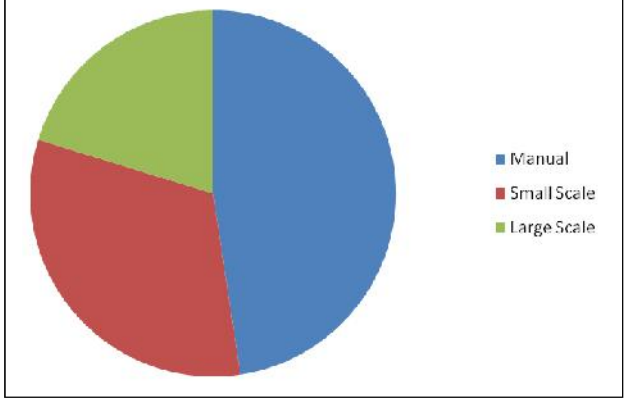


Figure 8: Number of Labors

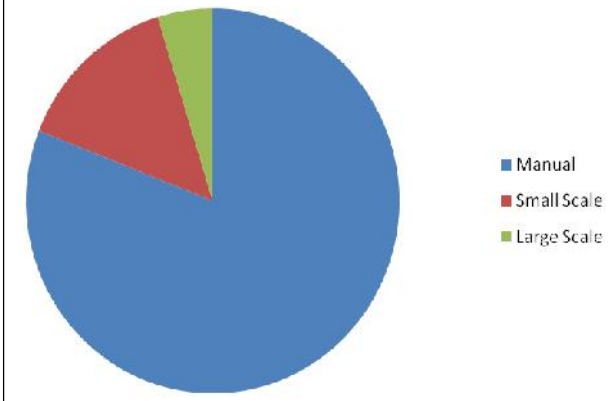
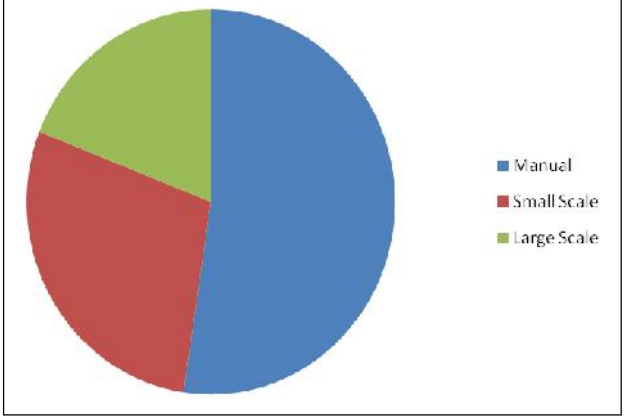


Figure 9: Wages / Ton / Labour in Rupees



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 labours 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 acre can be saved by small scale harvesting machine.

CONCLUSION

The small scale sugarcane harvesting machine is designed and fabricated. After testing small scale sugarcane harvester in the field it is found that the front wheels are struck in mud, due to that the machine was not moving so one more spoke wheel is fixed at the front for the proper and smooth movement of the machine.

The cost of the machine is about Rupees 30,000 and if the farmer buys this machine, farmer can recover the invested money back by harvesting two and half acre. Due to the heavier structure of the cutter frame, the initial tension at the pulley is high and the engine is unable to carry the load in order to start. So jockey pulley is incorporated to reduce the tension at the pulley and to make the engine easy to start. Initially the speed of the cutter was high, so the driver pulley is replaced by the small diameter which reduces the speed with alteration harvester working efficiently.

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. So, it reduces the labour cost. The machine is 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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