Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Design and Development of Sugar Cane Harvesting Machine

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Abstract: ***in today's competitive world there is a need for faster rate of production of agricultural products. Agriculture is the backbone of india. Almost all farmers are facing problems of labour shortage. Day by day labour wages and demand of agriculture products are increasing. This project aims to design and fabricate small scale sugarcane harvesting machine to reduce farmer's effort and to increase productivity of agricultural products. Machine consists of petrol/diesel engine and different mechanisms are used in this machine. Compared to manual harvesting machine harvesting has a higher cutting capacity rate leading to economy. The machine is useful for both harvesting small and big farms.***
Keywords: cutters, tyres, wheel, chassis, handle, frame, sugarcane.

I. INTRODUCTION

India is one of the major agricultural countries in the world. Maharashtra being a major sugarcane cultivating state had majority of labours for harvesting of sugarcane manually, but that was the situation of 10-20 years back. Today, as the demand of sugarcane products like sugar has increased, the cultivation of sugarcane is also increased. But as there has been a shortage of labours for the sugarcane harvesting process, due to which sugarcane which is ready for harvesting is left as it is in the field and dried which affects its quality & quantity of sugar content in it due to delay in supplying to the sugarcane industry. The process of harvesting consists of cutting the cane from bottom, then cutting off its top leaves, making a bundle which consists of 10 to 15 canes each and then carrying it to the trucks and loading it. This entire process is time consuming and requires a lot of hard work and is tedious as it is done manually by labours. When we look at the world scenario, it is found that the fields of sugarcane are extremely huge compared to the Indian farms and hence they use machines for harvesting instead of labours as it is not possible by the labours to harvest the farm quickly. Therefore, labours for harvesting are very rare case. Therefore, it is seen that machines specially for sugarcane harvesting have been built & used and they have worked out to be quite successful. There have been attempts made to make use of these harvesters in India, however, the attempts turned out to be unfavourable to the small size farms and land quality of our farms. Hence, till today also very few sugarcane harvesters are used for helping in the process even though a need is arising due to scarcity of labourer's and an increase in demand for a faster and more profitable output of farmers. 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 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. As per 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 in 2010. 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.

II. DESCRIPTION

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 machine is pushed through the field manually to perform cutting action. The guides/ram is provided in front of machine to lift abruptly grown sugarcane. Ergonomics is given importance as it involves pushing action. The cutter is driven with the help of belt and pulley arrangement. The pulley is mounted on the shaft of the motor which drives another pulley and shaft arrangement to which cutter is

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attached. V-belt is used to avoid slip factor. Following Fig. shows the model of the machine.

III. CALCULATION

Base frame: We design a basic frame for a prototype by mild steel channel (L beam),

L Channel- MS Angles are L-shaped structural steel represented by dimension of sides & thickness. For e.g. 25x25x3 means, both the sides of angles are 25mm & thickness is of 3mm. There are various sizes of angles which are as follows :-(there are also equal & unequal angles). Equal angles: - They are angles having both the sides of equal dimensions. For e.g. refer below given diagram, in which both the sides are of dimensions “a”. The L-angle bar dimensions fig. is given below

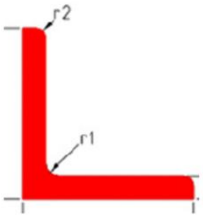

Fig. L-angle bar dimensions

Sizes with Section Weight Of Equal Angles

Size	Weight in Kgs.	Thickness
in mm	Per mm.	in mm
20x20x3	0.899x10^-3	3
25x25x3	1.099x10^-3	3
25x25x5	1.798x10^-3	3
31x31x3	1.280x10^-3	3

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By standard available sizes we select is 1 inch= 25 mm so because that will be easily available and have appropriate size for frame.

A. Design Of Frame Safety

Frame design for safety FOS 25*25*3 L angle mild steel channel
b = 25 mm, d= 25 mm, t = 3 mm.
Consider the maximum load on the frame to be 50 kg.
Max. Bending moment = force*perpendicular distance
= 50*9.81*15o
M = 73575 Nmm
We know,
We must calculate inertia of L angle cross section

$I=\frac{b1h1^3}{12}-\frac{b2h2^3}{12}=\frac{25\ X\ 25^3}{12}-\frac{22X22^3}{12}$ = 13030.75 mm^4

So, maximum bending stress is calculated as,
σb = My / I
= 73575*12.5 / 13030.75
σb = 70.57 N /mm^2
The allowable shear stress for material is σ_{allow}= Syt / fos
Where Syt = yield stress = 210 MPa = 210 N/mm^2
And fos is factor of safety = 2
So σ_{allow}= 210/2 = 105 MPa = 105 N/mm^2
Comparing above we get,
σb<σ_{allow}i.e. 70.57<105 N/mm^2
So, design is safe.
Cutting force-
The force required for cutting the pipe is calculated as follows,
Cutting force, Fc= S×t×l
Where,
F_c = cutting force
S=shear strength of cane = Sut/ FOS = 15 MPa / 2 = 7.5 MPa = 7.5 N/mm^2
t= thickness of sugarcane to be cut (for 1 inch diameter stem) = 25 mm
l= length of cutting edge (i.e. cutting blade thickness) = 2 mm
Then,
Cutting force, Fc= S×t×l
= 7.5×25×2 = 375 N.
Specifications of cutter
Power Source: - AC 240 V
Motor Speed: - 10000 rpm
Power Consumption: - 850 watts
Voltage: - 240 V
Disc Diameter: - 3.93 inches = 100 mm
Weight: - 1.8 Kg
Torque is calculated as
P = 2πNT /60
850 = 2*3.142*10000*T/60
T= 0.81 Nm
The conceptual CATIA model is given below

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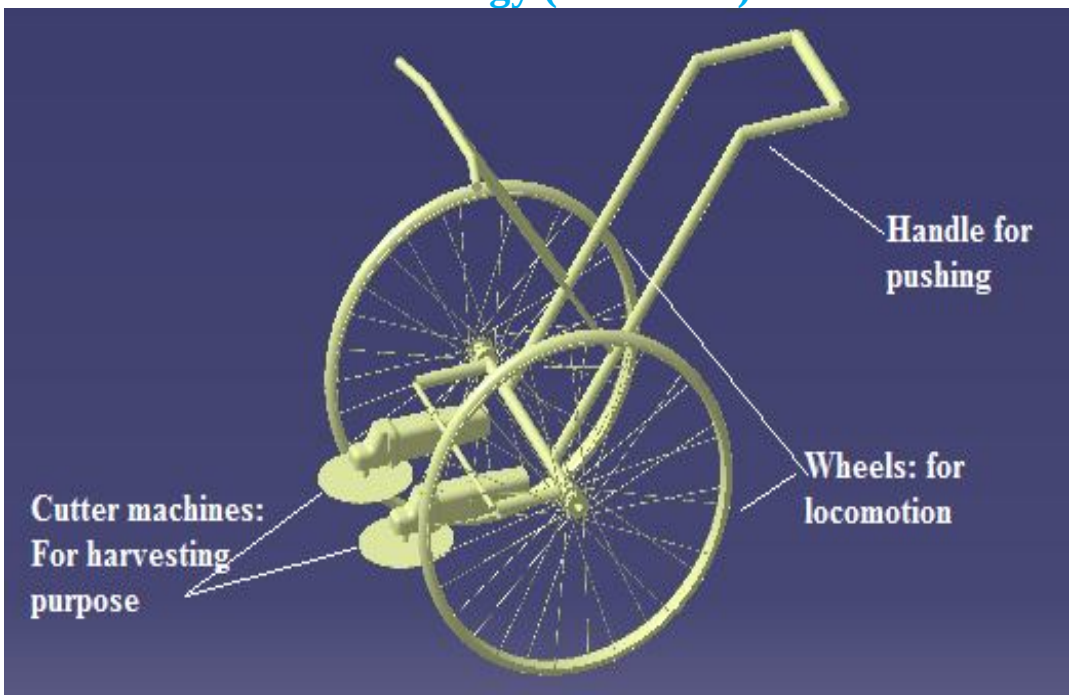
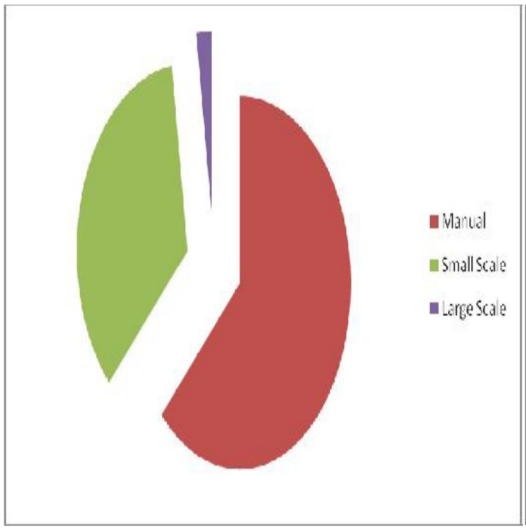


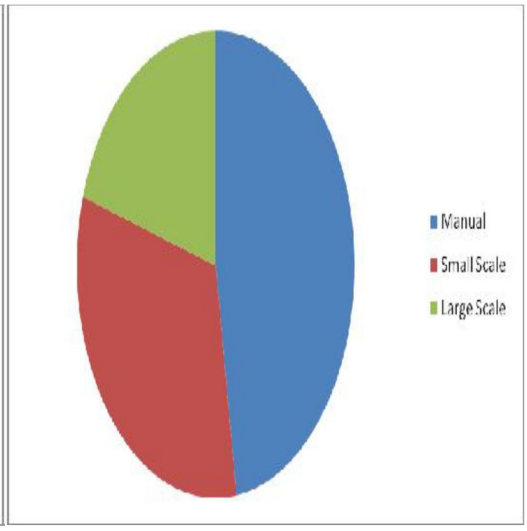
IV. RESULT

The Result is analyzed by comparing manual, small scale harvesting machine and large scale harvesting machine. 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 acre can be saved by small scale harvesting machine.

The figures given below gives us the information about hours required to cut one acre, total cost of harvesting, number of labors and wages/tons/labors in manual, small and large scale sugar cane harvesting;



Number of Hours Required to Cut One Acre



Total Cost of Harvesting/Acre in Rupees

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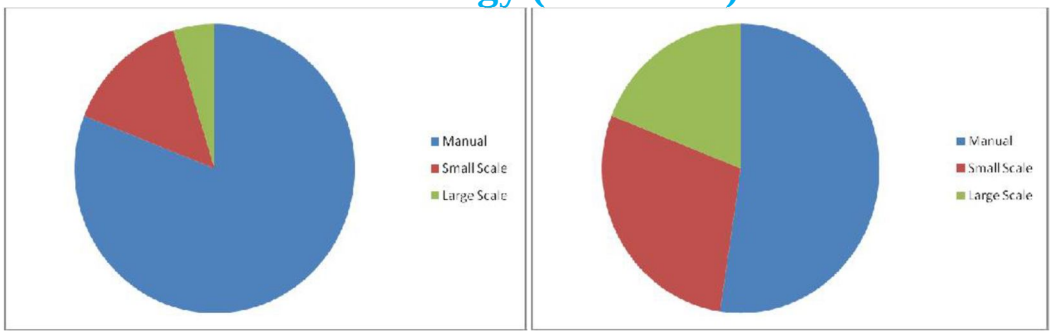

Number of Labors Wages/Ton/Labour in Rupees

V. CONCLUSION

The sugarcane is very important crop in our country. The sugarcane water level continuously decreases once it being harvested. So, it is very important to move it to market as soon as harvested. So here we designed a sugarcane harvesting machine which can cut sugarcane with required force and in limited time without using skilled labour for the operation. This machine is cost efficient and operating cast is also less.

VI. ACKNOLEDGEMENT

We express our deepest gratitude to our Guide and Mentor Dr. V. SINGH, Professor and DR. K. K. DHANDE, H.O.D. for their guidance and support during the entire project work. Their consistent supports and advices have helped us to complete this project successfully. We would like to thank all the professors of Department of Mechanical Engineering for their support. They have always been a source of inspiration to us. We take this opportunity to thank Dr. P. D. PATIL, Principal for providing necessary facilities.

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