Design and Development of Manual Drawn Mini Sugarcane Harvester

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Abstract-*Most of the agricultural lands in India are held by farmers as marginal (0.5-1Ha) and small scale (1-2Ha) land holders. when it comes to adopting machinery they fail to purchase due to heavy cost. The cost of sugarcane harvester is up to 1.3 to 2 cr. A small farmer is not having the capacity to buy the sugarcane harvester at that price. As a result they fail to get required quantity and quality of product. Specially in case of crops like sugarcane, mechanization plays a vital role. Hence for small scale land holders we have developed a harvester using rotary cutters and blades to cut the straw and stem respectively. By this we can reduce the cost of sugarcane harvester to a minimum of around Rs.15000 – Rs.20000*

Keywords-character recognition, character segmentation, Number plate detection, Toll collection, Vehicle number recognition.

I. INTRODUCTION

Agriculture is one of the most significant sectors of the Indian Economy. Agriculture is the only means of living for almost two thirds of the workers in India. The agriculture sector of India has occupied 43% of India's geographical area, and is contributing 16.1% of India's GDP. There are number of crops grown by farmers. These include different food crops grown in India.

Sugarcane (Saccharum Officinaram) has been known from the earliest times even before the Christian era and ancient civilization. India is a home of thin class of canes.. India is the second largest producer of sugarcane in the world and Brazil in first position. India is produce 351 million tons of sugarcane and 28 million tons of sugar in 2014-15,(htto://www.ikisan.com/links/ap_sugarcane).

Approximately 80% of the world's sugar is produced from sugarcane in tropical and subtropical climates, with the remaining 20% derived from sugar beet, which is grown mostly in the temperate zones of the northern hemisphere. 70 countries produce sugar from sugarcane, 40 from sugar beet and 10 from both.

In India's sugar production increased to 11.5% during the 2014-15, season on bumper cane production , the world sugar production amounted to approximately 175.1 million metric tons. Asia was the largest sugar producing region in the world, yielding approximately 66.12 million metric tons of sugar. India, China and Thailand where the region's top sugar producer,(www.business-standard.com).

Justification

In manual harvesting to cut one acre of sugarcane 15-16 labours are required they take 3 days to cut one acre. By using this machine problem of the labour crises can be reduced. Comparing with manual harvesting only 18% of labour 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 farmers.(Ratod et al,2013).

To overcome these problems this project work aims to develop low cost sugarcane harvesting machine which is more efficient and having sample mechanism for cutting the sugarcane at a faster rate.

The purpose of developing this machine is to reduce cost and time required for sugarcane harvesting. Sugarcane harvesting machine which is economical, more efficient and cuts the sugarcane at faster rate and it will be helpful for small scale farmers, unskilled labour can also operate without difficulty. By using this harvesting machine, we can also solve the problem of labour shortage. Considering above factors, this project is under taken to fabricate a low cost sugarcane harvesting machine with following specific objective.

1. To study the physical properties of sugarcane.
2. To design and develop a sugarcane harvester.

To evaluate performance of the developed machine.

II. REVIEW OF LITERATURE

Various harvesting practices are used in sugarcane production, each requiring different harvesting technologies to ensure effective and efficient field operations. The cited findings are presented in this chapter under following heads:

Braunbeck et al. (1999) determined the green cane harvesting process, without pre conditioning such as burning or removing leafy materials before harvest. A mechanical device was used to separate leafy materials. The residues left in the field could help to control weeds , reduce soil moisture loss and decrease soil erosion. Viator and Wang (2011) studied that green harvesting method can also have negative effects on cane yield in certain environments because the trash layer can lower the soil temperature, which can slow down plant growth and increase the risk of frost damage in young plants during freeze or near-freeze events summarizes the weakness of green cane harvesting practices. Sandhu et al. (2011) showed that the green cane harvesting method could reduce lesser cornstalk borer damage to sugarcane because the trash blanket can inhibit the egg deposition and increase the larval mortality.

King et al. (1953) found that the procedures have been using sugarcane burning as a standard pre harvest practice throughout the worlds since the industrial revolution because it loads to reduced pest stress and reduced pest stress and reduced load for top and trash handling.

Deepchand (1986) determined the burning process, fire is set in a confined predetermined field, which burns off leafy extraneous materials, including stalk top and dry leaves. Sugarcane composition Showed that the amount of the leafy materials constitute about 37% of whole cane plant dry matter and about 42% of cane plant dry matter above the ground. Pre harvest burning burns off about 80% of cane leafy materials leading to 30% to 40% improvement in harvesting productivity.

Cancado et al. (2006) reported that, pre-harvested burning has become one of the most sensitive environment issues faced by local communities and public pressure against cane burning is also increasing worldwide because of growing environmental and health concerns. It has been reported that cane burning.

III. METHODOLOGY

This chapter deals with the design, development and performance evaluation of light weight engine operated sugar cane harvester. The machine was designed and development to suit the Indian conditions. The various factors involved in the design were operational safety, cost of production and availability of spare parts and case of construction. The operation and adjustments were made simple so as to be used by the farmer.

Theoretical design

Frame: a suitable frame of suitable strength and according to the row spacing..The bending moment of frame suppose the frame was simply supported therefore the

$$B.M= \frac{wl}{4}$$

Where ,

B.M = bending moment ,kg-cm
W = total weight on frame, kg
L = total length of frame, cm

Simply design stress(working stress) of the frame can be calculated as:

$$\textbf{Working stress} = \frac{\text{ultimate stress}}{\text{factor of safety}}$$

Selection of power source

The cutting force required to cut one cane is 106.57N. (**Zode *et al***.2015). calculation of power required for sugarcane harvesting is given below

$$T= Fr$$

Where,

T= torque of the cutter , N-m
F= force required to cut sugarcane, N
R= radius of cutter ,m.

Length of the chain:

$$L=2C+\pi\times(D_1+D_2)/2+(D1 + D2)^2/4C$$

Where ,

L= length of chain, mm;
D_1=diameter of driver pulley, mm;
D_2= diameter of driven pulley, mm;
C= center to center distance of belt, mm.

Transmission ratio

$$=\frac{T2}{T1}=\frac{N1}{N2}=1$$

Torque on the counter shaft

$T_c= T_e \times L$

Where,

T_c= torque on counter shaft, Nm
T_e= torque on engine shaft, Nm;

Design of horizontal shaft

$$\frac{N2}{N3}=\frac{D2}{D1}$$

Where,

N_2= revolutions of driver pulley,

N_3= revolutions of driven pulley,
D_1= diameter of driver pulley;
D_2= diameter of driven pulley.

Torque on the horizontal shaft.

$T_h = T_c \times$ transmission ratio
$T_h = Tc \times 1$
Where,
T_h= torque on horizontal shaft, Nm;
T_c= torque on counter shaft.

Design of vertical shaft

$$\frac{N3}{N4} = \frac{T4}{T3}$$

Where,
N_3= revolution of driver gear;
N_4= revolution of driven gear;
T_3= no. of teeth of driver gear;
T_4= no. of teeth of driven gear;

Speed of cutter:

Shear force required to cut the wood is found to be 450N .Shear force required to cut the sugarcane is 106.57N. (zode et al.2015). so, shear force required to cut sugarcane is less than the wood cutting. Pulley is mounted to the output shaft of the engine and through the chain drives the power is transferred to the horizontal shaft of cutter assemnbly, bevel gear ia used tp transfer the power from horizontal to vertical shaft of cutter assembly.

$$\text{Gear ratio} = \frac{n1}{n2} = \frac{z2}{z1}$$

Where,
Z_1= bevel gear, driver pinion;
Z_2=driven gear, driven pinion;
N_1=speed of vertical shaft;
N_2= speed of cutter

Frame

Frame is made up of 1 inch thick angular iron .
The dimensions of the frame are as fol0ows
Length = 42inch or 107 cm
Width = 36inch or 92cm
Height (front) = 15inch or 38cm
Height (back) = 20inch or 51cm

Cutters:

Bottom cutters are adopted from wood cutter blades.
Cutters are made up of cast iron .
The dimensions of the frame are as follows
Diameter = 8 inch o
No of Teeth = 40
Top cutters are made with angular iron having three blades.
Bevel gears

1. Larger bevel gear teeth: 16
2 Small bevel gear teeth : 10

Sprocket wheel:

1. Sprocket wheel teeth: 44
2. Sprocket wheel dia : 7inch or 17cm.
3. It has given with a soft Waller having four pockets to hold the sprocket and its diameter is 5inch.

Engine details: TVS XL super
69.90cc
66kg weight
Bhp: 3.50 (maximum power)

Bottom Cutting Width adjustment:

As most of the farmers don't follow the regular spacing between the rows, we have provided cutting width adjustment by mounting the bevel gear assembly on a shaft and clamped by attachable and detachable bolt and nuts to adjust the spacing between the two vertical cutters. There is a minimum of 20cm -30cm width adjustability in they harvester.

Cutting height adjustment:

There are various varieties of sugarcane grown around us with varying heights. We have drilled holes to the vertical shaft, and a proper alignment makes the height adjustable.

IV. RESULTS AND ANALYSIS

The sugarcane is having the height of 8 to 9 feet in some areas the height is more than 10 feet. In that total sugarcane the sugar content is high at the bottom , and the sugar content is low at the top portion of the sugarcane. At the top of the sugarcane we have observed that there are long leaves and heavy straw is present, at the bottom the sugarcane is having the root system above the ground upto a height of 5 cm from the ground level. So here we have to cut the intermediate portion (From the top to the bottom) of the sugarcane. By this we don't loose the sugar content which is present in the particular sugarcane.

Top cutting of sugarcane

At the top portion of the sugarcane the long leaves and straw are present, these will be cut by the long blades which a present at the top of the harvester. In some cases the height of the sugarcane will be varies.

So here we are arranged the adjustment of height of the blades up to a height of 3 feet. These blades are tn the shape of fan. Due to rotation of the shaft these blades will rotate and they will cut the top portion of the sugarcane.

Bottom cutting of sugarcane

The sugar content is high at the bottom of the sugarcane. At the bottom portion of the sugarcane the roots are present i,e the roots of the sugarcane are also visible and are present at a height of 5 cm from the ground surface. At the maturity stage the bottom portion of sugarcane stem is having the high diameter . At the peak maturity stage the sugarcane is heaving high sugar content.

In this project we have arranged the rotary cutting blades at the bottom of the harvester to cut the bottom portion of the sugarcane. Due to the rotary motion engine power wheel the shaft will rotate, these shafts are connected to the bevel gears, these bevel gears will transfer the rotary power to the top and bottom cutters. the bottom cutter is having sharp cutting edges and having 40 sharp teeth. this will take 10 seconds to cut the sugarcane having a maximum diameter of 4 cm.

Theoretical field capacity=$\frac{s\times w}{10}$

W=width of the cutting=0.11m

S=speed=1.5 km/h

TFC=$\frac{01.5\times 0.11}{10}$ = 0.0165ha/hr

Effective capacity

Losses are considered as 20%

EFC=$\frac{s\times w}{10}\times\frac{Ef}{100}$

=0.0165×0.8=0.0132ha/hr

Field Efficiency=$\frac{Effective\ field\ capacity}{Theoritical\ field\ capacity}\times 100$

=$\frac{0.0132}{0.016}\times 100$

=80%

V. CONCLUSIONS

Harvesting of crop is one the important agricultural operations, which demand considerable amount of labour. The availability and cost of labour during harvesting season are the serious problem. Timely harvesting of the crop is vital to achieve better quality and higher yield of the crop. The shortage of labour, during the harvesting season and vagrancy of the weather cause great losses to the farmers. It is therefore, essential to adopt the mechanical methods so that the timeliness in harvesting operation could be ensured and field losses could be minimized and consequently the productivity could be increased. The available commercial sugarcane harvester has high initial cost i,e rent of this machine is also not affordable by small farmers.

Therefore developed a light weight engine operated sugarcane harvester, reduces cost and time required for sugarcane harvesting. 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 it without difficulties. It was found that this machine solve the problem related to the shortage of labour with the following objectives.

1) To study the physical properties of sugarcane.
2) To design and develop a sugarcane harvester and
3) To evaluate performance of the developed machine

Suggestions for Feature Work

Based on the feed back of from the field test it was to be appropriate that the harvesting machine may be further refined to make it versatile for multipurpose use on the following aspects.

1) The machine may be further tested for sweet sorghum.
2) Effects may be tried to reduce the weight of the harvester.
3) Study of the stability of the machine should be carried out in future.

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