Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 03, March -2018

Low Cost Sugarcane Bud Chipper

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Abstract — *Sugarcane is a crop of highest importance especially in a country like India where over 45 million people are practicing it and a majority of them are small scale farmers. To facilitate sugarcane cultivation highly sophisticated machines have been developed but however these machines cannot be afforded by small scale farmers. Hence it is required to develop a machine that can yield better results, provide high profits but still costs low on price and is simple in construction. Also in conventional method of sugarcane cultivation, the sugarcane is cut into pieces and is buried. However, only the bud alone is required enough for cultivating sugarcane. Our machine design facilitates the cutting of bud alone from the sugarcane and saves time compared to that of manual and other cutting processes. Our machine makes use of combined operation of a motor connected to a rotating circular disc which is further connected to a shaft which facilitates the reciprocating motion of a perpendicular cutter over the sugarcane, thus facilitating smooth cutting of bud from sugarcane. This design aims at simplifying the bud removal process by making use of the above mentioned machine which requires minimum human labour, less capital investment and saves time thus proving to be a profitable investment for every farmer*

Keywords- *Bud Chipper, Cultivation, Farming, Sugarcane.*

I. INTRODUCTION

Sugarcane is a crop of very high value in the present context of food and fuel crises. It is the most important sugar crop in the world. Presently it is considered as a multi-utility crop useful for producing sugar, ethanol, fibre, co generation of power, and a host of downstream products .It is one of the crops that will have to be increasingly depended upon by the humankind for its survival .Hence growing more sugarcane will be of great concern. Adoption of right and efficient technologies help in realizing higher yields of cane and sugar.

In India sugarcane is one of the important commercial crops. Sugarcane is the main source of sugar in Asia and Europe. Sugarcane is an important commercial crop of the country occupying around 3.8 million hectares of land with an annual cane production of around 270 million tonnes. That is, it occupies about 2.8% of the cultivated land area and contributes about 7.5 % to the agricultural production in the country. Sugarcane is also the raw material for the production of white sugar, jiggery (gur) and khandsari. It is also used for chewing and extraction of juice for beverage purpose. The sugarcane cultivation and sugar industry in India plays a vital role towards socio-economic development in the rural areas by mobilizing rural resources and generating higher income and employment opportunities. About 7.5percent of the rural population, covering about 45 million sugarcane farmers, their dependents and a large number of agricultural labors are involved in sugar cane cultivation, harvesting and ancillary activities. There are about nine States in India where sugarcane is grown on a large extent of area. Thus it is understood that Sugarcane has highest amount of importance amongst farmers in India, but due to lack of proper, efficient and low cost technologies farmers face difficulties during planting and harvesting of Sugarcane, and these problems are largely faced by small scale farmers who lack monetary funds compared to that of large scale farmers who have enough monetary resources to adopt and use sophisticated machines for sugarcane cultivation.

Hence the aim of this paper is to provide a machine design that costs low to manufacture and also simple in construction and operation and hence benefits the small scale farmers at large amount.

II. EXISITNG MACHINE AND ITS DRAWBACKS

The existing design consists of a punch operated by a lever and spring mechanism. When the punch is pressed, the lever and spring mechanism guides the cutter down, thus cutting the bud. However this machine takes up more amount of time to cut the required amount bud for an acre and demands the need of labour.

In order to overcome these drawbacks we have come up with a machine design that facilitates the removal of bud from the sugarcane easily without heavy amount of time consumption and also using minimum human labour which will not be adding up as an essential processing cost to the farmers of sugarcane.

Figure 1. Existing Design

III. DESIGN AND CONSTRUCTION OF LOW COST SUGARCANE BUD CHIPPER

The following segment explains the components used and as well the construction of Low Cost Sugarcane Bud Chipper,

3.1. Components Used

Our machine design consists of,

- Single Phase Ac Induction motor.
- A Gear combination consisting,
- Worm Gear- 3 teeth
- Helical Gear- 30 teeth
- Helical Gear- 15 teeth
- Helical Gear- 70 teeth
- Circular Disc.
- Shaft.
- M8 Bolt.
- Plate (Mild Steel) and Pillar (M12 Bolt)
- Cutter (MS Pipe)

3.2. Construction

- The single phase AC Induction motor is held in a clamp which is fixed to the base using bolts.
- This motor is connected to the gear combination which consists of three helical gears one of which is connected to motor and the other are meshed to each other.
- The gear house or the gear combination consists of a 30 tooth helical gear meshed with the 3 tooth worm gear of the motor.
- This helical gear consisting of 30 teeth is coupled to a helical gear of 15 teeth through a shaft.
- This 15 teeth helical gear meshes with a 70 teeth helical gear which is in turn connected to the output of the motor.
- Motor output is connected to a circular disc of 120mm diameter.
- The circular disc has a shaft connected to it and this shaft is connected using a M8 bolt.
- Further, the set up consists of two Mild steel plates, one of which is fixed to the wooden base using M8 bolt and the other plate is placed over the bottom plate and in between these two plates four pillars are used.
- Here four M12 bolts are used as pillars. The head of each M12 bolt is welded to the bottom plate and a open type compression helical spring is wound over each of the four bolts/pillars.
- The top plate has four holes drilled in it through which the bolts are let in and the top plate is balanced over the springs.
- To facilitate the placement of the cutter, a circular hole equivalent to the cutter's diameter is drilled in the top plate and the cutter is let through the hole.
- To hold the cutter firmly, the face of the cutter that is pointing towards outside is welded to a plate which is in turn bolted to the top plate through which the cuter passes and for the purpose of bolting four M8 bolts.

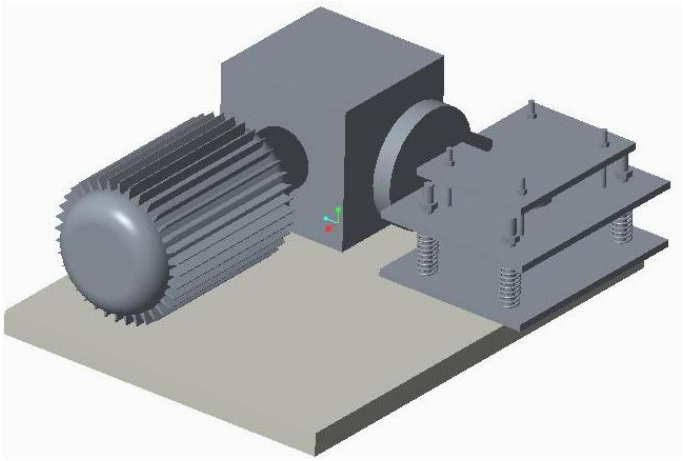

Figure 2. CREO Layout of Low Cost Sugarcane Bud Chipper (Standard View)

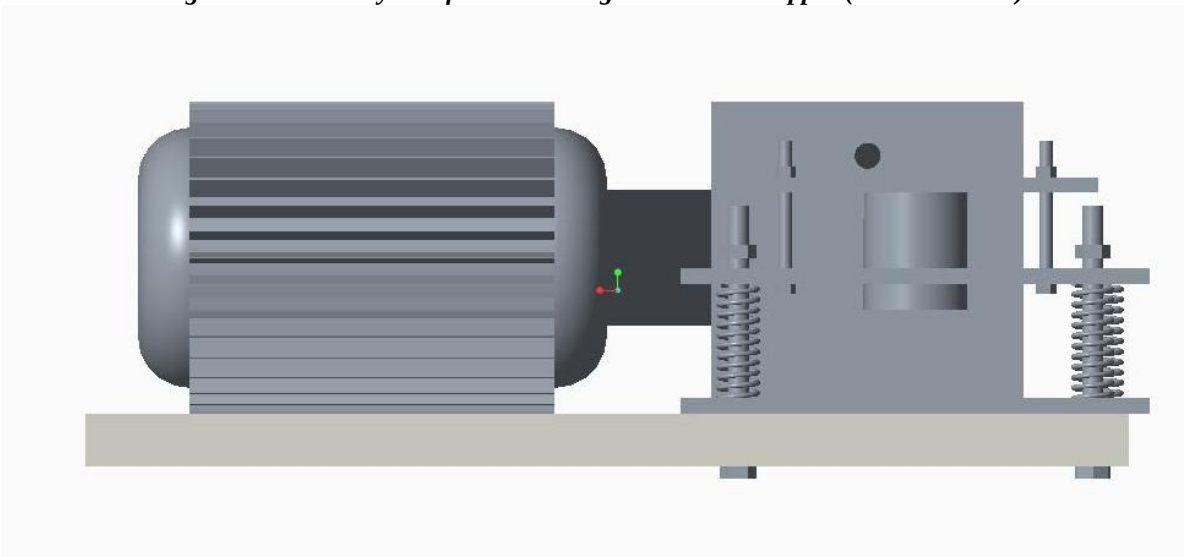

Figure 3. CREO Layout of Low Cost Sugarcane Bud Chipper (Front View)

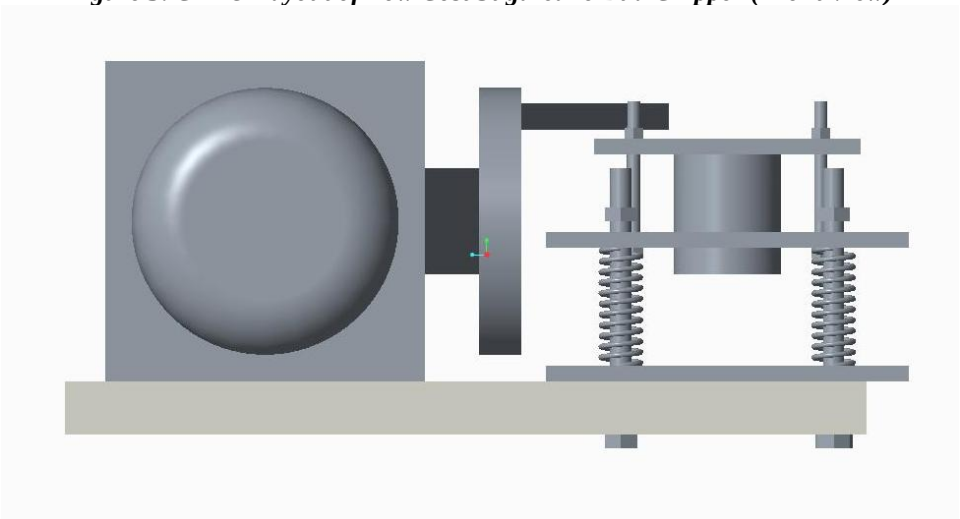

Figure 4. CREO Layout of Low Cost Sugarcane Bud Chipper (Side View)

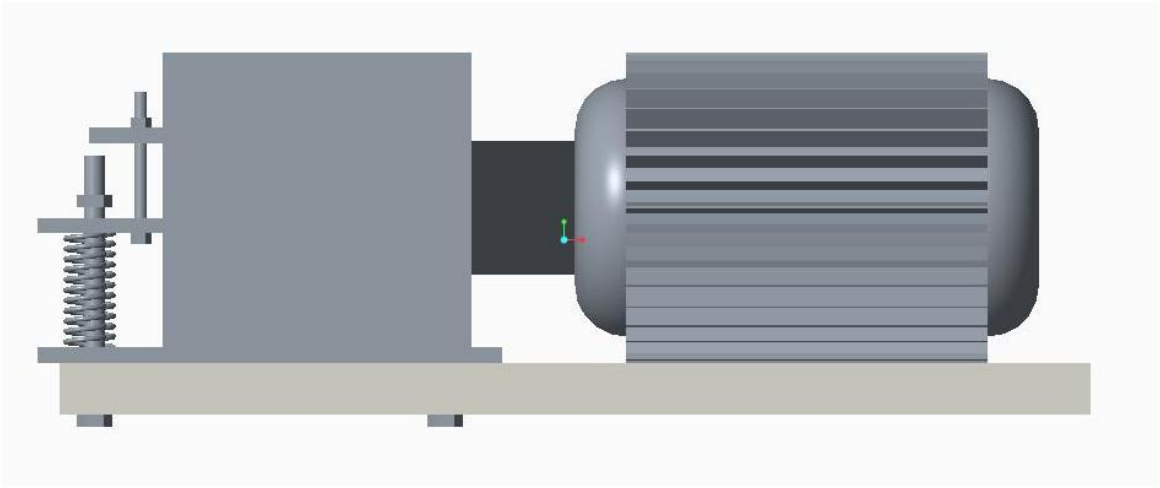

Figure 5. CREO Layout of Low Cost Sugarcane Bud Chipper (Rear View)

IV. SPECIFICATIONS OF LOW COST SUGARCANE BUD CHIPPER

Sl.No	Component	Material used	Dimension
1.	Worm Gear(connected to motor)	High speed steel	No. of Teeth- 3
2.	Helical gear	Hylem	30 teeth
3.	Helical Gear	High speed steel	15 teeth
4.	Helical gear(connected to output)	High speed steel	70 teeth
5.	Circular Disc	Aluminium	120mm
6.	M8 bolt + shaft	Mild steel	Length-70mm, Dia-8mm Pitch-1.25 mm
7.	Top & bottom plate/M12 bolt	Mild steel/mildsteel	l-190mm,t-5mm, b-128mm, l-100mm,dia12mm
8.	Springs(4nos)	Hardened steel	Length-50mm
9.	Cutter	MS pipe	O.D-35mm, I.D- 28 mm Length-50mm.
10.	Base	Wood	30.5cmx30.5cm Thickness-18mm

Table 1. Specifications

V. WORKING OF LOW COST SUGARCANE BUD CHIPPER

- When the Single phase Ac induction motor is switched on, it starts to run at a speed of over 1400rpm. This 1400 rpm is given at the end of Worm gear.
- The worm gear is further connected to a helical gear of consisting of 30 teeth which is further connected to two helical gears and these gears operate in combination to reduce the speed from 1400 rpm to 30 rpm
- Hence due to gear reduction the speed reduces down to 30 rpm. Now this speed is fed to the circular disc which is connected to the motor through a slot joint.
- This disc further has a shaft connected to it. As the motor gives a 30 rpm output, the disc also rotates at a speed of 30 rotations per minute.
- The shaft also rotates along with the disc.

- During the rotation, as the shaft comes down the Top plate of the plate-pillar assembly moves down. The Top plate also consists of the cutter.
- Thus the cutter moves down and cuts the bud from the sugarcane.
- As the disc further rotates, the shaft moves up and hence the top plate is released and hence it moves up.
- When the shaft again comes down the pressing action is repeated and eventually the cutting operation is repeated.
- By this method, rotary motion of the motor is converted and delivered as reciprocating motion at the cutter end and eventually the removal of bud is also achieved at a rate of 30 per minute.

VI. CALCULATIONS

6.1. Speed Reduction Calculations

Motor speed, **N1 = 1400 (rpm)**
Gear 1 = 3 teeth, Gear 2 = 30 teeth, Gear 3 = 15 teeth, Gear 4 = 70 teeth.

Gear 1 & Gear 2 are meshed together and their speed ratio is 1:10.
Hence, 1400/10 = 140 (rpm)
Gear 2 speed = 140 (rpm)

Gear 2 and gear 3 are coupled to same shaft.
Hence, **Gear 3 = 140 (rpm)**

Gear 3 and gear 4 are meshed together, and their speed ratio is 15:70.
Hence, 140/4.66 = 30 (rpm)
N2 = 30 (rpm)
Hence, the cutter reciprocates or cuts the bud, 30 times a minute.

6.2. Torque Calculation

Torque formula:
$P = (2*\pi*N*T)/60$
where,
P stands for Power,
N stands for Speed,
T stands for Torque.

Torque in the motor before speed reduction,
$P = (2*\pi*N1*T1)/60$
$100 = (2*3.14*1400* T1)/60$
Hence, **T1 = 0.68 (Nm)**

We know that,
T1*N1 = T2*N2
Hence, T2 = (T1 x N1)/N2
thus, T2 = (0.68 x 30)
T2 = 31.7 (Nm)

Assuming the transmission efficiency is 82%
hence, T2=31.7*0.82
Hence, **T2 = 25 (Nm)**

6.3. Cutter Force Calculations

We know that, **Torque = Force x Radius**
Here, Torque = T2 = 25Nm
Radius= Radius of disc = 60mm
Hence, F = 25/(60*10^-3)
Thus, **Force = 416.66 (N)**
This is the force exerted by the Cutter over the sugarcane.

6.4. Spring Calculations

Formula used,
Deflection of the spring:
$\delta = (64*W*R^{3}*n)/(C*d^{4})$
where,

δ stands for Deflection,
W stands for load applied,
R stands for Mean radius,
N stands for number of turns in the spring,
C stands for Modulus of Rigidity
D stands for Wire diameter.

Stiffness of the Spring:
K = W/δ
where,
K stands for Stiffness of the Spring
W stands for Load applied
δ stands for deflection.

Energy stored in the Spring:
U = 0.5*T*θ
where,
T stands for Torque,
θ stands for Angle of Twist.
Here,
W = 416.66 N
R = 12.5 mm
C = $6.5*10^5$ N/mm^2
n = 6
T = 25 Nm
θ = 30°

Calculations,
$\delta = (64*W*R^{3*}n)/(C*d^4)$
$\delta = (64*416.66* 12.5^{3*}6)/(6.5*10^{5*} 2^4)$

Hence,
Deflection, δ = 30 (mm)
now, K = W/δ
K = 416.66/30
Thus, **Stiffness, K = 13.8 (N/mm)**

and,
U = 0.5*W*δ
U = 0.5*416.6*30
Thus, **Energy Stored, U = 6.3 (Nm)**

VII. INCOME FOR FARMERS THORUGH OUR MACHINE

Based on the case study that we performed during the time of developing this machine's design, we collected certain data related to the conventional sugarcane cultivation method and our method of cultivating sugarcane. In conventional method about 36000 whole sugarcane pieces are required to be planted for cultivating sugarcane in one acre of land. However in our method only 36000 sugarcane buds are required for the same purpose and not whole piece of sugarcane. Therefore the saved parts of sugarcane can be sold to vendors in market which acts as an added source of income for the farmer. It is estimated that the profit that can be earned through this way is about Rs 10,500.

Here is the detailed calculation,
Conventional method:
36,000 pieces of sugarcane is required for cultivation (One acre)
1 Ton=6,750 pieces
Hence, 5.2 ton of Sugarcane pieces used (One acre).

Our method:
36,000 buds used for cultivation (One acre)
36,000 buds= 1.5 ton
Left out sugarcane pieces weight = 3.7 Tons

1 Ton sugarcane= Rs 2,850
Hence, 3.7x2850= Rs 10,500
This is the Profit that can be earned by the farmer.

7.1. Cost Comparison

The following are the data associated with conventional and our method of sugarcane cultivation.

Conventional method:
Amount to be invested to buy sugarcane = Rs 14,820 per acre
Amount collected as Revenue = Rs 1.42L per acre

Our method:
Based on our estimation, our machine will cost about Rs 7000
Amount to be invested =Rs 14820(per acre) + Rs 7000(first year only) = Rs 20820
Amount collected as Revenue = Rs 1.53L per acre
Therefore based on the above data it can be seen that a profit of Rs 3,500 can be earned by the farmer in the first year, and in the successive years a profit of Rs 10,500 can be obtained per year.

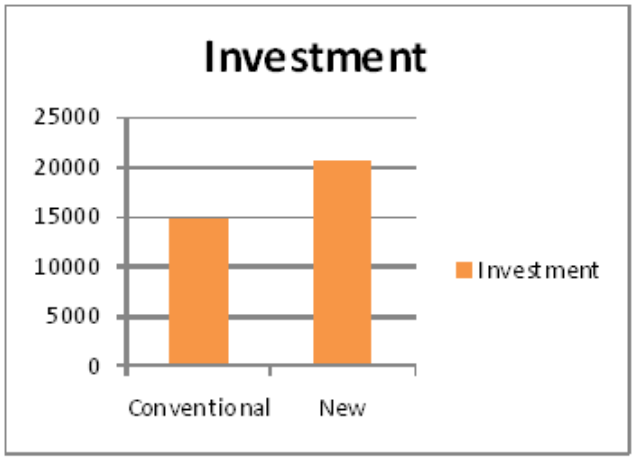

Figure 6. Investment Comparison Graph

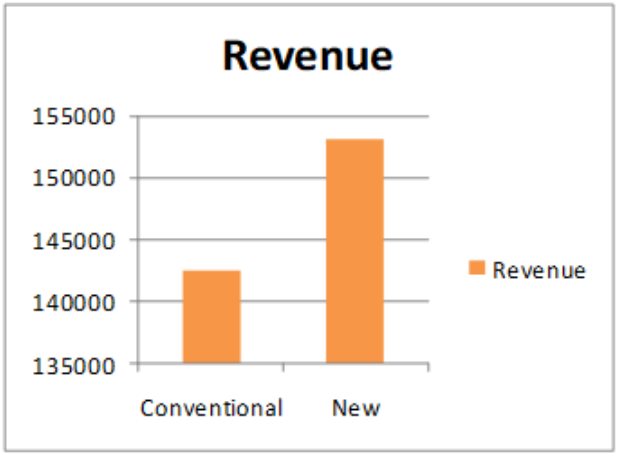

Figure 7. Revenue Comparison Graph

VIII. CONCLUSION

By providing high profits at low investment and also by simplifying bud removal process along with minimizing labour requirement, our machine proves to be a highly profitable investment for farmers and breakthrough in farming technology.

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