International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 10 | Oct 2018 www.irjet.net p-ISSN: 2395-0072

CAM OPERATED SUGARCANE BUD CUTTING MACHINE

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Abstract - *With the increasing levels of technology, the efforts being put to produce any kind of work has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs.*

Now a day's most of the agricultural equipment is working on the automatic system. We know that agriculture is the backbone of the Indian economy and Indian farmers are facing the problem of shortage of worker for doing the on-field work. To overcome this problem, we are designing the sugarcane bud cutting machine which reduces the wastage of sugarcane and also reduces the transportation cost. The production of bud using this automatic sugarcane bud cutting machine is high as compare to other conventional machines available in the market.

The buds cut by using this machine are light in weight and economic sugarcane seeding material. This technique of farming using the buds helps to the farmer developing the new varieties of the sugarcane. There is problem of initial growth using the sugarcane bud but it can be overcome using the suitable growth regulators and fertilizers. Also, this machine faster production rate which make it suitable for the competition with conventional sugarcane bud cutting machine.

Key Words: Automatic machine, Easy transportation, Economical, High productivity.

1. INTRODUCTION

Sugarcane is a vegetative propagated Crop. In India, for conventional system of cultivation, about 6 – 8 tones seed cane /ha is used as planting material, which comprises of about 32,000 stalk pieces having 2-3 buds. Sugarcane cuttings with one, two or three buds known as sets are used as seed. This large mass of planting material poses a great problem in transport, handling and storage of seed cane and undergoes rapid deterioration thus reducing the viability of buds and subsequently their sprouting.

One alternative to reduce the mass and improve the quality of seed cane would be to plant excised auxiliary buds of cane stalk, popularly known as bud chips. These bud chips are less bulky, easily transportable and more economical seed material. The bud chip technology holds great promise in rapid multiplication of new cane varieties. The left-over cane can be well utilized for preparing juice or sugar or jiggery. Despite of all these benefits of bud chips for rapid multiplication of new cane, a common problem many sugar cane farmers are facing in a developing country like India is affordable (low cost) bud chipping machine. The existing (traditional) tools used for bud chipping of sugar cane are unsafe, messy and need skill and training. The risk of injury is also too high. This necessitates the development of a bud chipping machine for sugar cane. In this direction, literature survey, patent search, market survey and concept generation were carried out. Different concepts were developed using concept generation.

Fig.1.1–Existing Manually Operated Sugarcane Bud Cutting Tools

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 33% of India's geographical area and is contributing 15.1% of India's GDP. Agriculture still contributes significantly to India's GDP despite decline of its share in India's GDP. There are number of crops grown by farmers. These include different food crops, commercial crops, oil seeds etc., sugarcane is one of the important commercial crops grown in India. Sugarcane is the main source of sugar in Asia and Europe. Sugarcane is grown primarily in the tropical and sub-tropical zones of the southern hemisphere. Sugarcane is the raw material for the production of white sugar, jiggery (Gur) and Khand sari. 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 socioeconomic development in the rural areas by mobilizing rural resources and generating higher income and employment opportunities.

About 7.4percent of the rural population, covering about 34 million sugarcane farmers, their dependents and a large number of agricultural labors are involved in sugar cane cultivation, harvesting and ancillary activities. Little portion of stem with one bud is known as bud chip. Bud chips are used to raise settling in nursery. They were found to produce a good crop when transplanted in main field. The principal advantage of bud chips is substantial saving in seed material. Seed requirement is reduced to less than one ton per hr.

The farmers usually remove the bud chips from whole cane using a sharp-edged knife in such a way that each bud has a little portion of stem. The method is laborious time consuming and dangerous. The seed cutter machines can efficiently conserve time and labour and cost as it chips more buds in less time.

Hence, non-availability of quality seed material is one of the major problems faced by farmers in developing countries. Further, the bulky cane cuttings used for planting as seed harbor many pests and diseases thereby decreasing cane yield and quality drastically. Accumulation of diseases over vegetative cycles leads to further yield and quality decline over the years. In fact, poor quality seed is a major constraint in sugarcane production. Development of tissue culture technology for rapid multiplication of disease-free planting material has greatly facilitated mass production of quality seed in sugarcane. A number of micro propagation techniques have been adopted successfully by farmers and industry in some sugarcane growing countries of Asia-Pacific, e.g. India, Australia and the Philippines.

2. PROBLEM STATEMENT

It has been observed in rural areas most of the people cut the sugarcane buds manually. This consumes a lot of sugar cane and time to cut the buds. In order to identify this cause, we have designed and fabricated the sugar cane bud chipping machine which works on electricity. It reduces about 70% of seeding cost. And get more yield the machine reduces tremendous labor and produces more number of buds in less time. This machine can be easily lifted as it is light in weight. It will prove one of the good ideas for the farmers.

3. COMPONENTS

3.1) Electric Motor (Single Phase):-

Electric motor is an electrical machine that is used to convert electrical energy into mechanical energy. For smaller loads as in household application. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives in variable-speed service. VFDs offer especially important energy savings opportunities for existing and prospective induction motors in variable-torque centrifugal fan, pump and compressor applications.

Fig-3.1 Electric motor

3.2) Shaft: -

A Shaft is a rotating element, usually circular in cross section; line shaft is used to transmit power from one shaft to another, or from the machine which produces power, to the machine which absorbs power. Shaft is used to transmit power from motor to gearbox and from gearbox to mechanism. A shaft is an element used to transmit power and torque, and it can support reverse bending. Most shafts have circular cross sections, either solid or tubular. Shafts have different means to transmit power and torque. Shafts are able to avoid vibration of the elements, and assure an efficient transmission of power and torque, some changes in the cross-section of the shaft can be made.

3.3) Cutter: -

This is the main section of the scooping machine. The scoop cutter is used to cut the sugarcane bud and to get the same size of sugarcane bud. Because of scooping cutter, the wastage of sugarcane reduces and safety of farmer increases.

3.4) Spring:-

A spring is an elastic object used to store mechanical energy. When a coil spring is compressed or stretched slightly from rest, the force it exerts is approximately proportional to its change in length. Spring is used to give the upward and downward direction to the cutter. Because of spring the cutter moves upward and downward direction. Spring is assembled with the cutter.

3.5) Cam: -

A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion or vice versa.It is often a part of a rotating wheel (e.g. an eccentric wheel) or shaft (e.g. a cylinder with an irregular shape) that strikes a lever at one or more points on its circular path. The cam can be a simple tooth, as is used to deliver pulses of power to a steam hammer, for example, or an eccentric disc or other shape that produces a smooth reciprocating (back and forth) motion in the follower, which is a lever making contact with the cam.

3.6) Main Pulley: -

The main pulley is V-belt pulley mounted on the input shaft by means of an Allen head grub screw. This pulley is a reduction pulley that is reduces the motor speed 5 times so also torque available at the machine input shaft is amplified.

Fig. 3.6 Main pulley

3.7) Pedestal bearing: -

It is also called Plummer block. Figure shows half sectional front view of the Plummer block. It consists of cast iron pedestal, phosphor bronze bushes or steps made in two halves and cast-iron cap. A cap by means of two square headed bolts holds the halves of the steps together.

Fig. 3.7 Pedestal bearing

The steps are provided with collars on either side in order to prevent its axial movement.

The snug in the bottom step, which fits into the corresponding hole in the body, prevents the rotation of the steps along with the shaft. This type of bearing can be placed anywhere along the shaft length.

The main function of a rotating shaft is to transmit power from one end of the line to the other. It needs a good support to ensure stability and frictionless rotation. The support for the shaft is known as “bearing”.

The shaft has a “running fit” in a bearing. All bearing is provided some lubrication arrangement to reduced friction between shaft and bearing.

3.8) V- belts: -

V-belts (also known as V-belt or wedge rope) solved the slippage and alignment problem. It is now the basic belt for power transmission. They provide the best combination of traction, speed of movement, load of the bearings, and long service life. They are generally endless, and their general cross-section shape is trapezoidal (hence the name "V"). The "V" shape of the belt tracks in a mating groove in the pulley (or sheave), with the result that the belt cannot slip off. The belt also tends to wedge into the groove as the load increases—the greater the load, the greater the wedging action—improving torque transmission and making the V-belt an effective solution, needing less width and tension than flat belts. V-belts trump flat belts with their small center distances and high reduction ratios. The preferred center distance is larger than the largest pulley diameter, but less than three times the sum of both pulleys. Optimal speed range is 1,000–7,000 ft/min (300–2,130 m/min). V-belts need larger pulleys for their larger thickness than flat belts.

Fig.3.8- V-belt

For high-power requirements, two or more V-belts can be joined side-by-side in an arrangement called a multi-V, running on matching multi-groove sheaves. This is known as a multiple-V-belt drive (or sometimes a "classical V-belt drive").V-belts may be homogeneously rubber or polymer throughout, or there may be fibers embedded in the rubber or polymer for strength and reinforcement. The fibers may be of textile materials such as cotton, polyamide (such as Nylon) or polyester or, for greatest strength, of steel or aramid (such as Twaron or Kevlar).

When an endless belt does not fit the need, jointed and link V-belts may be employed. However, they are weaker and only usable at speeds up to 4,000 ft/min (1,200 m/min). A link v-belt is a number of rubberized fabric links held together by metal fasteners. They are length adjustable by disassembling and removing links when needed.

3.9) Gear Train:-

A gear train is a mechanical system formed by mounting gears on a frame so the teeth of the gears engage.

Gear teeth are designed to ensure the pitch circles of engaging gears roll on each other without slipping, providing a smooth transmission of rotation from one gear to the next

Features of gears and gear trains include:

1) The ratio of the pitch circles of mating gears defines the speed ratio and the mechanical advantage of the gear set.

2) A planetary gear train provides high gear reduction in a compact package.

3) It is possible to design gear teeth for gears that are non-circular, yet still transmit torque smoothly. The speed ratios

of chain and belt drives are computed in the same way as gear ratios

4. DESIGN

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy & efficiency. Hence a careful design approach has to be adopted. The total design work has been split up into two parts;

4.1 System design

4.2 Mechanical Design.

System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man + machine interactions, No. of controls, position of controls, working environment of machine, chances of failure, safety measures to be provided, servicing aids, ease of maintenance, scope of improvement, weight of machine from ground level, total weight of machine and a lot more.

In mechanical design the components are listed down and stored on the basis of their procurement, design in two categories namely,

1) Designed Parts

2) Parts to be purchased

For designed parts detached design is done & distinctions thus obtained are compared to next highest dimensions which are readily available in market. This amplifies the assembly as well as postproduction servicing work. The various tolerances on the works are specified. The process charts are prepared and passed on to the manufacturing stage.

The parts which are to be purchased directly are selected from various catalogues & specified so that anybody can purchase the same from the retail shop with given specifications.

4.1 SYSTEM DESIGN:

In system design we mainly concentrated on the following parameters: -

4.1.1 System Selection Based on Physical Constraints

While selecting any machine it must be checked whether it is going to be used in a large-scale industry or a small-scale industry. In our case it is to be used by a small-scale industry. So, space is a major constrain. The system is to be very compact so that it can be adjusted to corner of a room.

The mechanical design has direct norms with the system design. Hence the foremost job is to control the physical parameters, so that the distinctions obtained after mechanical design can be well fitted into that.

4.1.2 Arrangement of Various Components

Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible. More over every component should be easily seen none should be hidden. Every possible space is utilized in component arrangements.

4.1.3 Components of System

As already stated the system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired.

4.1.4 Man-Machine Interaction

The friendliness of a machine with the operator that is operating is important criteria of design. It is the application of anatomical & psychological principles to solve problems arising from Man – Machine relationship. Following are some of the topics included in this section.

1. Design of foot lever
2. Energy expenditure in foot & hand operation
3. Lighting condition of machine.

4.1.5 Chances of Failure

The losses incurred by owner in case of any failure is important criteria of design. Factor safety while doing mechanical design is kept high so that there are less chances of failure. Moreover, periodic maintenance is required to keep unit healthy.

4.1.6 Servicing Facility

The layout of components should be such that easy servicing is possible. Especially those components which require frequents servicing can be easily disassembled.

4.1.7 Scope of Future Improvement

Arrangement should be provided to expand the scope of work in future. Such as to convert the machine motor operated; the system can be easily configured to required one. The die & punch can be changed if required for other shapes of notches etc.

4.1.8 Height of Machine from Ground

For ease and comfort of operator the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level, also enough clearance should be provided from the ground for cleaning purpose.

4.1.9 Weight of Machine

The total weight depends upon the selection of material components as well as the dimension of components. A higher weighted machine is difficult in transportation & in case of major breakdown, it is difficult to take it to workshop because of more weight.

4.2 MECHANICAL DESIGN

ELECTRIC MOTOR DETAILS

POWER= 180 WATT.

SPEED = 1425 rpm.

OPERATING SPEED = 1400 rpm.

DIA OF PULLEY = 406 MM.

PULLEY WEIGHT = 20 N

LENGTH = 875 MM.

1) Design of first shaft

As per design data Book.

Angle of lapping between belt & pulley=180 degree = π rad.

Km = combined shock & fatigue factor for bending= 1.5 (table 14.2 khurmi- gupta page 531).

Kt = combined shock & fatigue factor for bending = 2

Coefficient of friction μ = 0.3.

Allowable shear stress = 35 mpa = 35 N/mm^2

NOW;

$$\text{Power (P)} = \frac{2\Pi NT}{60}$$

$$\Rightarrow 180 = \frac{2 \times \Pi \times 1400 \times T}{60}$$

$$\Rightarrow T = \frac{180 \times 60}{2 \times \Pi \times 1400}$$

T = 1.22 N.m = 1.22 × 10^3 N-mm.

T1 & T2 = Tension in tight side & slack side of belt resp. In newtons

T = (T1- T2)R

1.22 × 10^3 = (T1- T2) × 203.

(T1 – T2) = $(1.22 \times 10^3)/203$

(T1- T2) = 6.00 N..1

We know that,

2.3 log $(T1/T2)$ = μ Ø.

log $(T1/T2) = (0.3 \times \pi)/2.3$

log $(T1/T2)$ = 0.4098...............................taking antilog.

$(T1/T2)$ = 2.57......................3.........................2

From above equations.

T1 = 2.18 N.

T2 = 3.82 N.

Total vertical load acting on the pulley.

Wt = T1 + T2 +W

= 6 + 20

= 26 N.

Bending moment acting on the shaft.

M = Wt × L

= 26 × 875.

= 22750 N.mm.

d=dia of shaft.

We know equivalent twisting moment.

kyTe $=\sqrt{(Km\,M)^2 + (Kt\,T)^2})$

Te = $\sqrt{(1.5 \times 22750)^2 + (2 \times 6)^2}$

= 34125.00 N.mm.

Equivalent twisting moment (Te).

Te = $\pi/16 \times \tau \times d^3$

Te = $\pi/16 \times 35 \times d^3$.

$d^3 = (34125.00 \times 16)/(\pi \times 35)$

d = 17.06 mm.

d ≈ 17 mm.

As we are using 25mm dia. Shaft. So our design is safe.

2) Calculation of cranking force

Crank force = T design × eccentricity.

Belt pulley have reduction ratio 1:3. Hence, T design = overload factor × 3 × T motor.

Consider 100% overload.

T design. = 1 × 3 × (1.22 × 10^3).

T design. = 3.66 N.m.

Crank force = 3.66 × 100 .

Crank force = 366000 N.mm.

4.3 MATERIAL SELECTION: -

REF: -PSG DESIGN DATA (1.10&12 1.17)

Table no. 4.3

MATERIAL DESIGNATION	TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
MS	600	380

3) Design of connecting rod as pull force.

cross section area = 100 × 25 = 2500 mm^2 .

direct tensile load = 366000 N.mm.

Check for failure of connecting rod under direct tensile load.

Ft = load/ area.

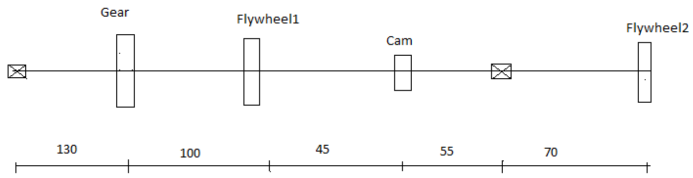
= 366000/2500.

= 146.4 N/mm^2.

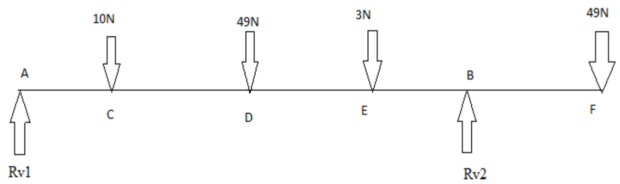
As Ft act < Ft all

The link is safe under tensile load.

4) Design of second shaft



Vertical Force Diagram:



Horizontal Force Diagram:

$$Mt = \frac{60\times10^6\times0.18}{2\pi\times630} = 2728.370 \text{ N-mm}$$

$$Pt = \frac{2\,Mt}{dg}$$

$$= \frac{2\times2728..37}{120}$$

Pt = 45.47 N

Pr = Pt tanα

= 45.47×tan (20)

= 16.56 N

For vertical force diagram

Rv1 + Rv2 = 16.55 + 49 + 3 + 49

Taking moment about A

16.55×130 + 49×230 + 3×275 - Rv2×330 +49×455 = 0

$$Rv2 = \frac{36541.5}{330}$$

= 110.73 N

Rv1 = 117.55 – Rv2

= 6.81 N

Moment about D = 6.81× 230 + 10×100

= 566.3 Nmm

Moment about E = 6.81×275 + 10×145 + 49×45

= 1782.25 Nmm

Moment about B = 49×70

= 3430 Nmm

Moment about C = 6.81×130

= 885.3 Nmm

For horizontal force diagram

Rh1 + Rh2 = Pr

Moment about A is

45.47×130 – Rh2×330 = 0

Rh2 = $\frac{5911.11}{330}$

Rh2 = 17.91 N

Rh1 = 45.47 – 17.91

= 27.56 N

Moment about C = 27.56×130

= 3538.2 Nmm

Moment about B = 27.56×330 – 45.47×200

= 0.8 Nmm

Moment about D = 0

Mb = $\sqrt{(3582.8)^2 + (3430)^2}$

= 4959.97 Nmm

Now

$$d^3 = \frac{16}{\pi \times \tau max} \sqrt{(Kb\ Mb)^2 + (Kt\ Mt)^2}$$

$$= \frac{16}{\pi \times 35} \sqrt{(2 \times 4959.9)^2 + (1.5 \times 2728.37)^2}$$

= 1561.48 mm

d = 11.60 mm

The next size available in market is 15 mm

Therefore d = 15 mm

But for safety purpose we take d = 25 mm

Gear Design:

We know,

Zp = 27 Zg = 60

Dp = 55 mm Dg = 145 mm

Module = Dg/Zg

= 145/60

= 2.41

As both the gears are made up of same material, the with smaller size subjected to greater stresses hence smaller gear is needing to design,

From design datebook

Lewis factor Y for 27 teeth=0.348

By analyzing the application, the service factor is considered as 1.5

For velocity factor, Cv = $\frac{6}{6+V}$ ————————

V = $\frac{\pi \times Dp \times np}{60 \times 10^3}$

= $\frac{\pi \times 55 \times 1400}{60 \times 10^3}$

= 4.03 m/s

Cv = $\frac{6}{6+4.03}$

= 0.59

Sb = m × b × (sigma B) $_{generated}$ × Y

1.22 ×10^3 = 2.41 × 10 × (sigma B) $_{generated}$ × 0.348

(b=10*m ......[here])

(sigma B) $_{generated}$ =145.46 N/mm2 {less than 200 N/mm2}

Hence assumption is correct, Design is safe

5. WORKING :-

When motor starts pulley rotates which is connected to the 2-inch pulley which drive to the 16-inch pulley. 16-inch pulley drive 25 mm shaft on which the circular cam is mounted. Cam drives the shafts which slide in the pedestal bearing and guide bush Shafts another end cutting blade is connected.

This project is we worked under by the cam and follower mechanism. The mechanism converts the rotary motion into the reciprocating motion. The machine has the prime mover at the bottom of the machine. The motor and pulley are connected with one V-type belt.

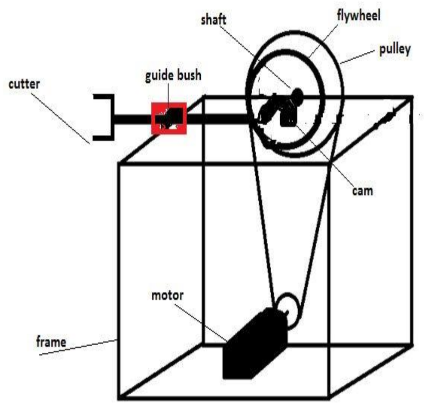


Fig.5.1- Working Model

Fig5.2 Working model

6. CONCLUSIONS

This is a new concept applied for sugarcane bud cutting process which finds suitable and viable and reduces human effort compared to traditional methods. This machine provides comfort to work for different positions depending upon ergonomics. The time requirement as well as efficiency of machine depends upon the size of sugarcane.

The sugarcane bud cutting machine is very useful for small scale farmers for planting sugarcane buds, also time is saved by this process as compared to traditional system of sugarcane bud cutting. Extra piece of sugarcane bud waste in small scale farm which can be saved by using sugarcane bud cutting machine that can be used as fodder for animals.

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