Design and Fabrication of Human Powered Bicycle Operated Sugarcane Bud Cutting 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. 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. In many countries, sugar cane harvesting is a very labour intensive activity in which workers usually become fatigued after manually cutting the cane for a few hours. They need frequent pauses for rest, and they experience sustained injuries from excessive stress on the joints and muscles of the body. And also today's world need faster rate of production of agriculture products. This project aims to Design and fabricate human powered bicycle operated sugarcane bud cutting machine for agriculture, to reduce farmer's efforts and to increase production of sugarcane based agriculture products.**

This paper describes the development and new type of sugarcane bud cutting. It is an optimized machine on previous techniques. We have also taken review of previous work which helps us to decide the work plan for the prepared machine. We also perform various experiments with respect to sugarcane and find out results. The machine doesn't need any kind of electricity. Pedal operation reduces the cost of the machine and it is economical and useful in rural India where electric power is not available.

Index Terms- **Bud, Fatigued, harvesting, Optimized, Pedal, Sugarcane.**

I. INTRODUCTION

I.I SUGARCANE FARMING

Agriculture is one of the most significant sectors of the Indian Economy. Agriculture is 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. Agriculture still contributes significantly to India's GDP despite decline of its share in India's GDP. There are numbers 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 production is not only limited up to India, but also set up in wide range of countries including Brazil, China, Thailand, Pakistan, Australia and many more. Brazil is the largest producer of sugarcane in the world, while India is the second leading country in the production of sugarcane. It is estimated that sugarcane is grown on about 4.4 million hectares with an approximate production of 345.72 million tonnes of cane with an average yield of 73 tonnes per hectares in an year.


Sugarcane cultivation and the development of sugar production industry run in parallel to growth of human civilization and are as old as agriculture. Sugarcane is the only 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. India has around more than 566 sugar mills. About 7.5% of the rural population, covering about 4 million sugarcane

farmers, their dependents and a large number of agricultural labors are involved in sugarcane cultivation, harvesting and ancillary activities. There are about nine states in India where sugarcane is grown on a large extent of area.

I.II STRUCTURE OF SUGARCANE BUD/STALK

Sugarcane is vegetatively propagated for commercial cultivation. Different kinds of planting materials viz., cane sets; settlings and bud chips are used for raising sugarcane crop.
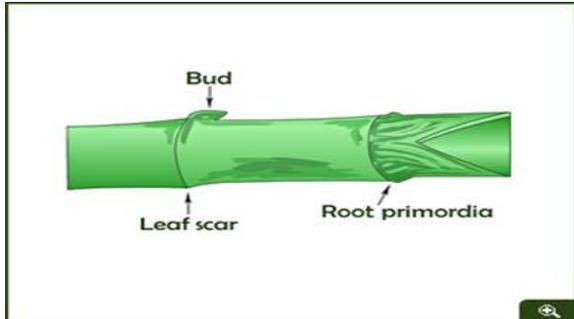
Stem cuttings or sections of the stalks are called "setts" or seed pieces. Each sett contains one or more buds. Always use fresh, genetically pure, pest and disease free setts as seed material. Generally, three bud setts are used for planting throughout the world, while in some areas two-bud setts are also used.

Experimental evidence shows that germination percentage of 3-bud setts is higher than the setts having more or less than 3-buds. The middle bud of a 3-bud sett has the highest germinating capacity followed by top end bud and the bottom end bud, respectively (Verma, 2004). The middle bud has an advantage in germination because, as a non-terminal bud having nodes on either side, its moisture resources are better protected than those of the terminal buds.

Germination capacity of single-bud sett is very poor due to loss of moisture from cut ends on either side. Further the plants arising from single-bud setts also lack vigour and yield low as compared to those from three-budded setts. Thus the preference given to three-budded setts over single-bud setts is partly based on germination capacity and partly on initial vigour of the germinated plants and cane yield.

If whole cane stalk is planted without being cut into setts, usually few buds at its top end germinate and the lower end buds remain inactive due to top dominance. The effect of top dominance is eliminated when stalk is cut into pieces.

II. USE OF PEDAL POWER

Throughout history human energy has generally been applied. Through the use of the arms, hands, and back. With minor exceptions, it was only with the invention of the sliding seat rowing shell, and particularly of the bicycle, that legs also began to be considered as a "normal" means of developing power from human muscles.
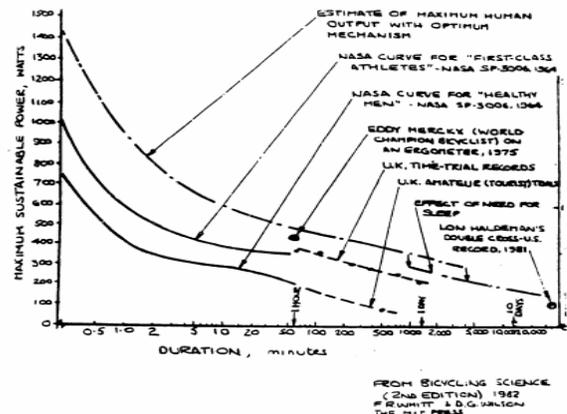

Fig 1. Human Power Output by Pedaling

A person can generate four time more power (1/4 horsepower (hp)) by pedalling that by hand hand-cranking. At the rate of ¼ hp, continuous pedalling can be done for only short periods, about 10 minutes. However, pedalling at half this power (1/8 hp) can be sustained or amount 60 minutes. Pedal power enables a person to drive devices at the same rate as that achieved by hand-cranking, but with far less effort and fatigue. Pedal power also lets one drive devices at a faster rate than before (e.g. winnower), or operate devices that require too much power for hand-cranking (e.g. thresher)

III. METHODS USED FOR SUGARCANE BUD CUTTING PROCESS

Traditional method of using Cane Knife:

This method is most abundantly used method throughout the world for cutting buds of sugarcane. The skilled farmer or skilled labours are employed to cut sugarcane buds by using cutting tool called as Cane Knife. With fine strokes of sharp cutting blade on the hard sugarcane the stoke or buds of sugarcane are cut.

However this method is more laborious with the requirement of efficient man power on the field and resulting in the problem of fatigue and cramps in the muscles of the labours. Also to save more time, more skilled labours are employed which increases the labour cost. There is a lot concern about the safety of labour. The labour can get easily hurt if blade is not handled properly.

Thus the efficiency is low and quality cutting of buds of sugarcane is hardly achieved. Hence to overcome this problem, new methods have emerged in market.

Modern Bud cutting machine using Electrical Motor

The electrical sugarcane bud cutting machine is generally equipped with maximum 1Hp electrical motor. This machine enables unskilled labours to operate it and more buds of sugarcane are cut in very less time. Thus it saves time and manpower i.e. labour cost along with providing more finely cut buds of sugarcane. But the cost of such machines is very high around Rs.35000 to Rs.45000. This machine also consumes more Electrical Energy and faces the problem of power cut-offs in village. Thus these problems make it unaffordable to many farmers. Hence this demotivates them to use traditional method of sugarcane bud cutting.

Hence our team has made a prototype of sugarcane bud machine based on human power pedal operated to provide an efficient optional machine. This machine does not required more than 2 operators and t costs less than the electrically operated machine. The efficiency is also

IV. DESIGN OF COMPONENTS

IV.I Design of CHAIN DRIVE :

2 ft =60 cm

For 2.5 ft

L=1050 mm

L=1.050 m

1 HP = 745.7 watt

For 0.5" pitch

Chain number 40

Pitch =12.7 mm

130 watt = 0.175 HP

W=1.2

Pd=0.12HP=0.156kw

(From DB fig 14.1 for P=0.21HP and 70rpm chain number 40 and pitch=12.7mm)

To find pitch line velocity

T1=13

Pitch diameter, Dp=P/(sin(180/T1))

Dp=12.7/(sin(180/13))

Dp=53.06 mm

Pitch line velocity Vp= πDN/60

$\qquad$ = (3.14x53.06x10-3x260)/60

$\qquad$ =0.7219 m/sec

Vp=43.31 m/min

Power capacity per strand

= P2 [v/104 - V1.41/526 (26-25cos (180/13))] x Kc

=12.72 x [0.72192/104 - 0.721921.41/526 x (26-25cos (180/13)] x 1

=0.7851

=1.053 HP

Here power per strand is greater than power developed

Therefore, need only 1 strand

Total power = power/strand x number of strand

$\qquad$ = 1.060 HP x 1

$\qquad$ = 1.060 HP

Check total power > Pd

Therefore, condition is satisfied

Hence design is safe

1) Number of teeth on larger sprocket and pitch diameter

$\quad$ T2= T1 x (N1/N2) = 13 x 260/70

$\qquad$ =48.28

$\qquad$ =48 teeth's

$\quad$ Dp1= P/sin(180/T2) = 194.18 mm

Maximum permissible bore

D < (T-5) P/4 for P<=25.4

$\quad$ =25.4 mm

From table XII-3

Shaft diameter for 0.156 KW and 260 rpm is 11 which is less than M.P.B of 25.4mm

Hence, it is ok.

Outer diameter of sprocket width

$Do1 = P(0.6 + \cot(180/11))$

$D01 = 59.14$mm

$D02 = P(0.6 + \cot(180/48))$

$D02 = 201.38$ mm

Width of sprocket T0

$T0 = 0.58P - 0.15$

  $= 0.58 \times 12.7 - 0.15$

  $= 7.216$ mm

Length of chain in pitches

$Lp = (T1 + T2)/2 + 2C/P + P(T1 - T2)2/40C$

$C = 750$mm

  $= (13+48)/2 + (2 \times 750)/12.75 + 2.75(48-13)2/(40 \times 750)$

  $= 149.12 = 150$ mm

Hence from the above calculations, the design procedure meets current dimensions which are under safety margins according to requirements. Therefore the design is safe.

IV.II Design of FLYWHEEL:

1) FOR DESIGN OF FLYWHEEL

From IZODE test

We get

$\Delta E = 162$ J

For N=120 rpm (from previous project files based on pedal operated rice milling machine year 2013-14)

$W = (2\pi \times 120)/60 = 12.56$ rad/s
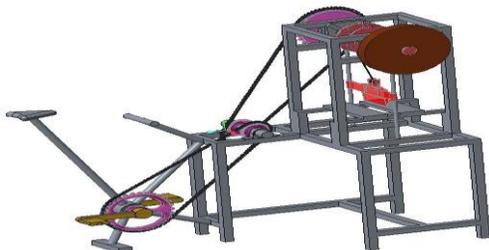
$\Delta E = IC_sW2$

$I = 0.544$ Kgm2

$I = mk2$ for (k=0.165)

... $0.544/0.1652 = $ mass of flywheel

        $M = 19.98 = 20$ kg

Hence from the above calculations, the design procedure meets current dimensions which are under safety margins according to requirements. Therefore the design is safe.

V. CAD MODEL:

VI.ACTUAL MODEL IMAGE

VII.CONCLUSIONS

This guide describes a pedal operated sugarcane bud cutting machine on village scale. Its shows how the ordinary bicycle can provide support both for the operator and the drive components. The cutter works at high speed and takes advantage of the smaller efforts required when the operator is using his legs rather than his arms to drive it. A second person is needed seldom to feed the sugarcane by hands toward the blade for better work output. The pedal operated sugarcane bud cutting machine is intended for use over a short period to farmers requirements. It is not intended t be used intensively for long periods. There is tremendous potential of this machine in market and it will be more beneficiary for large no. of farmers in the field of Sugarcane farming. As it removes the need of electricity, the cost of production is decreased simultaneously. The major problem of fatigue in labors has reduced drastically and the efficiency has been increased. The requirement of stalks/buds per acre of farmland has been achieved by this machine within less time and without electrical power consumption. There is no need to concern about the safety of operator as blade is placed is far at a safe distance.

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