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Design and fabrication of sugarcane plantation machine

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***Abstract*—India is the major producer of sugarcane in all over world. In older days the sugarcane sets are planted manually in the furrows. This process takes high labour cost and time taking. In our design of the sugarcane planting machine which includes rotary blade, soil digger, soil displacer, cutter. We are using 100cc engine to run the whole mechanism instead of tractor. The rotary blades & soil diggers are used to create furrows. The sliced sugarcanes are fall on the ground and adjustable soil displacer are close the furrows. we are simplified the working mechanism for single person usage. Minimum amount of investment and time.**

Keywords: Sugarcane, Planters, Performance, Costs, Furrow, Seed, Mechanism

I.INTRODUCTION

The world enthusiasm for sugar is the fundamental driver of sugarcane agribusiness. Stick speaks to 80% of sugar conveyed; most of the rest is created utilizing sugar beets. Sugarcane commonly creates in the tropical and subtropical regions, and sugar beet dominatingly creates in colder quiet locale of the world. Other than sugar, things got from sugarcane fuse molasses, rum, cachaca (a traditional soul from Brazil) and ethanol.

In India, between the sixth and fourth many years BC, the Persians, trailed by the Greeks, found the sugarcane. They grasped and after that spread sugar and sugarcane cultivating. Two or three merchants began to trade sugar a luxury and an expensive get-up-and-go until the eighteenth century. Prior to the eighteenth century, improvement of sugar stick was for the most part bound to India. Sugarcane farms, like cotton farms,

were a critical driver of generous human migrations in the nineteenth and mid twentieth century, influencing the ethnic mix, political conflicts and social improvement of various Caribbean, South American, and Indian Ocean and Pacific island nations. Sugarcane is in a vague family from grass, and creates as tall, restrict stalks, or sticks. Sugar stick is planted in trenches on its side in the fall. It requires no upkeep over the winter, and in spring that will create as tall as bamboo. Harvested sugar stick can be made into delightful syrup. Sugarcane stems are planted on a level plane on their sides, in four-inch significant wrinkles, or trenches. They require full sun, so pick a domain that isn't shaded.

II. LITERATURE REVIEW

[1] Elpidio et al, designed sugarcane planting machine. This creation identifies with a planting machine, and all the more especially to a machine for planting sugarcane stalks. The question of the creation is to give a machine which is adjusted to be hauled or towed behind a reasonable vehicle, for example, a tractor so a majority of stalks or plants, for example, sugarcane stalks can be promptly and helpfully planted in the ground and

furthermore this innovation is to give a sugarcane planting machine which incorporates an empty lodging or body part that is given separate compartments whereby a majority of stalks which are to be planted can be advantageously organized in these compartments, and wherein these stalks will move rearward by gravity into a bolstering load and from the nourishing load, the stalks are consequently released into individuals which adequately plant the stalks in the ground.

[2] Rodney et al, imagined billet grower. This development identifies with a sugarcane billet grower has a primary canister and a sorter container adjoining the principle receptacle. Billets are moved by a fundamental canister lift from the primary receptacle to the sorter container and henceforth, by a sorter receptacle lift from the sorter container to a billet chute. The lift used to pass on billets from the sorter canister to the billet chute utilizes a chain with transport fingers, each finger conveying an individual billet in a conclusion to-end association with nearby billets. Sorter fingers venture oppositely from the chain, adjust the billets inside the sorter receptacle and permit them tube conveyed by the transport 8 fingers. The chains and transport fingers are operable inside an opening of a width somewhat more noteworthy than the width of the chain and transport fingers.

[3] Donald et al, created sugarcane billet grower. The goal of the development is to furnish a novel-doffer in blend with a chain and brace transport which will expel abundance billets from the supports with insignificant harm to the eyes on the stick billets.

[4] Franklin et al, invented automatic sugarcane planter. In this a sugarcane planter which cheaply and efficiently plants seed cane is disclosed. The planter has a metal bin with two outwardly sloping sides and a deck extending transversely between the sides. Transverse bulkhead means mounted for longitudinal movement in the bin is provided for delivering an inclined mass of cane stalks to differential conveyor means which seizes the cane stalks from the inclined mass and makeover's them individually.

Summary of the literature review

- Energy prediction model for disk plough combined with a rotary blade in wet clay soil is concluded.
- The planter has a metal bin with two outwardly sloping sides and a deck extending transversely between the sides is studied.
- The invention is a multi-row full stalk sugarcane planter which utilizes a fully automatic hydraulically driven feed is studied.
- To provide a novel- doffer in combination with a chain and flat conveyor which will remove excess billets is concluded

Concept diagram of sugarcane planter

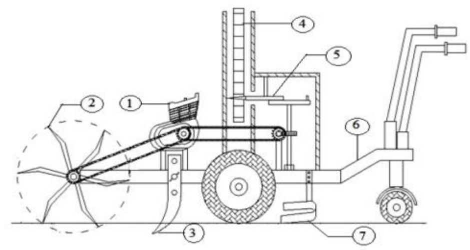

Fig.1 Conceptual design

Figure 1 shows the conceptual design of the sugarcane planting machine which includes soil digger, soil displacer, cutter with worm wheel design.

Table-1 Components Required

Component No.	Name of the component	No.of Components used
1	Engine	1
2	Rotary blade	12
3	Soil digger	1
4	Sugarcane	1
5	Cutter	1
6	Frame(square channel)	13
7	Adjustable soil displacer	1

Selection of materials

The material that we have selected is mild steel. The purpose of selecting mild steel is

- Mild steel is one of the most common of all metals.
- It is very durable.
- It can be welded easily and withstand higher temperature.
- The mild steel is used to withstand stresses induced in the component

III.DESIGN CALCULATIONS

Design of shaft

Fig.2 Shaft

M/I =σ/y

Where,

M - Bending Moment

I - Moment of inertia of the area of cross section

σ - Bending Stress

y - Distance from the neutral axis

I=(π/64)D4 {D = 19 mm, y = D/2 =9.5 mm}

I =6393.87 mm4

σ=(M/I)y

= (267000/6393.87) ×9.5

σ=396 Nmm/2

Maximum ultimate Stress of the material

σu = 841 Nmm/2

Factor of safety = σu/ σ = 841/396

Factor of safety = 2.1

Torque calculations

Number of teeth on worm wheel = 58

Outer diameter = 50.5 mm

Inner diameter = 12 mm

Number of starts on worm = 5

Engine Speed = 3000 rpm

Engine power = 5.7 kW

Torque of engine (T) =(P×60)/(2πN)

Where,

P – Power of engine

N – Speed of the engine

= (5.7×60×1000)/(2×π×3000)

T=18.15Nm

Speed ratio=58/5=11.6

Worm shaft speed N1 = 3000rpm

Worm wheel speed N2 = 3000/58

N2 = 51.7 ≈ 52 rpm

Torque on Wheel = (P×60)/(2×π×N2)

= (5.7×1000×60)/(2×π×52)

= 1047.28 N-m.

As the required torque can be obtained from the splendor engine and also due to its fuel efficiency and easy availability, it is chosen

Design of spring

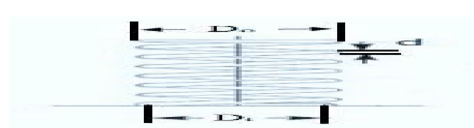

Fig.3 spring

Spring diameter (D) = 21 mm

Wire diameter (d) = 2 mm

No. of coils in spring = 23

Length of spring = 200 mm

Outer diameter of spring coil Do = D + d

= 21 + 2

= 23 mm

Inner diameter of spring coil Di = D - d

= 21 - 2

= 19 mm

Spring Stiffness

Spring material – stainless steel (17 – 7 PH)

{ E= 2.1×105 N/mm2,μ=0.313 }

K= (Gd4)/(8nD3)

Where,

G – Modulus of rigidity

d – Diameter of spring wire

n – No. of active coils

D – Mean coil diameter

K – Stiffness of spring

G= (E/2)*(1+μ)

Where,

E – Young's modulus

μ – Poison's ratio

$G = ((2.1 \times 10^5)/2) \times (1 + 0.313)$

G = 79960 N/mm2

{d= 2 mm,D = 21 mm, n = 23 }

$K = (79960 \times 2^4)/(8 \times 23 \times 21^3)$

K = 0.750 N/mm

Cutting Force

F x r = P x R

Where,

F – Spring force

r – Radius of curvature of the spring

P – Cutting force

R – Radius of curvature of cutter

F = K.δl

Where,

K - Stiffness

δl– Change in length

δl = 2 x π x R x (θ/360)

Where,

θ – Angle of deflection

= 2 x π x 150 x (20/360)

δl = 52.33 mm

F = 0.750 x 52.33

= 39.40 N

P x 380 = 39.40 x 150

P = 15.55 N

P x 380 = 39.40 x 150

P = 15.55 N

Chain drive calculations

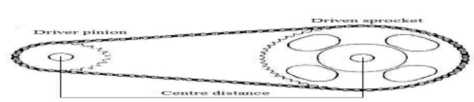

Fig.4 Chain

- Calculation of Chain drive ratio

=Number of driven teeth/Number of driving teeth

= 50/15

=3.33

- Determination of sprocket and pinion teeth

Number of sprocket teeth (Z2) = 50

Number of pinion teeth (Z1) = 15

- Determination of service factor

Ka= K1 .K2.K3.K4.K5.K6

i) Load factor K1

Variable load with heavy shocks = 1.5

ii) Factor for distance regulation K2

Fixed center distance = 1.25

iii) Factor for center distance of sprocket K3

ap = 1

iv) Factor for the position of sprocket K4

Inclination of line joining up to 60^0 = 1

v) Lubrication factor K5

Periodic = 1.5

vi) Rating factor K6

Single shaft = 1

Ka = 2.8125

- Design power

Dp = Input power x service factor

= 5.7 x 2.8125

Dp = 16.031 kW

- Calculation of center distance

a=30p to 50 p

a1 = 30 x 15.875

= 476.25 mm

a2= 50 x 15.875

= 793.75 mm

- Length of chain

Lp=2ap+Z1+Z22+((Z2−Z12π)2ap/)

Where,

Lp – Length of continuous chain

ap– Approximate Centre distance

` Z1 – Number of teeth on pinion

Z2 – Number of teeth on sprocket

a_p =a/p

Where,

a – Centre distance

p – Pitch of chain

a_p = 30

Lp = 93.534 mm

- Actual center distance

$a=e+\sqrt{e2-8m4p}$

$e= lp-(Z1+Z22)$

e = 61.03 mm

$m=(Z2-Z1)/2\pi)^2$, constant

m = 31.02 mm

a = 476.217 mm

IV. WORKING PRINCIPLE

Fuel from the tank is supplied into the engine. The fuel undergoes complete combustion and energy is produced. Energy produced has to be transmitted from the engine to various parts. Main purpose of power transmission is to rotate the rotary blades for ploughing operation and to rotate the worm drive for cutting operation. To rotate the blades for ploughing the soil, chain drive is employed to transmit power from the engine to rotary blades. Spacing between cutting of successive sugarcane depends on the ploughing and closing of sugarcane in the field. Timing takes around seven to ten seconds per feet depending on the throttle. To increase the cutting speed, gear mechanism is used.

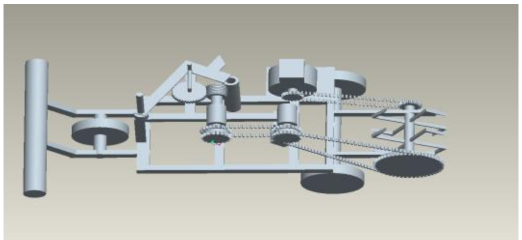

Fig.5 Modeling diagram

V. FABRICATION PROCESS

Frame construction

Hollow square frames are purchased based on the design and are joined by using arc welding process. Frame is the base for the machine in which all the components are inserted in it.

Shaft machining

To transmit the power from the engine to wheel, shaft plays a vital part. Based on the design shaft is machined by using turning process in the lathe.

Fitting of all parts

Engine is fitted on the left side of the frame. To transmit the power from engine, chain drive is connected at the both end of the frame. From the chain sprocket, worm wheel is connected to rotate the cutter blade to perform the cutting operation. For closing of sugarcane in the soil, soil displacer is used.

Testing of sugarcane planter in the field

After all the fabrication process, sugarcane planting machine is tested in the agricultural field. Under dry conditions of soil, field testing of sugarcane planting machine is done which is shown in the Figure 6

Fig.6 Field testing

VI.CONCLUSION

With the increasing demand for sugarcane these days, there is a primary need for sugarcane cultivation. The process of cultivation involves ploughing of soil, cutting of sugarcane and planting of sugarcane in the field. To perform all these operations, there is a need for large number of labours which in turn increases the overall cost of production. The cost reduction could be achieved by combining the three stages of cultivation into single stage. Further the machine tends to be highly compatible with any kinds of soil, by achieving different speeds based on soil condition. The variation in the speed is obtained by using four speed gear box. Thus this project is shown to be a highly efficient semi-automatic machine which requires less man power to carry out the sugarcane cultivation process.

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