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Research Article

Design and Fabrication of Multipurpose Machine for Sugarcane Planting

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Abstract

India is a major producer of the sugarcane in the world and during 2009-10 it produced 18.9 million tons of sugar, which was nearly 11.8 % of the total sugar production of the world. So there is large space for development in sugarcane plantation. In conventional method of planting sugarcane sets are planted manually in furrows. This process is very much time consuming and labour intensive. So we developed the new machine which cuts the sugarcane and feeds into furrow as well as feeding of fertilizer and spraying pesticide is done automatically. We use the cam operated mechanism with rotary cutter which cuts the sugarcane in uniform length and fed into the furrow due to gravitational force automatically. So piece of the sugarcane is distributed uniformly in the furrow so density of the sugarcane production is uniform. In traditional method fertilizer is spread by the hand so the density of feeding fertilizer is varies as per the worker which leads to extra supply of fertilizer. Due to this there is loss of farmer so we develop mechanism which feeds the fertilizer in uniform quantity. So after all processes leveler spreads the soil on pieces of sugarcane in the furrow.

Keywords: *modeling, design, furrow, cam, fertilizer. sugarcane , labour, planker, etc.*

1. Introduction

In conventional method of planting sugarcane sets are planted manually in furrows, opened manually followed by conveying manually. This is then covered manually or by animal operated plankers. Thus, the process is very much time consuming and labour intensive.

Many Tractor operated sugarcane planters have been developed. But the sugarcane planters which are currently available in the market are large in size and operated with the help of tractor. So, they can't be operated in smaller lands.

Our project is a compact Sugarcane Planter which can be operated in smaller lands by 2-3 labours, thus reducing the labour cost and speeding up the plantation process. This manually operated sugarcane planter will cut the sugarcane into equal parts and will plant them at equal distance.

1.1 Traditional method of sugarcane planting

Sugar cane grows from a stem, into a tall upright plant that looks similar to reeds that grow on the banks of a river. Unlike most stems that are planted upright, a sugar cane stem has to be furrowed and placed on its side in order for it to grow.

Farmers prepare the field very well by using disc narrows and cultivators. Tractor drawn ridgers are used to open furrows. Furrow to furrow spacing of 90cm is most common. Labours are employed to cut the sugarcane into three budded pieces, which is called sets. Fifty to sixty quintals of cane is required to meet the seed (sets) requirements for one hectare. The huge amounts of sets are transported to field and then manually dropped in furrows. Fertilizer and insecticide are also dispensed in the furrow, manually. Then sets are covered with soil either manually or by plough. Besides land preparation, all other operations required 50-60 man-days and 4-5 tractor hours. A farmer has to spend Rs 4000-Rs 4500/-for planting of sugarcane in one hectare.

1.2 Limitations of conventional method-

In conventional method more numbers of labors are required as well as more time requires. Non uniformity in stem cutting length and also in planting. Fertilizers are feed by hand so sometime extra fertilizer is provided so this raise to loss in money.

So for overcoming the limitation we are developing the new combined technology which digs, cuts the sugar cane and soil leveling in the farm automatically after feeding the sugar cane.

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1.3 Furrow dimension

We are using the ridge and furrow method which is most common method of sugarcane planting followed in Maharashtra. Below diagram shows the dimensions of furrow. Distance between two furrows and depth of furrow are the important dimensions.

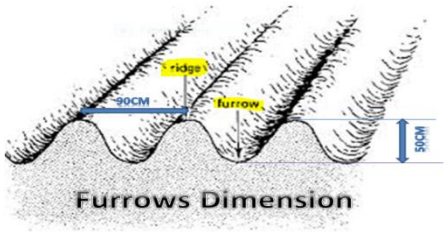

Fig.1 Furrows dimension

Length between two furrows- 90 cm
Height of the furrow- 50 cm

1.4 Length and spacing of sugarcane

Pieces of the sugarcane are planted with some distance between the two pieces. Length of the sugarcane pieces are selected such that there two eyes on the pieces which gives maximum output as compared with the one eye and three eye methods. It avoids heavy risk of gaps in single eye bud and over population by three eye bud planting method.

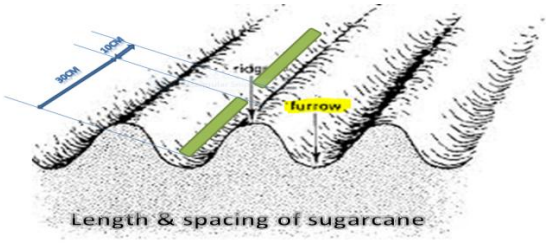

Fig.2 planting dimension

Length of sugarcane piece- 30 cm
Distance between two pieces- 10 cm

2. Design Section

2.1 Distance between two wheels (Length of the wheel axle)

For smooth running of the machine the wheels of the machine should travel through the furrow otherwise machine will tilt in one side. Since the distance between two furrows is 90cm so we kept the distance of 90cm between two wheels.

Distance between two wheels- 90 CM

2.2 Diameter of the wheel

During deciding the height of the axle from ground surface the depth of the furrow is important factor. To avoid the destruction of the furrow due to axle the height of the axle should be greater than the depth of furrow. Generally the height of the furrow varies in the 30-50cm as per the type of soil.

Diameter of wheel – 80CM

2.3 Axle

Considering the weight of the person and sugarcane, total weight on the shaft is 200kg approximately.
Number of shaft-2
Weight on one shaft -100kg =1KN (approx.)
Maximum bending moment = 50000 N-mm
Torsional moment = 26720837 N-mm
Material of shaft=30c8
Yield strength =400N/mm^2 fos - 2
Allowable shear stress= τ_{max} = 100 N/mm^2

Using Shear Stress Theory
$\tau_{max} = 16/(\pi*d^3) * (M_b + M_t)^{0.5}$
Diameter of the shaft – 52 mm

2.4 Speed calculations

For linear speed of 2 km/hr. of tractor
Linear speed of wheel (v) = 0.56 m/sec
Rpm of the wheel = 13.33
For 1 revolution of the wheel length of sugarcane required for feeding = 1884.95 mm
Piece length of sugarcane = 300mm
Number of pieces cut for 1 revolution = 1884.95 /300
= 6.28 = 7

Chain Drive

Power = 5hp = 3730watt
Maximum speed =200rpm (approximately)
Power transmitted (P) = 3.73 kW

From standard table of power rating, Chain no. 12B (KW rating-3.75) is suitable for above application.
The dimensions of the chain as follows:
Pitch (p) = 19.05 mm Width (b) = 11.68 mm
Roller Diameter (d_1) = 12.07 mm
Transverse pitch (p_t) = 19.46 mm
Braking load (N) = 28900 N
To avoid polygonal effect Z_2= 11
Pitch circle diameter of driven sprocket =68 mm
Now, $N_2/N_1 = 46.65/13.33 = 3.5$ Number of teeth on driving sprockets=$Z_1 = 3.5*11 = 39$
Pitch circle diameter of driving sprocket = 240 mm
Center distance between the sprocket (a) = 650 mm
Number of chain links = 94

Springs

Assuming force of 50N 0n the spring during extension
Spring Material= Patented Cold drink Steel Wire
Tensile strength=1190 N/mm

Modulus of rigidity G=81370N/mm^2
Permissible stress=0.50 Sut
Max. Spring Force=P=50N
Required Deflection= δ =70mm
Spring Index=C=8 … (std. table)
Wire diameter (d) =2mm
Mean Coil Dia. =D=C*d=2*8=16mm
No. of Active Coil (N) =55
End Type= Square &Ground Ends
N=Nt-2 N_t =57
Solid Length=Nt* d=57*2=114 mm
Total Gap= (Nt-1)*(0.5) = 56*(0.5) = 28mm
Free Length=114+28=142mm

Bearing Design

Shaft diameter=52mm
Load on bearing=1KN (Radial)
Equivalent bearing load =P=X V F_r + Y F_a
P=equivalent bearing load F_r=Radial load
F_a=Axial load V=Race rotation factor
In this application inner race is rotates whole the outer race is stationery. Therefore V=1
P=1*1000=1000N
Bearing life for automobile application is given as 50 million revolutions. L_{10}=50 million rev.
$L_{10}=(C/P)^p$ p=10/3 For roller bearing
Dynamic Load Capacity=3233.3N
From std. table for dynamic load capacity of 3233.63N & 50mm inner diameter bearing is 61810 (6240N)
Inner diameter=50mm Outer diameter=65mm
Axial width=7mm

1.5 Guide ways
Length of the guide ways=400mm
Width of guide ways=50mm
Thickness of guide ways=20mm

2. Modeling

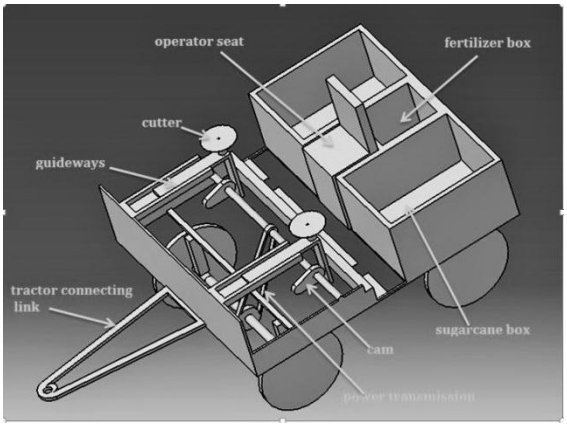

Fig.3 project structure

Motor is used to rotate the rotary cutter with a speed of 500rpm whereas the supporting plate with motor and cutter reciprocates on the guide ways. Reciprocating motion of cutter and plate is controlled by the cam and follower. Follower plate follows the curved shape of the cam. Cam is rotated at particular by drive train from the main axle of the machine. So camshaft is depending on the linear movement of the machine. After cutting the billets drop down in the furrow. For travel of 40cm of machine there is one rotation of the camshaft. So, we get one piece of 30cm for 40cm travel or linear movement.

For one rotation of the cam is there are 3 function are exist:

1. Cutting: During first 120^0 angle of rotation there is cutting stroke and the cutter moves towards the sugarcane and cuts the piece .During the cutting there is extension of the helical spring which connected between the supporting (motor) plate and frame. The forward movement of the cutter is 70mm which cuts the sugarcane completely and piece of sugarcane fall down in the furrow.
2. Return: After completion of cutting the rotor with plate moves backwards due to return force of the extended spring. For fast return stroke we give the less angle of rotation of cam.
3. Dwell: During this period there is no improvement of the cutter and plate. The sugarcane comes down for cutting of next piece. So after completion of this period again cycle is repeated.

Conclusion

1) From the simulation of the entire mechanism we got result as the safest design which can be able to take maximum load without failure with the given factor of safety.
2) And we are having a complete machine with the proper structural arrangement of the elements.
3) By using this machine we are getting uniformity in planting with minimum time and in less cost as compared to conventional method.
4) Also here we are added some additional accessories to this machine like fertilizer and pesticides feedings which raises its advantages.
5) We can attach this machine to any driving vehicles like tractors so furrow making and planting takes place simultaneously.
6) So, by combining all these attachments and mechanisms, accessories we are getting an whole planting process automatically with simultaneous other works like pesticides sprays etc. and the most important thing is that, all the activities are carried out in an accurately controlled manner which results into the highly précised planting process.

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