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Design and Fabrication of Crop Cutting Machine

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***Abstract*— This paper addresses a Crop cutting Machine which is fabricated with very simple mechanisms at very low cost. Cutting of crop is one of the important agricultural operations which demand considerable amount of Labour. The availability and cost of labour during cutting season are the serious problem. The Shortage of labour during harvesting season and vagaries of the weather cause great losses to the farmers it is therefore, essential to adopt the mechanical methods so that the timeliness in cutting operation could be ensured. The use of mechanical harvesting device has been increased in the recent years. Farmers using reapers or combines to harvest their crops but these means especially combine; these are very costly making it un-affordable to most of the small farmers. Although, some manual operated reapers were developed. But, due to limitations of manual power, none of them become popular as the power available for transportation of the machine as well as cutting and conveying of the crop was not sufficient. In this research, we are study and fabricate a Crop Cutting Machine at very low cost and techniques were carried out.**

Keywords*— Crop Cutting Machine; Crop Cutter; Crank and Slotted lever mechanism; Pulley; Gears

I. INTRODUCTION

Agriculture is the backbone of India. In India agriculture has facing serious challenges like scarcity of agricultural labour, in peak working seasons but also in normal time. This is mainly for increased nonfarm job opportunities having higher wage, migration of labour force to cities and low status of agricultural labours in the society. In India two type of crop cutting like as manual method (conventional method) and mechanized type of crop cutter. The crop cutting is important stage in agriculture field. Currently Indian former used conventional method for crop cutting i.e. cutting crop manually using labour but this method is very lengthy and time consuming. To design and analysis the crop cutting Machine which is help to the Indian farmer to small farm. It will reduce the cost of crop cutting in field. It will help to increase economical standard in Indian former. The design of the crop cutting machine will be presented by using CATIA software. Crop harvesting is last stage in farming which takes maximum time of farmer among all farming Process. In India harvesting is generally done manually. Thus our intention is to provide farmer a "Crop Harvester in Agriculture Approach" This machine consists of simple Mechanism make to run by a 2 stroke petrol engine which will be economical to farmer and will take less time for harvesting operation.

II. LITERATURE REVIEW

1. Godfrey P. Caldwell and Nigel W. Meek- The present invention relates to "crop cutting apparatus" and is concerned in particular, but not exclusively, with mowing apparatus suitable for cutting grass and other fodder crops.
2. Ingo Boeing and Andreas Haffert- The present invention relates to an "agricultural harvesting machine". For the operator of a harvesting machine, it is imperative that the parameters of the machine components be set correctly in order to ensure that a harvesting process is attained that reaches a desired harvesting goal to be attained at the end of the harvesting process chain.

III. WORKING PRINCIPLE

This machine consists of two mechanisms one is a Crank and Slotted Lever Mechanism for reciprocation of cutter blade over stationary cutter blade and this mechanism is used to convert rotary motion into linear motion. Second is collecting mechanism which consist chain sprocket and motorcycle chain. This machine is powered by 7.5HP, 3200 rpm 2 stroke petrol engine. By using V-Belt power is transmitted to bevel gear box. Bevel gear box is used to change direction of drive by 90 degree in the gear system. One end of this output shaft is connected to Crank and slotted lever Mechanism which converts rotary motion of shaft into reciprocating motion of cutter blade. Reciprocating cutter blade slides over fixed blade and creates scissoring action responsible for cutting the crop and other end is connected to the collecting mechanism.

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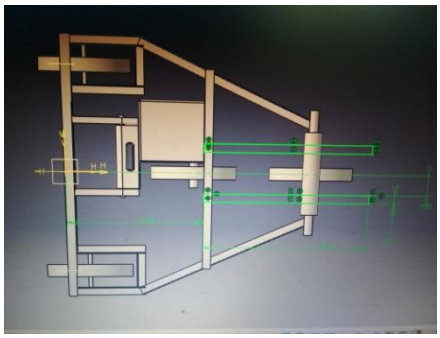
IV. CONSTRUCTION

Main Frame



The required frame must be in light weight and able to sustain weight of petrol engine. This crop cutting machine having dimension 72× 48 ×24 (l × b × h) inch^3 is fabricated. For fabrication purpose the mild steel angle section is use to built the frame.

Petrol Engine

2 Stroke Petrol engine of 7.5HP, 3500 rpm is used. And it is kick start type engine. Petrol engine is used because of it has good efficiency and easily available in rural areas.

Specifications- Displacement – 145.45cc
Maximum Power – 7.5HP (5500rpm)
Maximum Torque – 10.8nm (3500rpm)
Number of Cylinder – 1(2 stroke)

Cutter Assembly

Cutter assembly consists of a sliding and stationary cutter plate. A 1.5 mm thick plate is used to give a support at teeth. In this project the idea is to make the mechanization of small scale crop cutting machine. The machine focuses to combination of cutting and collecting the crop for small scale farmers. Different parts of a machine will be mounted on strong chassis. The wheel will be attached to this chassis. The petrol engine is mounted on the chassis which provides the power to the wheels to move by chain drive and gear.

Bevel gear Mechanism

It is required to transmit a power to two mechanisms that is four bar mechanism and collecting mechanism. To divert the motion by 90 degree this type of gear box is used.

Collecting mechanism

Collecting mechanism consists of motorcycle chain on which metal strips are welded for collecting crop. Chain sprocket used to carry chain. When cutting action takes place simultaneously collecting mechanism collects the crops.

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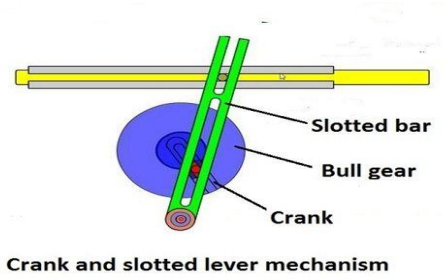
Crank and Slotted Lever Mechanism



Crank and slotted lever mechanism

The slotted lever mechanism is used to convert the linear motion of a slider into rotational motion or vice-versa. This mechanism is generally found on shaping machines where single point cutting tool is mounted on the front of the slider or ram, in a hinged tool post.

V. MATERIAL USED

- ✓ Bevel gear - carbon steel
- ✓ Angle - Mild steel
- ✓ Sprocket - alloy
- ✓ Pulley - cast iron
- ✓ V-Belt - synthetic rubber
- ✓ Shaft - mild steel

VI. DESIGN OF MACHINE

Calculation for Wheel RPM

Diameter of the Wheel (D) = 17 inch
= 17 x 25.4 = 431.8 mm
Diameter of driver Pulley (d_1) = 7 inch
= 7 x 25.4 = 177.8 mm
Diameter of driven Pulley (d_2) = 3 inch
= 3 x 25.4 = 76.2 mm
Teeth of driver Chain Sprocket (T_3) = 30
Teeth of driven Chain Sprocket (T_4) = 58
Speed of vehicle = 12 km/hr
= 12 x (5/18) = 3.333 m/sec
= 3333.33 mm/sec
Perimeter of wheel = $\pi D = \pi$ x 431.8
= 1356.54 mm
Revolution of wheel/ sec = (3333.33/1356.54)
= 2.457 Rev/sec
= 147.43 Rev/min

Calculation for driver and driven Pulleys

RPM of driver Pulley = RPM of Wheel
= 147.43 RPM
$(d_1/d_2) = (N_2/N_1)$
$N_2 = (d_1 \times N_1)/d_2 = (177.8 \times 147.43)/76.2$
RPM of driven Pulley (N_2) = 344

Calculation for driver and driven Chain Sprockets

Let, RPM of driven Chain Sprocket = N_4
RPM of driver Chain Sprocket (N_3) = RPM of driven Pulley = 344
$(N_3/N_4) = (T_4/T_3)$
$N_4 = (N_3 \times T_3)/T_4 = (344 \times 30)/58$
= 177.93≅ 178 RPM

Blade reciprocation in 1 revolution of driven Chain sprocket = 2
Total blade reciprocation in 1 min. = 178 x 2
= 356
Total reciprocation of blade in 1 sec = 356/60
= 5.93 ≅ 6

Forces and Energy calculation required to cut the Crop

Area of the wheat straw to cut by 1 teeth of blade
$= (\sqrt{3}/4) \times b^2$
$= 0.433 \times 25.4^2$
$= 279.36 \text{ mm}^2$
Area of wheat straw cut by the 10 teethes
$=10 \times 279.36 \text{ mm}^2$
$= 2793.6 \text{ mm}^2$
$A = 0.002793 \text{ m}^2$
Shear strength of the wheat straw (τ_{ult}) = 10 MPa = 10 N/mm^2
Required cutting force (F) = τ_{ult} x A
= 10 x 2793.6 N
= 27936.2 N
= 27.936 KN

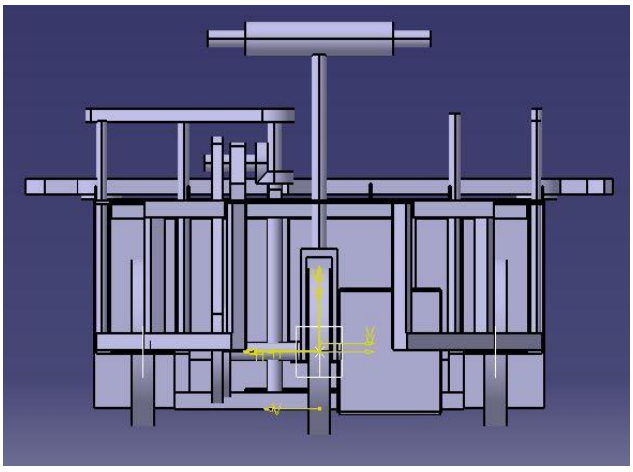
Calculation for velocity of collector mechanism belt

RPM of 2nd driven pulley = RPM of 1st driven pulley = 344
Diameter of plastic pulley (d) = 5 inch = 0.127 m
Peripheral velocity of plastic pulley = $\pi dN_4/60$
= (π x 0.127 x 344)/60
= 2.28 m/sec

Drawing of Machine

The drawing of the crop cutting machine will be presented by using CATIA drawing software.

Front/ Back view



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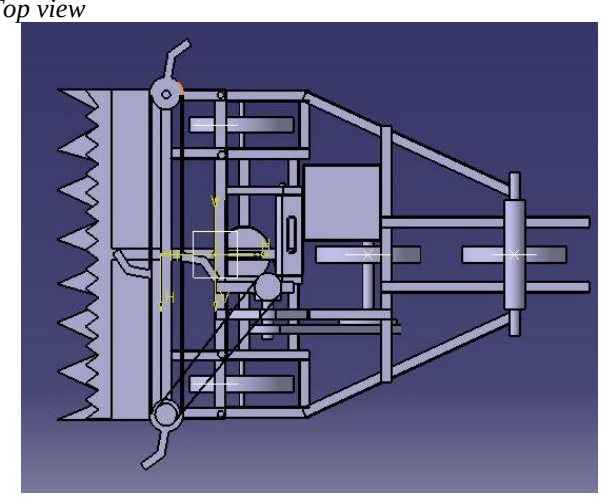
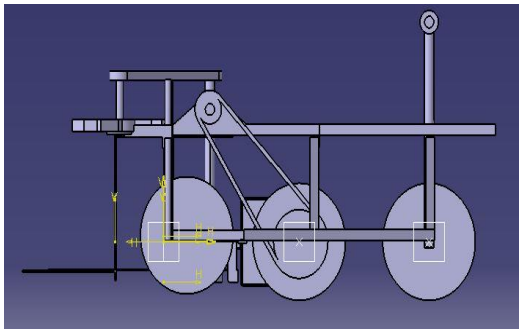
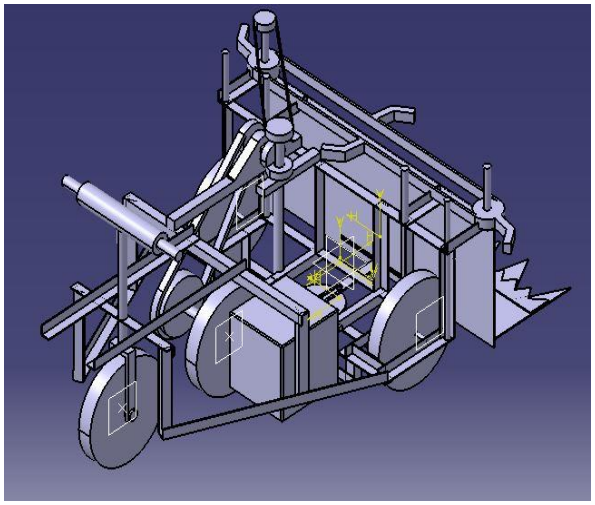
Top view

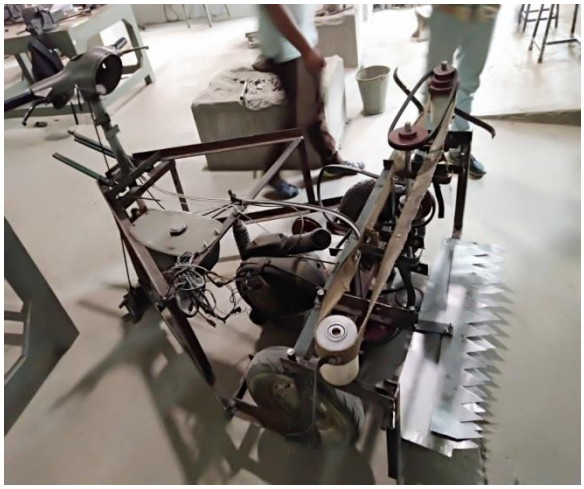


Side view



Isometric view





VII. COST ESTIMATION

A **cost estimate** is the approximation of the cost of a program, project, or operation. The cost estimate is the product of the cost estimating process. The cost estimate has a single total value and may have identifiable component values. A cost estimator is the professional who prepares cost estimates.

The total cost of the tool includes following costs:

1. Raw Material Cost
2. Standard Material Cost
3. Engine Repairing cost
4. Machining Cost
5. Transportation Cost

RAW MATERIAL COST CHART

Table 1

Parts Name	Material	Cost /kg	Weight in kg	Quantity	Total Cost (Rs)
Angles	MS	25	20	1	500
Shaft	MS	55	6.4	1	350
Engine	--	---	---	1	2500
Wheels	Alloy	---	---	3	1200
Handle	CI	---	---	1	500
Sheet Metal Sheet	Sheet Metal	11	10	1	110
Plate	MS	60	3.5	1	210
Engine Oil	---	270	0.75	---	200
Petrol	---	75	2	---	150
Paint	---	100	1.5	---	150
Painting Brush	Plastic	50	---	1	50

Total Raw Material Cost = Rs. 5920

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Standard Item Cost

Table 2

Sl. No.	Description	Total Number	Total cost in Rs.
1.	Nut-1	20	15
2.	Bolt-1	20	35
3.	Nut-2	10	15
4.	Bolt-2	10	35
5.	Bevel Gear	2	1000
6.	Pulley	4	800
7.	Bush Bearing	7	1400
8.	Grinding and cutting Blades	10	150
9.	Chain Sprocket	2	900
10.	V-Belt	2	300
11.	Flat Belt	1	250
12.	Plastic Pulley	2	100
13.	Welding Electrode	1.5 Packet	300
14.	Bush	5 Packet	100
15.	Allen Bolts	10	80
16.	Chain	1	150
17.	Bearings	4	350
18.	Break Lever	1	100
19.	Grease	1 Packet	50
20.	Drill Bit	2	100

Total Standard Item Cost = Rs. 6230

Machining cost

The time required to convert the raw material into the finished products is called as machining time. The machining time is to be calculated for each part. The machining time can be calculated by following formulae.

1. Turning, $Tm = \frac{L}{S \times N}$

Where, L = Length of job in mm,
S = Feed rate in mm/rev. and
N = RPM

2. Drilling, $Tm = \frac{L}{S \times N}$

Where, L = Depth of job in mm

3. Milling, $Tm = \frac{L}{S}$

Where, L = Length of travel in mm
S = Feed rate in mm/rev

Practically machining time includes material handling time, setup time, and idle time.

Our total machining Cost = Rs. 1000
Our Engine Repairing Cost = Rs. 850
Transportation Cost = Rs. 1000

Total Material Cost

Total material cost = Raw material cost + Standard item cost
= 5920 + 6230
= Rs. 12150/-
Total machining cost = Rs. 1000/-

Total Cost

Total cost = Total material cost + Total machining cost + Engine Repairing cost + Transportation Cost
= 12150 + 1000 + 850 +1000
= Rs. 15000

VIII. ADVANTAGES

- **Reduce the human effort-** Crop harvester is mostly design for reduce the human effort in which only one operator can be operate or handle the machine. While the machine will begin there not required more than one or two worker.
- **Reduce the cost-** In the agriculture for cropping the Wheat, Javar and Tuvar. It can cut at cheapest prices because it saves the worker cost.
- **Reduce the time-** When worker is cutting the crop they have more time for cutting but when the use of the crop cutter harvester they increase the capacity of the working and cutting and it can possible the maximum cutting within minimum time.
- **Easy to handle-**Crop cutter machine is easy to handle and we can easily start the machine.
- **Unskilled worker can operate-** No skilled person required for operating this machine.
- **Safety to use-** during the working if any problem occurs in the machine we can easily find it.
- **Adjustable Cutting mechanism-** The Cutting mechanism of this machine is adjustable. We can remove this mechanism very easily so it can be change, repair and replace with other mechanism also.

IX. DISADVANTAGES

- It can't cut Heavy weight crops.
- Water is harmful for this.
- Exhaust gases of engine is Harmful for environment.

X. CONCLUSION

FOR MACHINE:-

Machine is working in 1 acre area = the fuel consumption is 2 liter/-
Fuel cost is Rs. 150 + labor cost is Rs. 200 + M/C cost is Rs. 50 = Rs.400
Time for cutting of 1 acre area= 3 Hr.

FOR LABOUR:-

Labor Working in 1 acre area the associated cost = Rs. 1000
Cutting time for 2 labor in 1 acre area of farm = 10 hr.
Hence in above comparison it is clear that the cost of working by machine in the farm for said application is less as compared to labour cost.

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