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# Automatic Mechanical Cutter Using Crank and Slotted lever Mechanism

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**ABSTRACT:** The present world is heading towards the rapid growth and development of all sectors with the help of machines including the agricultural sector. Agriculture is one of the oldest professions and the use of machinery has replaced the requirement of human efforts. With the help of technology, a smaller portion of our population is providing food by working in agricultural fields. The Industrial Revolution and the development of complicated machines used to perform the complicated tasks have changed the basic technology of agricultural machines to boost the production rate. The aim of this project is to design and fabricate the automatic mechanical cutter by using crank and slotted lever mechanism for cutting agricultural products like sugarcane etc. and even it can be used to cut the wooden pieces. The instrument uses crank and slotted lever mechanism with a slider to couple with an electric motor using pulley and belt drive.

**KEYWORDS:** Lever, Link, Quick return mechanism, Slotted bar.

## I. INTRODUCTION

The working principle behind the operation of the simple mechanical cutting machine is the four-rod chain mechanism, especially the crank-arm mechanism and the slotted lever mechanism. It is also used for agricultural purpose. This plan aims to upgrade the machine to reduce the Labor cost and time required for the cutting process. The rotation of the crank wheel is done by the motor with the help of pulley belt assembly. The crank converts rotational motion into reciprocating motion by the coupling link using the slider. The oscillating motion at the other end of the coupling link is converted to a reciprocating motion towards the blade using a guide hole. Therefore, the rotational motion of the crank is converted to a reciprocating motion towards the blade through the mating link. The object to be cut is placed on the platform. Due to the reciprocating motion of the blade, the object placed on the platform is a knife to successfully transmit the rotational motion of the motor to the crank with a minimum slip V-belt drive. The bearing that supports the shaft is a ball bearing for smooth operation.

Earlier saws for cutting metal were being used for a long time, in the 1880s noteworthy upgrades in lifespan and effectiveness were made by Max Flower-Nash. The tests were directed which included changing the measurements, states of teeth, styles of set, and variable warmth medications of cutting edges. Clemson guaranteed tremendous changes to the cutting capacity of edges and constructed a noteworthy mechanical activity fabricating hacksaw sharp edges sold under the exchange name Star hacksaw.

## II. LITERATURE SURVEY

**Elizabeth, [1999-2000] [1]** studied the design and tested the sugarcane yield monitoring system during the 1999 and 2000 harvest year. The sugar stick yield observing framework consisted of a scale, an information picking up framework, and a level of contrast worldwide situating framework (DGPS).

**Chaudhari, [2015] [2]** studied the planning and manufacturing of little scale sugar stick gatherer for sugarcane collecting to lessen rancher's exertion and to build creation of farming products was made.

**Chander, [2020] [3]** designed a solar powered Agri-cutter that consists of D.C. motor, a rechargeable battery, solar panel, a stainless-steel blade that is directly paired with the shaft of the D.C. motor.

**Wilson, [1986] [4]** studied the vast literature to understand the concept which affect the performance of the machine. The concept of the two-way hacksaw cutting machine mainly carried out for production-based industries.

**Lin Xu, [2011] [5]** researched about the shaft of the motor that rotates at about 90 – 100 rpm with the 2HP power. A disc is mounted on the shaft of motor with the help of key and key slot arrangement. It consists of pedal powered machine setup which has a simple mechanism that operates with a chain and sprocket arrangement.

**Chaudhary, [1986] [6]** studied about the chain which is put on the teeth of the haggel. The pole mounted on platform direction. To initiate with mechanical linkage is evacuated by expelling nut and screws and v belt drive boring connection. It is realized that regular power hacksaw machine can be supplanted with robotized control hacksaw machine.

**Layer, [2002] [7]** concluded that the process of identifying a failure mode is complicated because different techniques can be used to determine the actual case of failure.

**Boyer, [1975] [8]** conveyed that mechanisms and environmental factors could give rise to failures. He also suggested that identifying the type of failure mode is required for failure analysis of a metal structure. The failure mode is classified as either a deformation or a fracture.

**Bahaley, [2012] [9]** expressed that automated power hacksaw machine gives high efficiency in brief day and edge in examination with the ordinary power hacksaw machines. The real preferred standpoint of this machine is intercessions of work is lessened to greatest level. The material choice and testing of hacksaw sharp edge in light of mechanical properties expressed that the suitable saw edge must be chosen for better activity and fine cutting by choosing number of teeth per inch.

**Khan, [2017] [10]** expressed that the industries are essentially implied for generation of valuable merchandise and enterprises at low creation cost, Machinery cost and low stock cost. Information about building a model of a machine reach would be fit to carry out various tasks all the while, and it ought to be monetarily productive. A solitary stage vertical electric engine unbendingly set at the focal point of metallic establishment.

**Panchkand, [2015] [11]** did the structure and created little scope sugarcane gathering machine to diminish rancher's exertion and to build creation of agrarian items. As compared to labour-intensive harvesting this machine has an ability to cut in faster rate and it is economical.

**Linder, [2009] [12]** expressed that they are worried about the numerical displaying of split expanding in weak materials utilizing limited components with installed solid discontinuities, that is, discontinuities in the relocation field characterizing the arrangement of the basic limit esteem issue. The execution of the new components is represented with a few numerical reproductions including different methodologies for the treatment of expanding and examinations with accessible trial.

**Travas, [2009] [13]** explored the influence of loading rate on the failure mode of the beam parametric. In accordance with test results known from the literature, the numerical results are evaluated, discussed and compared. The beam resistance and failure mode strongly are dependent on loading rate. The output matches the theoretical and experimental results known from the literature.

**Leonel, [2011] [14]** stated that the designers of machines or structures must achieve acceptable levels of performance and at the same time, assure the part is safe and durable. Therefore, it is necessary to avoid excess deformation, such as bending, twisting, or stretching, of the machine components. To avoid structural failure, the stress in a component must not exceed the strength of material, where the strength is simply the stress that causes the deformation or fracture failure.

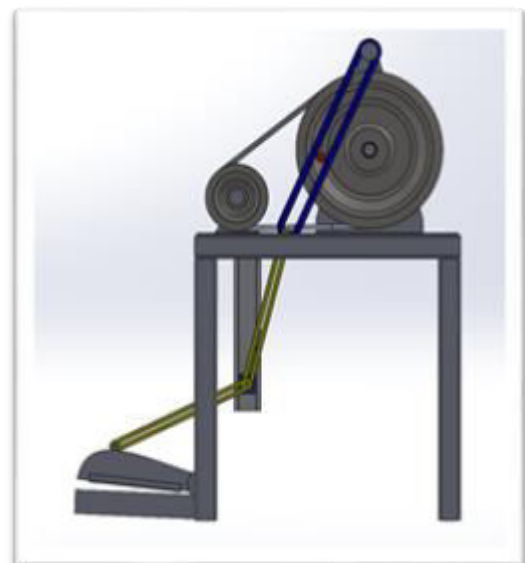
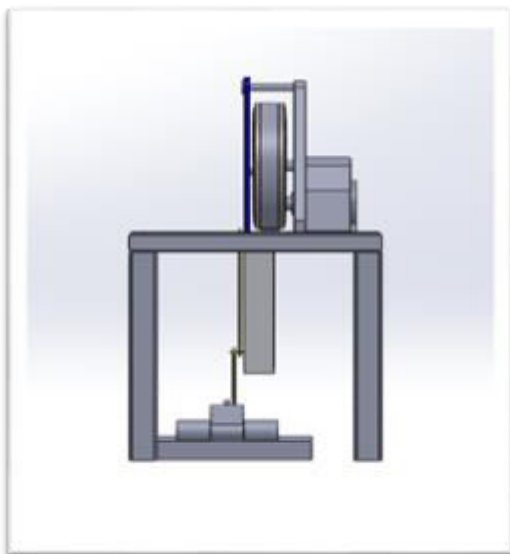
**Joby Bastian, [2014] [15]** the mechanical properties of the plant material fundamentally impacted the exhibition of the diverse unit activity in join collector. Henceforth, investigations of these properties were done before the structure of sugarcane reaping frame-work.

### III. PROBLEM STATEMENT

To design and fabricate a mechanical cutter using crank and slotted lever quick return mechanism for effective cutting of sugarcane and similar crops.

### IV. DESIGN AND FABRICATION OF MECHANICAL CUTTER

- The frame forms the base structure of the machine, it's made up of L-section and is fabricated and formed as a single component. The material used for the base frame is mild steel, as the frame should be strong enough to carry the load of the assembly. The frame being made of mild steel, is durable and flexible. Mild steel may be a sort of steel with a low amount of carbon – it's actually referred to as "low steel". It contains about 0.05% to 0.25% of carbon by weight. Due to the less carbon content, it is more ductile, machinable, weldable and affordable.
- The motor used is 1.5 HP single phase AC electric motor, with 2 poles and copper winding. This machine can reciprocate about 1440 times per minute. It has 50 Hz frequency and voltage around 220 V to 240 V. It has a metal sheet body, to be capable of withstanding heavy pressure without collapsing. The durability extends to the elements as well as the metals are resistant to corrosion, moisture and sun. Sheet metals lends itself to project in each type of material.
- The belt used for the machine is of rubber canvas material, as these types of belts are very flexible, and can be easily made endless. These belts are made with impregnating fabric or canvas with rubber and have a thin layer of rubber on the surface of the belt. They are reinforced with nylon strings or steel cords for better tensile strength. This material is suitable where the belt is exposed to moist.
- The structure of the belt pulley is simple and easy to adjust. It works smoothly with low noise and low vibration. The belt pulley used for transmission is made of Gray Cast Iron, as it has high compression strength and tensile strength. It is immune to deformation as well as resistant to oxidation which is made by reaction of oxygen and iron. The amount of carbon in Gray Cast Iron is about 3 – 4%. It is very strong, non-deformable and cheaper. It is an alloy of Carbon and Iron and is formed by remelting of iron, small amount of Silicon, Phosphorus, Manganese and Sulphur are also present in it.
- The cutter is made of high carbon steel, which contains about 0.60% Carbon. It is also referred to as carbon alloy steel, with around 0.16% to 1.5% carbon. The carbon content is what makes the steel stronger and harder, which makes a nice and sharp blade.
- The design and fabrication of this machine is done in SolidWorks Fig. 1.





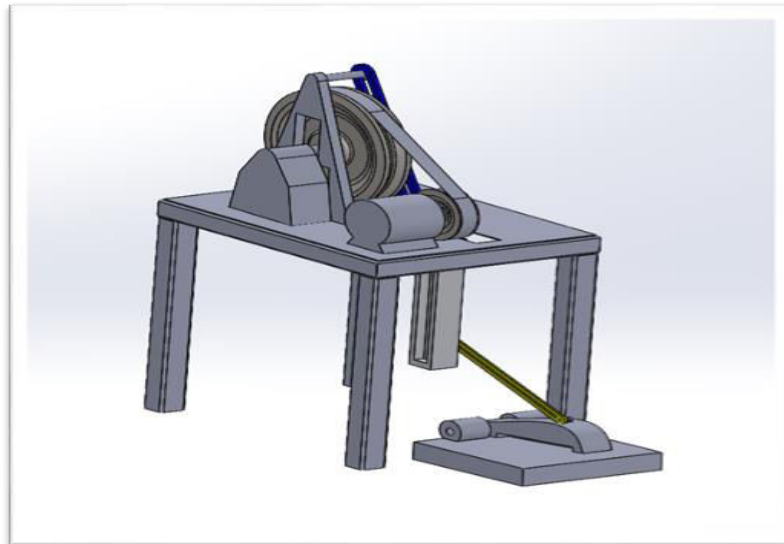


Fig. 1. Mechanical cutter design model in SolidWorks

## V. EXPERIMENTAL SETUP

The existing model has an integration feature of all hardware components that have been used and developed in it. The presence of each single module has been thought out and positioned very carefully. The experimental setup represents the manufacture of mechanical cutters for agricultural purposes. For experimentation or to check the skill of the work it is created with crank and slotted lever mechanism and all the required components are carefully connected. As with the four-bar link, the current job is set up in the same order. The electric motor is mounted on the frame. First the rotor shaft is connected with the crank. The first edge of the rocker is connected with the crank, and the second edge of the rocker is locked with the splined lever, it moves with the parallel movement. Finally, the slotted lever joins the working blade. The working blade is fixed at the bottom of the holder.

## VI. DESIGN ANALYSIS

### 1) Frame Design

Height of frame = 600 mm  
Length of frame = 600 mm  
Width of frame = 450 mm

### 2) Calculation for motor selection

Torque  $T = \text{Force} \times \text{Perpendicular distance}$

Power  $P = \frac{2\pi NT}{60} = 1693.31 \text{ Watt}$

2.1) For light duty work up to 10 hrs/day

Design Power = S.F X P = 1.6933 kW



- Motor Specifications and parameters

| PARAMETERS     | SPECIFICATIONS  |
|----------------|-----------------|
| Voltage        | 230 V           |
| Power          | 2 HP            |
| Current        | 14.5 A          |
| Motor Type     | Single Phase AC |
| RPM            | 1440            |
| Hz             | 60              |
| Service Factor | 1               |

3) Smaller Pulley Diameter (d)

$$1100(P_d/N_1)^{1/3} \leq d_{min} \leq 1300(P_d/N_1)^{1/3}$$

$$d = 125\text{mm}$$

4) Larger Pulley Diameter (D)

$$D = d \times (N_1/N_2) \times \eta = 315\text{mm}$$

4.1) Actual  $N_2 = (d/D) \times N \times \eta = 560\text{ rpm}$

5) Pulley Speed

$$V = (\pi d N_1) / 60 \times 1000 = 9.42\text{ m/s}$$

6) Centre Distance

Speed Ratio =  $D/d$   
 $C = 315\text{mm}$

7) Belt selection

Selecting V-belt as V-shaped section of belt follows a groove in a pulley which prevents the belt from slipping and improves the torque transmission. It takes less space.

$$\text{Belt Length } (L_p) = 2C + \pi/2 (D + d) + (D - d)^2/4C = 1415\text{mm}$$

8) Final Central Distance

$$C = A + (A^2 - B)^{1/2} = 350\text{mm}$$

9) Angle of Lap / Contact over small pulley

$$\Theta = 180^\circ - (D - d)/C \times 60^\circ = 2.57\text{ rad}$$

10) Belt specifications

Material → Rubber Canvas Material

$$\mu = 0.3$$



11) Belt Tension

$$T_1/T_2 = e^{(\mu\theta/\sin\beta)} = 9.75$$

12) Torque acting on pulley

$$Mt_1 = (P \times 60 \times 10^6) / 2\pi \times N_1 = 11229.04 \text{ N.mm}$$

13) Number of belts ( $n_b$ )

$$n_b = (P \times F_s) / (k_w \times F_c \times F_d) = 0.63 \approx 1$$

14) Smaller Pulley Construction

$$l = 2f + (n_b - 1) \times e = 20 \text{ mm}$$

Assuming Shaft Load

$$Mt_{sq} = (Mb_1^2 + Ml^2)^{1/2} = 12244.66 \text{ N.mm}$$

Shaft Diameter

$$d_{s1} = 16Mt_{sq} / \pi\tau = 20 \text{ mm}$$

Thickness of Web = 3.33 mm  $\approx$  5 mm

15) Larger Pulley Dimensions

Material  $\rightarrow$  Cast Iron

$$Mt_{sq} = (Mb_2^2 + Mt_2^2)^{1/2} = 28714.62 \text{ N.mm}$$

$$d_{s2} = 16Mt_{sq} / \pi\tau$$

$$d_{s2} = 50 \text{ mm}$$

$n$  = No. Of arms = 4

$$\text{Major axis (a)} = 2.94 [(l \times D) / 4n]^{1/3} = 25 \text{ mm}$$

$$\text{Minor axis (c)} = 0.5 \times a = 12.5 \text{ mm}$$

$$\sigma_b = Mb/Z = 25.18 \text{ N/mm}^2$$

## VII. CONCLUSIONS

This model is made with preplanning and provides flexible operations. The mechanical cutter system is very economical. The automatic mechanical cutter using four bar link mechanism is designed and fabricated with the hope that according to the torque given in the crank wheel, it may be used in different fields. It helps in agriculture product cutting and reduces the human support. The each and every module present in it is reasoned out and placed very cautiously. Hence contributes as the best working unit for "Designing and development of mechanical cutter". This work helped us to know how to work in group for achieving the goals. Thus, we have completed the project successfully.



## VIII. DISCUSSION

During the early-nineteenth century, cutting methods involved hand tools and cranks, which consumed a lot of time and human efforts. Joseph Whitworth created the quick return mechanism in the mid-1800s. Using kinematics, he set on that the force and geometry of the rotating joint would affect the force and motion of the connected arm. From an engineering standpoint, the quick return mechanism had a great impact on the technology of the Industrial Revolution by minimizing the duration of a full revolution, thus reducing the time required for a cut or press. Reciprocating motion for operating the tool of a shaping machine etc. In which the return stroke is faster than the cutting stroke so as to reduce the idling time.

## IX. ACKNOWLEDGEMENT

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