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Design and Fabrication of Multi-Purpose Cutting Machine for Agricultural Uses

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Abstract: ***As agriculture is one of the main occupations in India, it is very essential to discover and implement new ideas in this field, although a lot of work has been done in this area. It is a pity that these ideas are not properly implemented in the real field. This is due to the high cost and difficult for the rural population.***

Multi-purpose agricultural cutting equipment is the basic and main equipment involved in agriculture for maximum performance.

The conventional method of planting and growing crops is a laborious process, and therefore there is a shortage of manpower, resulting in a delay in agriculture to overcome these difficulties.

Multi-purpose agricultural equipment is designed. Agriculture plays a vital role in the Indian economy. Over 70% of rural households depend on agriculture.

Agriculture is an important sector of the Indian economy, contributing approximately 8.4% to the total GDP and providing employment for over 60% of the population. Indian agriculture has experienced impressive growth over the past few decades.

Keywords: Sugarcane Seed Cutting, Groundnut Stripper, Straw Cutting, Design, Fabrication, Modeling.

I. INTRODUCTION

In India, agriculture has faced serious challenges such as agricultural labor shortages not only during the peak working season, but also during normal working hours. On the other hand, arable land is decreasing due to urbanization. Agricultural mechanization is one way to overcome this problem.

The main agricultural products of India are peanuts, rice, sugar cane and wheat. Some of these agricultural products are explained below:

To plant sugar cane, sugar cane seeds should be planted in moist soil. This sugar cane seed is nothing more than a part of the sugar cane. In the traditional way, farmers usually cut the entire sugar cane into 5-6 parts, so that each part has 2-3 seeds. Then those cut off parts are planted in the ground.

The chaff is the remaining part of the Jowar and corn plant, after removing the corn part. Farmers used to cut this straw and use these cut parts as pet food such as buffalo, oxen, cows and goats etc. Peanut is one of the most important agricultural products in India. Farmers used to manually separate peanuts from their plants. This is more labor intensive like 20-30 jobs per acre, and it is also a very time-consuming operation. Rice is one of India's favorite foods.

II. OBJECTIVE

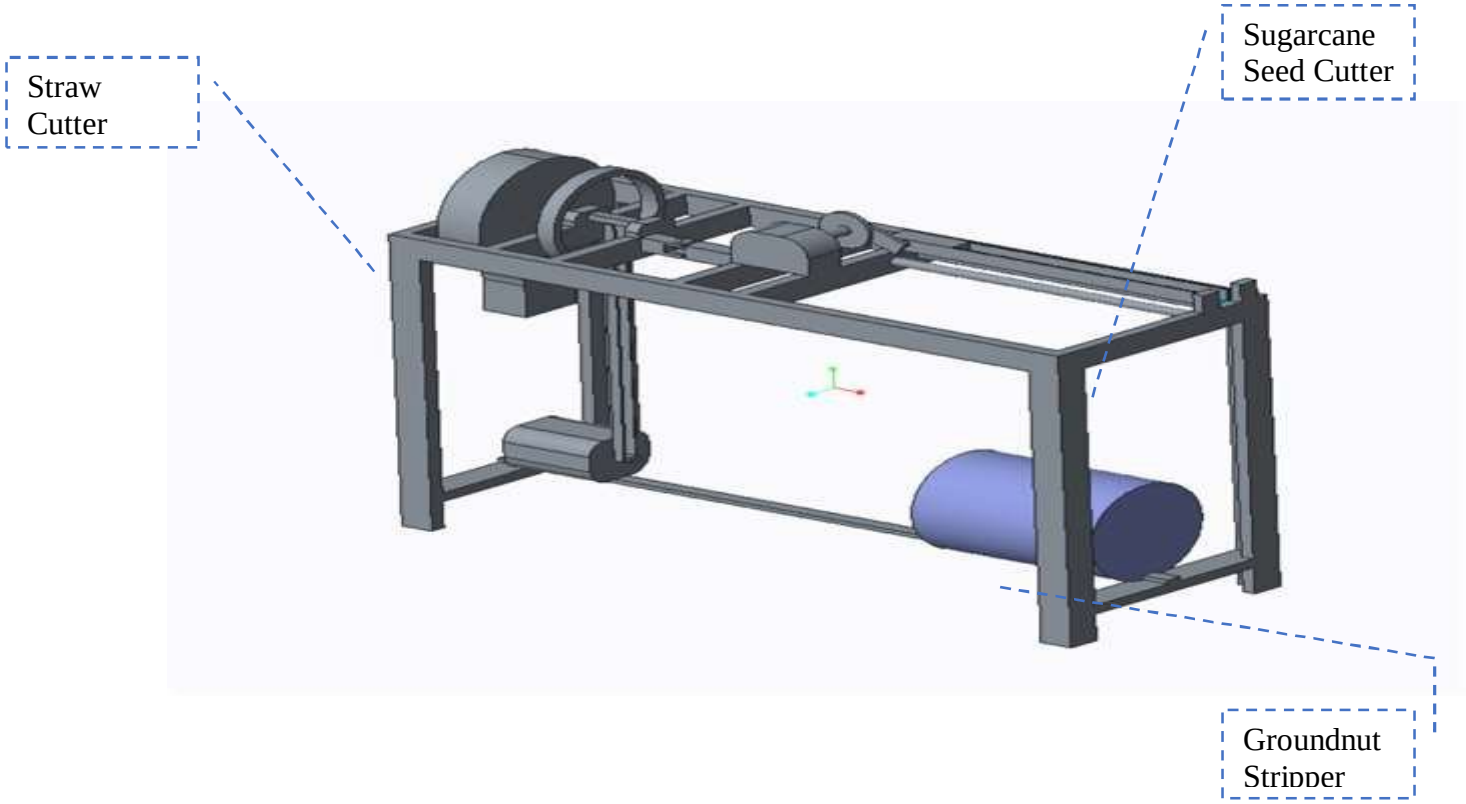
1) To perform more than one operation at a time.
2) To achieve high volume mass production of agriculture products.
3) To reduce most of processing time.
4) To reduce labour cost.
5) To overcome the problem of labour crises.

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III. MODELLING OF MACHINE

The 3D isometric view of multipurpose cutting machine, including different operation by using creo cad software.



IV. MAIN COMPONENTS

1) *Power Source (Motor):* The electric motor is an electric machine used to convert electrical energy into mechanical energy, for smaller loads such as in domestic applications. Although traditionally used in fixed speed services, induction motors are increasingly used with variable frequency drives in variable speed services. Power of motor= 1 hp. Speed of motor 1400 rpm.



2) *Gearbox:* The gearbox is used to reduce shaft speed and control rotational movement. Most modern gearboxes are used to increase torque by reducing the speed of the output shaft of the prime mover. This means that the output shaft of a gearbox rotates at a slower speed than the input shaft and this reduction in speed produces a mechanical advantage by increasing the torque. Some of the simpler changes simply change the physical direction of rotation of the power transmission. The helical and helical gearbox is used to transmit the output power. A reducer designed with a worm and a worm wheel is considerably smaller than one made with a simple spur gear and has its drive shafts at 90 ° to each other. With a single worm, for each 360-inch revolution of the worm, the worm advances only one gear tooth .



Gear ratio 1:30.

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3) *Shaft:* A solid shaft rotating at 1440 rpm is assumed to be made of mild steel. A Shaft is a rotating element, usually circular in cross section, line shaft is used to transmit power from one shaft to another, or from the machine which produces power, to the machine which absorbs power.



4) *V-Belt Pulley:* To transmit power from motor to cutter blade shaft this V pulley is used. V belt drive arrangement is used to transmit power from motor to shaft which is connected to cutter mechanism. The use of V-belts in multiple, allowed drives with a much variable range of power capacity than ever before obtainable using single belt drives.



5) Universal Join: A universal joint is a joint or joint that connects rigid shafts whose axes are inclined relative to each other. It is commonly used on shafts that transmit rotary motion. It consists of a pair of hinges placed close together, oriented at 90 ° to each other, connected by a transverse axis.



6) *Pedestal Bearing:* It has two Pedestal bearing are extensively used for furnishing support for a rotating shaft with the help of compatible comportments . It's used for long shafts taking intermediate support.



7) *Clutch:* Clutch is used to allows motor power to be applied gradually when a groundnut stripper is starting out it is operate manually by lever. It is connected to the shaft.





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8) *Wheel:* In market wheels are available in different size , shape and material. In our project we choose of straight fixed caster wheel sixer.



V. CONSTRUCTION AND WORKING

In this project, the idea is to mechanize a bit of agriculture as well
designed and built a machine, where it is possible to perform the following operations,

1) Sugarcane seeds cutting.
2) Groundnut stripping.
3) Straw cutting.

The different parts of this machine will be mounted on a sturdy frame. The wheels will be attached to this frame, so that it can move around the farm and it is a multipurpose cutter, to work in different conditions.

A. Sugarcane Seed Cutting

When the single-phase motor is turned on, it starts running at 1400 rpm. Belt and pulley drive reduces speed to 700 rpm. This speed is transmitted to the gearbox which contains the worm and the worm wheel which has a gear ratio of 1:30. The speed is now reduced to 23 rpm. A cam is connected to the gearbox which converts the rotary motion into reciprocating motion of the cutter. As the cutter advances, it cuts the sugarcane which is manually fed. When the cutter moves backwards, it releases sugarcane sprouts and these sprouts are collected in the collector. With this method, the rotational motion of the motor is converted and delivered as a reciprocating motion at the end of the cutter and, finally, the removal of the yolk is also achieved.





B. Groundnut Stripper

It consists of hollow cylinder with the rod welded on the its periphery. The electric motor which is connected to the external power supply transmitted to the shaft. The rotating shaft is mounted on the roller cylinder. Groundnuts are supplied in a rotating blades will be separating the groundnut from the plants and shelling.

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C. Straw Cutting

It consists of two blades which is mounted in a circular ring that connected to the motor through the belt drive. Rotating blades will be cut the straw into small pieces.




VI. DESIGN CALCULATIONS:

A. Sugarcane Seed Cutting

Force required to cut the bud of sugarcane F= 400N Bud cutting frequency = 23/min
Leather Belt specification:
ρ= 0.95 g/cm³
μ=0.35
t=5 mm
Permissible stress:
σ= 2.45 N/mm²
Centre distance of pulley = 25 cm
width of belt= 13 mm
thickness=5 mm

Worm gear specification:
Speed ratio:- N2/N1= 30:1
So N2=N1 x30
So N2-23 x30
So N2-690
Pully:-D2=10 cm
V=TD2N2/1000*60
V=(π×10×100x690)/1000*60
V= 3.611m/s

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Length of belt :-
L=2C+ ((D1+D2))/2+ (D2-D1)2/4C
L=2×250+ (π(64.28+100))/2+ (100-64.28)2/(4×250)
L=759.1955mm
a 180-2 sin-¹(D2-D1)/2C
a 180-2 sin ¹(100-64.28)/(2×250)
a=171.806º
a=171.806/180×T
a=2.997 rad

Volume of belt:
V=LXBXT
V=100×13/10×5/10
V-65 cm3/m

Mass of belt:
m=0.95×65 gm
m=0.95×65/1000 kg
m=0.06175kg
mv^2=0.06175 × 3.6112
mv^2=0.80522
e(μxa)= e(0.35×2.997)=2.854
(T1-mv2)/(T2-mv^2)= e(uxa)-2.854
(T1-0.80522)/(T2-0.80522)= e(uxa)=2.854

Max permissible stress in the belt:
0= T1/A
T1= o XA
T1= 2.45 ×5×13
T1= 159.25N
So, T2= 55.798N
P=(T1-T2)XV
P=373.5 W
Torque Calculation

Torque formula:
P= (2*3.14*N*T)/60
where, P stands for Power, N stands for Speed, T stands for Torque. Torque in the motor before speed reduction,
P= (2*3.14*N3*T3)/60
373 = (2*3.14*1400* T1)/60
Hence, T3 = 2.54 (Nm)

We know that,
T3x N3 = T2x N2
Hence, T2 = (T3 x N3)/N2
thus, T2 = (2.54 x 30) T2 =5.08 (Nm)
Assuming the transmission efficiency is 82% hence, T2=5.08x 0.82
Hence, T2 = 4.16 (Nm)

For gear box :
T2x N2= T1x N1
4.16x 700 Tlx 23
T1= 126.6 (Nm)

Design of shaft:
Total vertical load acting on the pulley:
Wt = T1+T2 +W
= 159.25 + 55.798 +2
= 217.048 N

Bending moment acting on the shaft:
M = Wt x L
= 217.048 × 50
= 10852.4 N-mm

Twisting moment acting on the shaft:
T = 4160N - mm
Equivalent twisting moment:
T_{e} = root(2, (M ^ 2 + T ^ 2))
overline 2) 4^ 2 +4160^ 2) = sqrt[2] (10852.4^ 2 +
=11622.40 N-mm
t = 250N / m * m * 2
sigma yt
fos = 4
tau yt =0.5* sigma yt =125 N/mm^ 2
tau_{w} = 125/4
=31.25 N/mm^ 2
tau_{w} = 16T_{e} / pi * d ^ 3
d = (16 x 11622.40)/π x 31.25
=12.37 mm
=13 mm

As we are using 25mm dia. Shaft. So our design is safe.

Cutter Design:
Tyt = 125 N/mm² F= the average force for punching from the literature and the experiment is 400 N.
Tyt = F/A
= 400/2 x (D²/4)
= 400/2 × (25²/4)
= 0.4076 N/mm²

Since, t<<ty
Hence design is safe under shear.

B. Straw Cutting

This part of machine will cut straw, grass, maize plant and paddy plants etc., among these all the maize plant having more strength. So the machine requires more power to cut this maize plant. The force required to cut maize plant is 243 N. Now the calculation for power required for straw cutting operation is given below,
Torque = force × distance

Force = Force required to cut maize plant in N
Distance = 47.5/2 (47.5 is radius of pulley on which blade will be placed)
= 23.75 cm

Torque = 243 × 23.75= 5771.25 × 10-2 Nm
Power (P) = (2 × π × N × T)/60= (2 × π × 150 × 5771.25× 10-2)/60
P = 906.54 W
By considering loss,
Efficiency of belt = 85%
P = 906.54/0.85
= 1066.52Watts
P = 1 HP

C. Groundnut Stripper

Cutting energy = 147 mJ/mm2
Power (P) = 147 × Area
P = 147 × (π × d2)/4
P = 147 × 9.62
(By considering diameter of groundnut rubber blades is 3.5 mm)
P = 1414.30mJ
P = 1.414 J
This power is for only one groundnut plant, so by considering nearly a bunch of
30 groundnut plants the power is given below, also by taking belt efficiency as 85%l .
P = 1.414 × 30
P = 42.42 J
But, 1J/s = 1 W
P (J) = 42.42 J
P (W) = (42.42 × 480) / (60 × 0.85)
P = 399.24 Watts
P = 0.54 HP
According to power calculation maximum power required is 1 hp. So, the
motor is purchased of 1.50hp, because the standard available motor is of that value.

VII. ADVANTAGES, DISADVANTAGE AND APPLICATION OF MACHINE

A. Advantages

1) Labour cost is reduced.
2) Wastage of sugarcane is reduced
3) Easy in construction.
4) Easy to maintain.
5) It reduces time.
6) It does not create air pollutant.

B. Disadvantage

1) Machine is heavy weight.
2) Machine creates more noise.

C. Application

It is used in agriculture sector.
It helps institutions such as the agricultural university, the agricultural university and, in School children to learn about the agricultural operation of farmers.



Figure :- Actual Machine



Figure :- Sugarcane Seed Cutting



Figure :- Groundnut Stripper

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Figure :- Straw Cutter

VIII. FUTURE SCOPE

The future scope of this machine is very broad. There are separate machines available on the market for individual operation, and these machines are also more expensive. Other operations can be combined. And some of the operations can be done manually. If the wheels are supplied to the machine, it can be moved from one place to another. Through the use of worm gears, it is possible to realize automatic straw feeding in the straw cutting operation.

IX. CONCLUSION

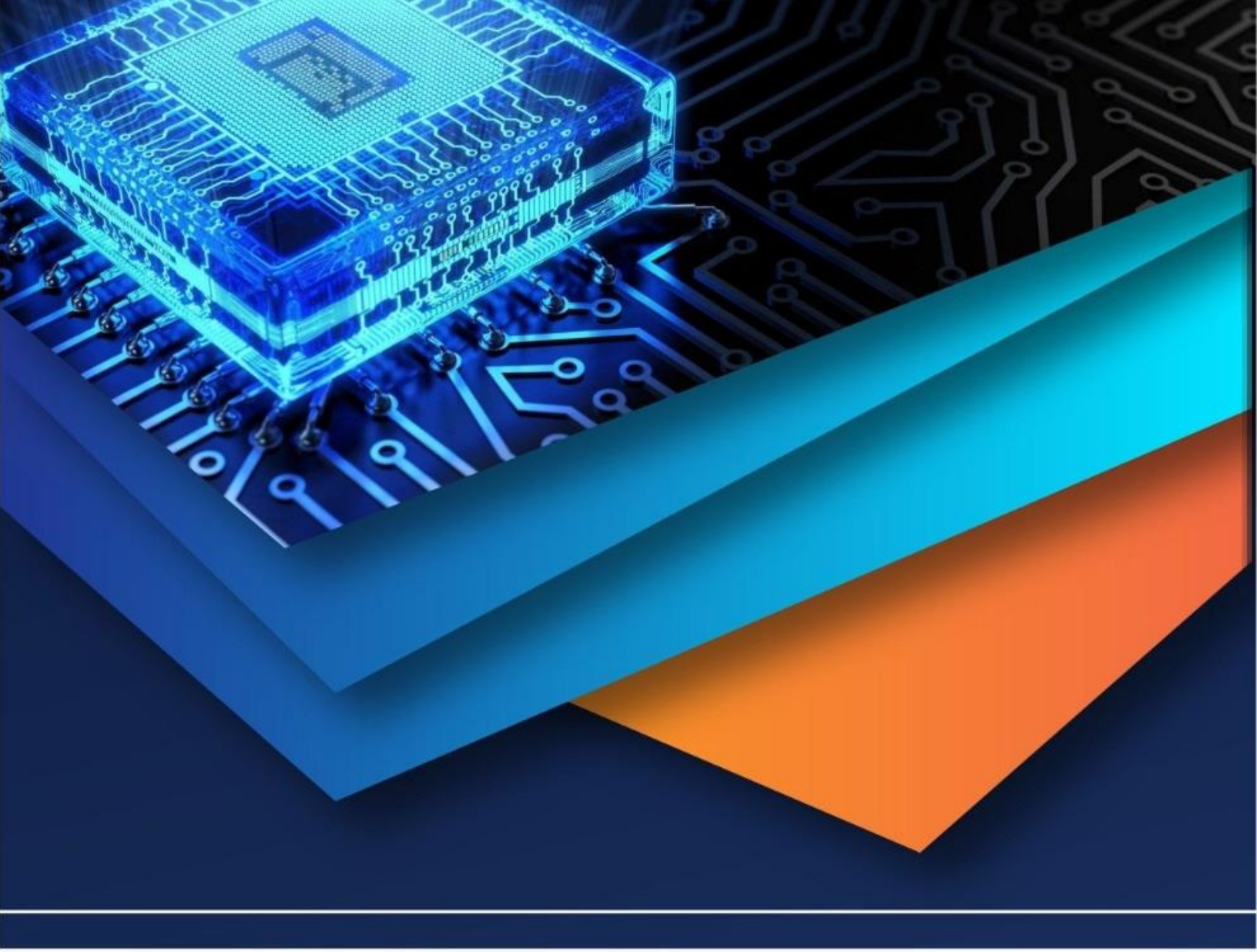
In the robust multi-purpose cutting machine, three individual operations are combined. Using this machine it is possible to reduce the problem of labor crises as it makes the process faster and the manpower required to operate the machine is also less.

It performs more than one operation, so you can save processing time. In the sugarcane seed cutting operation, the sugarcane waste can be controlled and the cut seeds are easy to sow. In the peanut shelling operation, instead of 10-20 jobs per acre, only two jobs can separate the peanuts from the plant using this machine. In the rice husking operation, while separating the rice from the grinding waste, more traditional methods will be used. Using this machine, the waste will be less and instead of 5-6 jobs, only 2 jobs can perform the same operations in a minimum time. If this machine is used by the maximum number of farmers, surely the farmer can overcome the problem of job crises, thus reducing the number of jobs. cost and process become faster and easier.

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