Design and Fabrication of Reaper

Machine for Wheat and Rice Crop

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***Abstract* - The ultimate aim of agriculture or farming in India is not only limited to growing of crops but is also associated with the economic growth of farmers and labours. Small scale farmers frequently face the problem of labour shortage or are unable to afford the wages to be paid. It is therefore, essential to adopt the mechanical methods so that the timeliness in harvesting operation could be ensured .considering different factors as power requirement , cost of equipment , ease of operation , field condition , time of operation and climatologically conditions. It runs on two stroke petrol engine of 3HP, this power from engine, is provided through pulley and gear box arrangement to the cutter. This compact harvester is manufactured using locally available spare parts and thus, it is easily maintainable. This harvester might be the solution to the problems faced by a small scale farmer regarding cost and labour implementation.**

***Keywords*** - **Agriculture, Reaper, Cutting Blade *.***

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 cuter machine which is help to the Indian former which is in ruler side and small farm. It will reduce the cost of crop cutting in field. It will help to increase economical standard in Indian former. In modern times, powered machinery has replaced many jobs formerly carried out by manual labour or by working animals such as oxen, horses and mules.The history of agriculture contains many examples of tool use, such as the plough.

Mechanization involves the use of an intermediate device between the power source and the work. This intermediate device usually transforms motion, such as rotary to linear, or provides some sort of mechanical advantage, such as speed increase or decrease or leverage. Current mechanized agriculture includes the use of tractors, trucks, combine harvesters, airplanes (crop dusters), helicopters, and other vehicles. Modern farms even sometimes use computers in conjunction with satellite imagery and GPS guidance to increase yields. Reapers are used for harvesting of crops mostly at ground level. Reapers are classified on the basis of conveying of crops. It avoids fuel consumption, labour requirement. As the population of India increases day by day, there is increment of food, vegetables so need of farm mechanization also increases, machineries provides more operations in less time, but the machineries are very costly for the common man, it is not affordable for them ,so manually operated machineries, equipment’s are also the most important factor. Reaper harvesters on the other hand are other alternative harvesting equipment, provided straw is considered as economic by-product for animal feed and/or industrial applications. Keeping these in view, a feasibility study was undertaken to reduce the cost of harvesting in paddy crop through mechanization of harvesting and manually operated reaper is more important it, this type of reaper can easily be operated by single person, only the pushing efforts are required in less economy, easily affordable for farmers for keeping the better farming.

The reaper is very compact and user friendly low cost mini harvester and collector machine which will simultaneously perform both jobs of harvesting and collecting the harvested crops. This machine is cost effective, easy to maintain and can be simply manufactured as it comprises of locally available spare parts. Manual labour takes time and is not effective as they can work for 3-4 hours at a stretch. According to oral survey, on an average 5 labours are required to harvest 1 acre of wheat crop and rice crop in a day. Even if the land holding is small it takes approximately 4-5 labours and they will take a time of two or three days to completely harvest the wheat and rice crop By using this harvesting machine, problem of the labour crises can be reduced. As compared with manual harvesting only 1-2 labours are required. This makes the process faster hence reduces most of the harvesting time. So, it reduces the labour cost. Definitely this machine will be used by maximum number of fanners. Farmers can overcome the labour crises problem. The productivity is also increased. In the country like India where the main source of income is agriculture. Needs to concentrate in some aspects like how to increase productivity and profit, how to reduce cost and how to solve and ease the problems of workers. To overcome this a

new manually operated cutter is fabricated for cutting of multiple types of crop during harvesting. It possesses four criterion ease in manufacturing, ease in handling, low cost and light weight. There are some procedures involved in fabrication of this device such as fabricating prototypes, material & component selection, etc. Slow agricultural growth is a interest for policymakers as two-thirds of India's people depend on rural employment for a living. The agricultural practices which are currently employed are neither economically nor environmentally sustainable and India's yields for many agricultural material are comparatively low. The time saved was almost 1/3rd to that of manual harvesting.

1. ***Problem Statement***

Manual labor takes time and is not effective as they can work for 3-4 hours at a stretch .Even if the land holding is small, it takes two or three days to completely harvest the crop. High costs of machines and maintenance, non-availability of appropriate agricultural machines and equipment that cater to and suit the requirements of small scale farms. In conventional harvesting process, the crop is cut manually by labour and then this crop is get threshed by Thresher. It takes time and it

is not effective as they can work only 5-6 hours in a day. Even though the small scale farmers who having land less than 5 acres, it takes two to three days to cut.

1. ***Objective***
2. To reduce the time required for cutting crop manually.
3. To increase the capacity of the working and cutting and it can possible the maximum crop cutting within minimum time.
4. To reduce the cost of cutting crop in the agriculture, it can cut crop in cheap price because it saves the worker cost .
5. To avoid harms to the labour's.
6. ***Scope***

This machine can also be used for cutting other crops such as cotton stalks and maize.

As the field is uneven, the cutter height varies from mode to node, so a slider mechanism can be used to vary the height of cutter from time to time.

II. **LITERATURE REVIEW**

1. ***Amar B. Mule, Etc All, Jan-2018,Design and Fabrication of Performance in Reaper Machine*** says The reaper, first developed in 1830 by a Virginia farmer, Cyrus McCormick, cuts the wheat at a specific height and leaves the cut stalk in rows beside the bed. Men then follow gathering the bundles into sheaves (reaper windrower),or the reaper bundles the sheaves itself (reaper-binder) (Dvorak, 2009).Depending on their construction features (adjustability of height, width of cutter,whether self-propelled or tractor mounted), the work capacity of these machines varyfrom 3-20 h/ha with grain losses lower than 2 percent. The thresher basicallyseparates the grains from the straws. The first stage involves putting the bundles ofstalk into the feeder, which controls the feeding rate of the machine to preventoverloading. The combine harvester, being the most common and efficient machinefor harvesting crops, is capable of doing the three basic harvest operations (cutting,threshing and winnowing) all in one, hence the name combine harvester. The basicunits for the design of a combine harvester are the cutting, conveying and threshingunits.[1]
2. ***Imrul Kaes, Etc All (2017),Design and Analysis of Arm of Reaper and Binder Machine****,*says Until the 19th century, most grain was harvested by cutting with asickle, scythe, cradle or manual mowers then manually flailed or beaten to break thebond of the grain with the stalk, then winnowed to separate the grain from materialother than grain. In the developing world, these practices or the use of small stationarythreshers are still in use for grain harvesting. A sickle is a curved, hand-heldagricultural tool typically used for harvesting grain crops before the advent of modernharvesting machinery. The inside of the curve is sharp, so that the user can swing theblade against the base of the crop, catching it in the curve and slicing it at the sametime. Scythe is a similar tool with the sickle used to harvest grain crops. The mostnoticeable difference between a sickle and the scythe is the shape of the blade ofwhich the Scythe blade is more linear whereas a sickle blade is more in the shape of aC with a point at the top. Cradle is a more developed tool for reaping and harvesting.It consists of an arrangement of fingers attached by a light frame work to the snatch ofa scythe. Its purpose is to gather the straw as it is cut and deposit it in a swath. At theend of the cutting stroke, the cradle is tilted to drop the straw in a pile. Also, substantially more grain can be cut in a day with the cradle. However, loss due toshattering (grain dislodged from heads due to shock) is greater with the cradle whichmakes to continue using the sickle to harvest grain. Reapers are harvesting-machinesused for cutting grain-crops. They either deliver the grain to one side in gavels readyto bind into sheaves, or elevate the gavels upon platform where two operators bindthem into sheaves by hand. During the 19th century, mechanical reapers and binderswere developed to cut and windrow grain for field drying. The sheaves were thenhauled to stationary threshers. Around Around the start of the twentieth centuryanimal drawn machines, “combines,” were developed that integrated cutting,threshing, and separating wheat and small grains.[2]
3. ***Aravind C, Etc All (2015),Design and Fabrication of Agricultural reaper*** *’* says et.al paper made by student of BNM Institute of Technology, Banglore. They provided design concept of Paddy harvester and calculation between conventional and modern harvester.[3]
4. ***Mr. P. B. Chavan, Etc All (2015,Performance evaluation of reaper-binder in rice crop*** says Dhondg.Various approaches have been proposed for improving mechanizedtype of crop cutter in agriculture field. Designing a reaper machine to harvest grains more efficiently. The research Work focusing on harvesting operation to the smallland holder to cutting varieties of crop in less time and at low cost by considering thefactor as power requirement, ease of operation , field condition , time of operation andclimatologically condition.[4]
5. ***Laukik P. Raut, Etc All, (2014), Design, Development and Fabrication of a Compact Harvester,*** say et.al project made by student of GHRCE Nagpur. Theymade modern reaper at low cost which is beneficial and efficient for small landholder.[5]

III. Design Methodology

Proposed Machine increase the capacity of the working and cutting and it can possible the maximum crop cutting within minimum time.

1. ***Frame***

A truss of frame may be defined as a structure ,made up of several bars,riveted or welded together.These are made up of angle irons or channeled section and are called member of frame or frame structure.

**Specifictions**

Frame Dimension =l\*b\*h=80\*50\*80 cm

Material =Mild steel

1. ***Engine Specifications***

4-stroke petrol engine

Engine Power-1HP

1HP= 746 Watt

RPM=6000

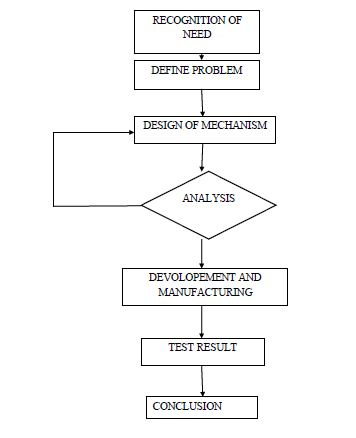


Fig 1. Design Methodology of Fabrication of Reaper Machine for Wheat and Rice Crop**.**

1. ***V-belt Pulley***

**V** Belts are used because its advantages over flat belts in compact transmission

design. Engine power is transmitted to ther spur gear box with the help of belt drive

**Specifications**

N1=Engine RPM=6500

d=dia of small pulley

D=dia of large pulley

N1\*d=N2\*D

6500\*2.5”=N2\*6”

N2=2708 Rpm

1. ***Spur Gearbox***

The main advantage of gear drive is that it transmit same velocity ratio and also it is

used to transmit a very large power with very good reliable service.

**Specifications**

Pinion=19 teeth

Gear=68 teeth

T2=No of teeth on pinion

N3=Output rpm

T3=No of teeth on gear

N2\*T2=N3\*T3

2708\*19=N3\*68

N3=756 rpm

1. ***Bevel Gearbox***

Bevel gear box is used to change direction of motion by 90 degree. This type of gearbox is used because there was a need to transmit power to two mechanisms that isslider crank and collecting mechanism.

**Specification**

Pinion=10 teeth

Gear=16 teeth

N4=N3

T4=No teeth on pinion

T5=No of teeth on Gear

N4\*T4=N5\*T5

756\*10=N5\*16

N5=472 rpm

1. ***Belt Drive For Engine***

N1=6500 rpm

N2=2708 rpm

Service factor for engine=1.2

Small pulley dia=2.5”

Large pulley dia=6”

C=centre distance =6+2.5=8.5”

C=215.9 mm

L=length of belt=2C+1.57(D+d)+1/4C\*(D-d)^2α=sin^-1)

α=11.88

Ө=π-2α=156.24

fc=belt length correction factor=0.63

fd=arc of contact of correction factor=0.94

Pd=design power=fa\*p

=1\*0.7 =0.7 Kw

Z=no of belt=p/ pd\*Fd\*Fc=1.77=2.

1. ***Collecting Mechanism***

The collecting belt is used to carry out crops sideways proper collecting of crop is very important to reduce grain losses.

**Specifications**

dc=dia of small pulley=2”

Dc=dia of large pulley=3”

C=dc+Dc=5”

L=length of belt=2C+1.57(D+d)+1/4C\*(D-d)^2

=19.89”=505 mm

α=sin^-1(D-d/4C)

α=5.73

Ө=π-2α=168.54

fc=0.59

fd=0.97

Zc=0.7/07\*0.97\*0.59

Zc=1.74=2

D/d=n/N

3/2=n/472

n=708 rpm

1. ***Cutting Mechanism Specification***

Cutter blade is riveted on 3 mm plate and in stationary cutter blade having thickness 5 mm.

V=π\*\*d\*n/60

V=1.88 m/sec

Vc=1.88 m/sec

***H. Shaft***

Material=40C8 medium carbon steel

Syt=380 N/mm^2

Sut=660 N/mm2

Nf=factor of safety=2

Shear stress

τ=0.75\*0.18\*Sut

=89.1 N/mm2

τ=0.75\*0.18\*Syt

=85.5 N/mm2

P=2ΠNT/60

T=2.46\*103 Nmm

τ =16T/πd

d=10 mm

This is by theoretical results, but in actual practice we are using d=12mm which is

safe for design.

Diameter of larger sprocket =12mm

Assuming factor of safety = 2

Shear Stress = 7 N/mm2

Shear Force of the Shaft

Fs = 170 N

T=F\*R

F=4.44 N

As Per Calculation.

Ft=0.3097 N

Fa=0.1546 N

Fr=0.2109 N

Take Moment at point A

ΣMA=90×120-Rb×410-0.3097×500-5=0

∴ Rb=34.75

**Σ**Y=0

**=**RA-90+RB+0.3097

=RA-90+34.75+0.3097

∴ RA=54.94

Moment at point B

MB=54.94×205=11537.4 N.mm

Moment at point C = 432 N.mm

Max MB=11537.4 N.mm

Bending moment at point B

ΣMB=0.2109×180=18.981 N.mm

Max Bending Moment

=((18.981)2 +(11537.4)2)(1/2)

**=**11537.4 N.mm

Where,

Kb=1.5

Kf=1.5

Te=((Kb M)2+(Kt T)2))(1/2)

Te=((1.5×(11537.4)2+1.5(26.69)2)(1/2)

Te=17.30 N.m

Design of shaft is safe.

***I.BEARING***

A bearing is a machine element that constrains relative motion and reduce friction between moving parts to only desired motion . The design of the bearing may, for example,provide for free linear movement of the moving part or for free rotation around a fixed axis ; or ,it may prevent a motion by controlling the vectors of normal force that bear on the moving part . Bearing is subjected to radial as well as axial loading. Selected bearing as per standard table.

Length of shaft = 50cm =500mm

F=((Fr )2+(Fa )2)(1/2)

Where,

Fr=Radial Force in ,N

Fa=Axial Force in,N

Fa=Fb=F/2N

Equivalent Dynamic Load

Pe=Vfa×Ka

Pe=1.5×f×1.25

Pe=1.875 F

Rating Life

L20= (Lh20×60×n)/106

Total Load Acting on Bearing

F=F1+F2

= 1404.22 + 782.561

= 2186.78 N

RA=RB=F/2

= (F1+F2)/2

=2186.78/2

=1093.39 N

Radial Load on Bearings

Fr=RA=RB

Equivalent Dynamic Load on Bearing

Pe=Fr×Ka

=1093.39 × 3

=3280.1715 N

Rating Life

Lh05= (30000×60×60)/(10)6

108 million revolution

L05= (4.48×L10(Loge 1))/(Rn) (1/1.5)

L10=174.62 million revolution

L10= C/(Pe)a

174.62= C/(1093.39)3

C = 6111.38 N

C = 6.11 KN

Dia of Shaft = Bore dia.(D) = 12 mm

Bearing No = 6001

Outside Dia.of Bearing(D) = 28 mm

Width of Bearing(B) = 8 mm

Static Capacity of Bearing (Co) = 2.36 KN

Dynamic Capacity of Bearing(C) = 5.4 KN

Maximum Speed = 6000 RPM

***J. CUTTER***

**Specifications**

Cutter Materail = 35C8 Plain Carbon Steel

Thickness-3mm

angle = 60°

Blade length = 702 mm

Shaft = 500 mm

Single Blade = 78 mm

Shear Stress Required for Cutting Crop,

Max.Shear Stress = 5 to 6 N/mm2,for dry crops.

= 7 to 12 N/mm2,for wet crops.

Maximum Shear Strength we get an angle 35 to 45 degree

Cutting Speed V = 1.88 to 2m/s

Bending Stress = 40.5 to 45 N/mm2

Carbon harden tempered steel material is used , But we use MS sheet material in actual.

***K. Wheel***

A wheel is made up of rubber with the diameter of 210 mm and width 35 mm. Two wheels is used in this machine for the motion. Distance between two wheels is 300 mm. Inner diameter of wheel to connecting of shaft is 12 mm.

***L.Crank and lever***

Type of crank and lever used in machine is single slider crank chain . It is a modification of the basic four bar chain in which one sliding pair and turning pair is included it converts rotary motion into reciprocating motion and vice versa.

σd=(F×4×d2)/π

σd= (F×4×(12) 2)/π

σd=3.38 N/mm2

σb=(Max Shear Stress)/Nf

=42/1.25

= 33.6 N/mm2

Design is Safe.

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Fig 2.3D CAD Model of Reaper Machine.

Acknowledgment

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g.” Try to avoid the stilted expression, “One of us (R. B. G.) thanks …” Instead, try “R.B.G. thanks …” Put sponsor acknowledgments in the unnumbered footnote on the first page.

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