© 2019 IJSRST | Volume 6 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology
DOI : 10.32628/IJSRST1962154

Corn Cutting Machine

Prof. S. S. Kale[1], Rajat Taral[2], Pravin Kapade[2], Kailas Ghute[2], Deepak Wakle[2]
[1]Professor, Department of Mechanical Engineering, SKNSITS, Lonavala, Maharashtra, India
[2]B.E Scholar, Department of Mechanical Engineering, SKNSITS, Lonavala, Maharashtra, India

ABSTRACT

The Crop reaper machine targets the small-scale farmers who have land area of less than 2 acres. This machine is compact and can cut up to two rows of plant. It has cutting blades which cut the crop in a scissoring type of motion. There are cutters on two metal strip (plate) upper cutter plate will be reciprocate by scotch yoke mechanism. It runs on engine, this power, is provided through pulley and gear box arrangement to the cutter. A collecting mechanism is provided for the collection of crops to one side after cutting. This mechanism is also powered by pulley arrangement, two sprockets and chain arrangements given for collection of crops. 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 labor implementation. After testing this machine in farm, it is found that the cost of harvesting using this harvester is considerably less as compare to manual harvesting. The 3D model will be drawn with the help of CATIA software. All the components required for the project are collected and manufacture. After making the parts assembly was done and after that the result and conclusion was carried out.
Keywords : Metal Strip, Small-Scale Farmer, Agricultural Products, CATIA

I. INTRODUCTION

A reaper is a farm implement or person that reaps (cuts) crops at harvest when they are ripe. Usually the crop involved is a cereal grass. The first documented reaping machines were Gallic reaper that was used in modern day France during Roman times. The Gallic reaper involved a comb which collected the heads, with an operator knocking the grain into a box for later threshing.

These reapers are costly and only available of very large-scale farming. However, agriculture groups make these available for rent on an hourly basis. But the small holding farm owners generally do not require the full-featured combine harvesters. Also, these combine harvesters are not available in all parts of rural India due to financial or transportation reasons. Thus, there is a need for a smaller and efficient combine reaper which would be more accessible and also considerably cheaper.

Farming is most widely followed profession in India. Agricultural products contribute a major portion to our economy. Engineering science has brought tremendous changes in traditional methods of agriculture viz. sowing, planting, irrigation, fertilizer spraying, harvesting, etc. However, to increase our economic condition, we must increase the productivity and quality of our farming activities. Nowadays very few skilled labors are available for agriculture. Because of this shortage the farmers prefer to use reaper harvesters.

The mission is to create a portable, user-friendly and low-cost mini harvester taking into account the requirements of current situation; the idea was created to prepare a machine which is cheap and will reduce the labor required to cut crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings. This machine is cost effective and easy to maintain and repair for the farmers. The machine model is designed based on the demand for a compact and economical reaper. This demand is taken into consideration by consulting farmers in person, for their problems and requirements.

Taking into account the present scenario of sugarcane harvesting we decided to prepare a model of sugarcane reaper with compact construction which will be mostly suitable for farmers having small and for agriculture. The machine prototype will be economical and most convenient for cutting corn stalks and other similar plants having same or less shear strength than corn. Harvesting is the process of gathering a ripe crop from the fields. Reaping is the cutting of grain or pulse for harvest, typically using a scythe, sickle, or reaper. Process automation has increased the efficiency of both the seeding and harvesting process.

Most modern mechanical reapers cut the grass; most also gather it, either by windrowing it or picking it up. Modern machines that not only cut and gather the grass but also thresh its seeds (the grain), winnow the grain, and deliver it to a truck or wagon it are called combine harvesters or simply combines; they are the engineering descendants of earlier reapers.

Hay (grass) is harvested somewhat differently from grain; in modern haymaking, the machine that cuts the grass is called a hay mower or, if integrated with a conditioner, a mower-conditioner. As a manual task, cutting of both grain and hay may be called reaping, involving scythes, sickles, and cradles, followed by differing downstream steps. Traditionally all such cutting could be called reaping, although a distinction between reaping of grain grasses and mowing of hay grasses has long existed; it was only after a decade of attempts at combined grain reaper/hay mower machines (1830s to 1840s) that designers of mechanical implements began resigning them to separate classes.

Mechanical reapers substantially changed agriculture from their appearance in the 1830s until the 1860s through 1880s, when they evolved into related machines, often called by different names (self-raking reaper, harvester, reaper-binder, grain binder, binder), that collected and bound the sheaves of grain with wire or twine.[3] Today reapers and grain binders have been largely replaced by combines in commercial farming, but some smaller farms still use them.

Types of reaping:

1. Hand Reaping –

Hand reaping is done by various means, including plucking the ears of grains directly by hand, cutting the grain stalks with a sickle, cutting them with a scythe, or a scythe fitted with a grain cradle. Reaping is usually distinguished from mowing, which uses similar implements, but is the traditional term for cutting grass for hay, rather than reaping cereals. The stiffer, dryer straw of the cereal plants and the greener grasses for hay usually demand different blades on the machines.

The reaped grain stalks are gathered into sheaves (bunches), tied with string or with a twist of straw. Several sheaves are then leant against each other with the ears off the ground to dry out, forming a stook. After drying, the sheaves are gathered from the field and stacked, being placed with the ears inwards, then covered with thatch or a tarpaulin; this is called a stack or rick. In the British Isles a rick of sheaves is traditionally called a corn rick, to distinguish it from a hay rick ("corn" in British English retains its older sense of "grain" generally, not "maize"). Ricks are made in an area inaccessible to livestock, called a rick-yard or stack-yard. The corn-rick is later broken down and the sheaves threshed to separate the grain from the straw.

Collecting spilt grain from the field after reaping is called gleaning, and is traditionally done either by hand, or by penning animals such as chickens or pigs onto the field.

Hand reaping is now rarely done in industrialized countries, but is still the normal method where machines are unavailable or where access for them is limited (such as on narrow terraces).

The more or less skeletal figure of a reaper with a scythe – known as the "Grim Reaper" – is a common personification of death in many Western traditions and cultures. In this metaphor, death harvests the living, like a farmer harvests the crops.

2. Mechanical Reaping –

A mechanical reaper or reaping machine is a mechanical, semi-automated device that harvests crops. Mechanical reapers and their descendant machines have been an important part of mechanized agriculture and a main feature of agricultural productivity.

Mechanical reapers in the U.S.[edit]

The 19th century saw several inventors in the United States claim innovation in mechanical reapers. The various designs competed with each other, and were the subject of several lawsuits.

Obed Hussey in Ohio patented a reaper in 1833, the Hussey Reaper. Made in Baltimore, Maryland, Hussey's design was a major improvement in reaping efficiency. The new reaper only required two horses working in a non-strenuous manner, a man to work the machine, and another person to drive. In addition, the Hussey Reaper left an even and clean surface after its use.

Objective

a) To formulate an idea to suit our required functionality that is to reap the crops.
b) To develop the idea to suitable mechanical principles and to design the idea to practice.

Problem Definition

a. Manual labor takes time and is not effective as they can work for 3-4 hours at a stretch.
b. Even if the land holding is small, it takes two or three days to completely harvest the crop.
c. 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.

II. LITERATURE REVIEW

Performance evaluation of reaper-binder in rice crop R. JAYA PRAKASH, B. ASHWIN KUMAR, G. ARAVIND REDDY AND K.V.S. RAMI REDDY

Field performance of reaper-binder was assessed in rice crop and compared with manual method of harvesting by sickle at farmer’s field under farm implements and machinery scheme during Rabi 2013.

The effective field capacity of the reaper-binder was found 0.294ha h-1 with a field efficiency of 67 per cent at an average operating speed of 3.6 kmph compared to 0.025 ha h-1 for manual harvesting. The fuel consumption was found 5.27 l ha-1. Labor requirements for mechanical and manual harvesting were 36 and 176 man-h ha-1, respectively. The harvesting losses for mechanical and manual harvesting were 1.44 and 1.88 per cent, respectively. The cost of harvesting operation was Rs.5500/ha for manual harvesting and Rs.2241/ha for mechanical harvesting. The harvesting cost of reaper binder was reduced by 40.74 per cent compared to manual harvesting method with sickle. The feedback of machine operation was collected by some farmers at the time of harvesting and the performance of the reaper-binder at the farm was satisfactory.

A CRITICAL STUDY ON CROP HARVESTING MACHINES Manjeet Prem, Nikhlesh Kumar Verma, K. L. Dabhi, R. Swarnka

Harvesting of crop is one of the important agricultural operations which demand considerable amount of labor. The availability and cost of labor during harvesting season is the serious problem. The shortage of labor 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 harvesting operation could be ensured. The use of mechanical harvesting device has been increased in the recent years. The farmers using reapers or combines to harvest their crops. But these means especially combine, 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, study on different types of harvesting machines and techniques were carried out.

DESIGN AND EVALUATION OF SELF-PROPELLED REAPER FOR HARVESTING MULTI CROPS
Muhammad Nadeema, Muhammad Iqbalb, Aitazaz Farooquec, Anjum Munirb, Manzoor Ahmadb, Qamar Zama

Harvesting of cereal crops is one of the major operations in agriculture production, which requires great attention. The objective of this work was to design of self-propelled reaper, and to evaluate its performance for harvesting of rice, brassica and wheat crops. Fields of rice, wheat and brassica were selected University of Agriculture Faisalabad, Pakistan. Factorial experiments (3 x 3) were conducted at each site with three levels of moisture content i.e.27%, 22% and 19 % for rice, 16.7%, 14.5% and 13% for wheat, and 18.32%, 16.05% and 15.7% for brassica were selected. The levels of machine's ground speed were1.94, 2.54 and 3.18kmh-1. Twenty-seven plots (1.524 x 3m) were selected randomly in each field to collect data for average percentage (%) slippage, shatter losses and field efficiency. The machine was operated at selected levels of ground speeds and moisture contents for each crop. Factorial analysis of variance (ANOVA) showed that the selected levels of ground speed and moisture contents have significant (p=0.05) effect on % slippage and field efficiency and non-significant on shatter losses for rice and wheat crops, whereas significant effect in brassica. Results indicated that in early harvesting at high moisture content, the shatter losses were significantly lower with the higher % slippage. Results reported that the shatter losses, field efficiency and % slippage were influenced by selected levels of ground speed and moisture contents. A suitable combination of ground speed and moisture content can minimize the grain losses and increase the yield and profitability of the farmer's community.

Design and Development of Manually Operated Reaper Machine

Tesfaye Olana Terefe

Grain harvesting is the important part in agricultural mechanization. The use of reaper technology in developing countries to minimize the product cost which will be result in economic development of agricultural production. This paper tends to provide the design and development of manually or mechanically operated reaper machine. The current situation in our country the traditional use of harvesting mechanism is more tedious, time consuming and not able to develop the agricultural sector of the low farmers in economic. Depending on the problem stated through abstraction of literature and the existing reapers, to satisfy the customer needs the gathered data has been interpreted to meet the requirement of the objective of the problem. The mission of this project through which the product is developed to spread out the appropriate technology to the countries primary and the secondary market are identified with the stakeholders. The general procedure of conceptual design used; concept generation by decomposing into main and sub function, product ideas from internal and external search, generating alternative solution by setting criteria's and Digital Logical Approach has been used for concept evaluation and selection. The product architecture and configuration finally introduced in the embodiment design after the selection of final concept. Design and development of mechanically or manually operated reaper for grain harvesting machine which is evaluated against the technical and economical criteria's can be carried out to be suitable with the most Ethiopians low farmers capacity.

Design and Fabrication of Agricultural Crops Reaper

A R Bhabad, G S Puranik, I S Sonawane, M R Pawar, A.R.Mali

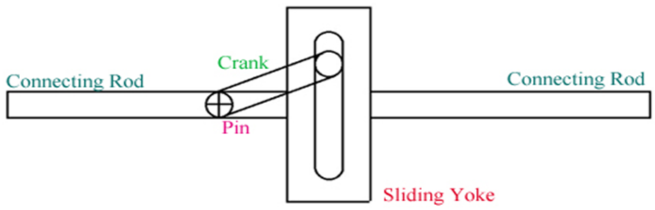
Recently India has seen a shortage of skilled labor available for agriculture. Because of this shortage the farmers have transitioned to using crop reaper. These agricultural crop reapers are available for purchase but because of their high costs, they are not affordable for small scale farmers. The idea was to create a machine which is cheap and will reduce the labor required to harvest crops. This machine is suitable for the small-scale farmers who have farm area of less than 2 acres. This reaper is compact and capable to cut up to 2 rows of maize stalk / bajara stalk and 60 cm width of wheat crops rows. It has a high strength cutting blade which cuts the crops in a scissoring type of motion. It runs on an engine of 3HP, this power from engine is provided through pulley and gear box arrangement to the cutter. A collecting mechanism is provided for the collection of crops to one side of reaper after cutting. This mechanism is powered by pulley arrangement. This reaper might be solution to the problems faced by small scale farmers regarding cost and labor implementation.

III. METHODS AND MATERIAL

OPERATIONAL MECHANISM

This mechanism is used for converting rotary motion into a reciprocating motion. The inversion is obtained by fixing either the link 1 or link 3. In Fig. 5.35, link 1 is fixed. In this

Mechanism, when the link 2 (which corresponds to crank) rotates about B as center, the link 4 (which correspond to a frame) reciprocates. The fixed link 1 guides the frame.



Scotch yoke Mechanism

Components:

Shaft: A shaft is a rotating or stationary component which is normally circular in section. A shaft is normally designed to transfer torque from a driving device to a driven device. If the shaft is rotating, it is generally transferring power and if the shaft is operating without rotary motion it is simply transmitting torque and is probably resisting the transfer of power. A shaft which is not rotating and not transferring a torque is an axel .

Mechanical components directly mounted on shafts include gears, couplings, pulleys, cams, sprockets, links and flywheels. A shaft is normally supported on bearings. The torque is normally transmitted to the mounted components using pins, splines, keys, clamping bushes; press fits, bonded joints and sometimes welded connections are used. These components can transfer torque to/from the shaft and they also affect the strength of the shaft a must therefore be considered in the design of the shaft.

Shafts are subject to combined loading including torque (shear loading), bending (tensile & compressive loading), direct shear loading, tensile loading and compressive loading. The design of a shaft must include consideration of the combined effect of all these forms of loading. The design of shafts must include an assessment of increased torque when starting up, inertial loads, fatigue loading and unstable loading when the shaft is rotating at critical speeds (whirling).

Drive may be inclined at any angle with tight side either at top or bottom. In order to increase the power output, several V-belts may be operated side by side.

Pedestal bearing: Pedestal bearing (Pillow blocks) is also known as housings which have a bearing fitted into them. Pillow blocks are usually mounted in cleaner environments and generally are meant for lesser loads of general industry. The fundamental application of the pedestal bearing is to mount bearings safely enabling their outer ring to be stationary while allowing rotation of the inner ring. The housing is bolted to a foundation through the holes in the base. Bearing housings are of two types. They are split type or un-split type. Split type housings are two piece housings where the cap and base can be detached, while certain series are one single piece housings. Various seals are provided to prevent dust and other contaminants from entering the housing. Thus the housing provides a clean environment for the expensive bearings to freely rotate, hence increasing their performance and duty cycle. Bearing housings are usually made of grey cast iron. However various grades of metals can be used to manufacture the same.

V-Belt Pulley: The pulleys are used to transmit power from one shaft to another by means of flat belts, V-belts or ropes. Since the velocity ratio is the inverse ratio of the diameters of driving and driven pulleys, therefore the pulley diameters should be carefully selected in order to have a desired velocity ratio. The pulleys must be in perfect alignment in order to allow the belt to travel in a line normal to the pulley faces. The pulleys may be made of cast iron, cast steel or pressed steel, wood and paper. The cast materials should have good friction and wear characteristics. The pulleys made of pressed steel are lighter than cast pulleys, but in many cases they have lower friction and may produce excessive wear. In this, I have used a Cast Iron Pulleys

V-Belt: Generally, we know that a V-belt is mostly used in factories and workshops where a great amount of power is to be transmitted from one pulley to another when the two pulleys are very near to each other. The V-belts are made of fabric and cords molded in rubber and covered with fabric and rubber as shown in Fig. below. These belts are molded to a trapezoidal shape and are made endless. These are particularly suitable for short drives. The included angle for the V-belt is usually from 30° to 40°. The power is transmitted by the wedging action between the belt and the V-groove in the pulley or sheave. The wedging action of the V-belt in the groove of the pulley results in higher forces of friction. A little consideration will show that the wedging action and the transmitted torque will be more if the groove angle of the pulley is small. But a small groove angle will require more force to pull the belt out of the groove which will result in loss of power and excessive belt wear due to friction and heat. Hence the selected groove angle is a compromise between the two. Usually the groove angles of 32° to 38° are used. A clearance must be provided at the bottom of the groove as shown in Fig. below, in order to prevent touching of the bottom as it becomes narrower from wear. The V-belt drive may be inclined at any angle with tight side either at top or bottom. In order to increase the power output, several V-belts may be operated side by side.

Bevel gear: Two important concepts in gearing are pitch surface and pitch angle. The pitch surface of a gear is the imaginary toothless surface that you would have by averaging out the peaks and valleys of the individual teeth. The pitch surface of an ordinary gear is the shape of a cylinder. The pitch angle of a gear is the angle between the face of the pitch surface and the axis.

The most familiar kinds of bevel gears have pitch angles of less than 90 degrees and therefore are cone-shaped. This type of bevel gear is called external because the gear teeth point outward. The pitch surfaces of meshed external bevel gears are coaxial with the gear shafts; the apexes of the two surfaces are at the point of intersection of the shaft axes.

Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears. Bevel gears that have pitch angles of exactly 90 degrees have teeth that point outward parallel with the axis and resemble the points on a crown. That's why this type of bevel gear is called a crown gear.

Engine: Engine is power producing device its work on fuel to perform the operation the engine output shaft connected to bevel gear shaft by pulley arrangement through v belt. Its work on scotch yoke mechanism for the cutting operation through help of v shape cutter.

Mileage:	67 Kmpl
Engine Displ.	99.7 cc
Speed	6000 rpm max
Max Power:	4.35 PS
Weight:	5 Kg
Starting:	Kick Start Only
Standard Warranty	1 Year

Step 1

Calculation of Torque

1ps =735Watt

4.35 pHs = 3310 Watt

Max RPM = 6000

P= 2πnt/60

3310=2*π*6000*T/60

T=5.27 N-M

Step 2

Calculation

Selection of Belt Drive

Engine RPM= N1
=2400RPM
Output of belt drive required=N2
=2100 RPM
Diameter of input pulley= D1 (From table no. 21-4 B)
=75mm
Diameter of output pulley = D2
= 280mm
Selection of belts
Power to be transmitted=1.8KW
Service factor=Fa=1.2 (Service factor = 1.1 to 1.4 from table 21.1)
Therefore
Design power=Fa x Power to be transmitted
=1.2*1.8
=2.16kw
Hence the Engine output power is safe
Pitch length of belt:
Center distance = 2x D2
=2*280
=560mm
L= 2C + π (D+d)/2 + (D-d)2 /4C
=2(560) + π (75+280)/2+(280-75)2 /4*560
=1120+258+18.76
=1396.76 mm
=1397 mm
Cutting blade types = V edge section
V section= standard Blade type
Rectangle Width=38mm (From Table 21-30B)
Thickness=3mm
Angle between cutting edge and axis of knife section=31°

Material-High carbon steel
Determine number of blades on reel Deflection angle Ø =54º (constant angle)
Reel rotational speed=100 Rpm
Rotational velocity of the reel
ω=2ЛN/60
=2Л*100/60
=10.47 Rad/sec

Design of shaft

Specification of shaft
Material of shaft (MS-low Carbon Steel)
Grade (40C8)
Max Power =2.5HP
Speed=1400rpm
Tensile strength (sut) =640N/mm^2
Yield strength (syt) =380N/mm^2
tmax =0.18*sut
=O.18*640
=1 15.2MPa
tmax =0.3*Syt
=O.3*380
=1 14MPa
tmax 1 is greater than rmax 2
Hence the design is done by t max 2,
Now considering keyway effect on shaft:-
tmax 2 =0.75*114
=85.5MPa
Taking Bevel Gear Torque 180 Nm
t actual =16*Td/(π*d^3)
85 5 =16*180*10^3/(3.14*d^3)
d=22.45mm
As per the standard diameter is 28 mm.
But while doing production we consider the diameter of shaft as 30mm.
Now, checking shear stress for diameter 28 mm.
Design Torque (W): 180 N-m.
Actual =16*Td/(π*d^3)
=16*180000/(3.14*28^3)
=41 .76MPa
tactual<tmax
Hence the design for shaft is safe.

Advantages

1) The cost of harvesting using this machine is considerably less as compare to manual harvesting.
2) Simple to construct.
3) Low capacity motor is sufficient.
4) Easy maintenance.
5) Less skilled operator is sufficient.
6) Less power consumption.
7) Noise of operation is reduced.

IV. CONCLUSION

The crop reaper machine is used to cut the crops. This machine is developed so that the efforts of human are decreased. We have produced this machine which is helpful for the farmers which is available in cheap cost. The design can be carried out with affordable capacity and better-quality product is manufactured.

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Cite this article as :

Prof. S. S. Kale, Rajat Taral, Pravin Kapade, Kailas Ghute, Deepak Wakle , "Corn Cutting Machine", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 6 Issue 2, pp. 704-712, March-April 2019.
Journal URL : http://ijsrst.com/IJSRST1962154