IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. I (May. - Jun. 2015), PP 15-22
www.iosrjournals.org

Design and Development of manually Operated Reaper

Prof. P.B.Chavan[1], Prof. D .K. Patil [2] Prof. D .S. Dhondge [3]
[1,2,3.] *(Mechanical, Sandip Institute of polytechnic. Nashik,Maharashtra / MSBTE, India)*

Abstract: *This project is to help small-scale farmers to meet an increased demand for local grains, by designing a reaper machine to harvest grains more efficiently. Our research work will focusing on ease of harvesting operation to the small land holders for harvesting varieties of crop in less time and at low cost by considering different factors as power requirement , cost of equipment , ease of operation , field condition , time of operation and climatologically conditions. The operating, adjusting and maintaining principle are made simple for effective handling by unskilled operators.*

Keywords: *Cost of equipment is low , ease of operation , not having limitations of field condition , time of operation and climatologically conditions.*

I. Introduction

Mechanized agriculture is the process of using agricultural machinery to mechanize the work of agriculture, greatly increasing farm worker productivity. 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.

Rice is one of the most important crop and staple food of millions of people which is grown in many countries of the world. The total area planted under rice crop in India is 42.20 million hectares. Improved weeder reduces weeding cost by 79-90%. Walking type vertical conveyer reaper, power tiller and tractor front mounted reaper save 50-60% labour and harvesting cost by 60-70% as compared to manual harvesting. Combine harvesting save 40-50% cost as compared to manual harvesting and threshing by power thresher. Use of pedal operated thresher, motorized hold on thresher reduce time, labour, cost of threshing to a great extent.

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 for 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.

❖ Importance of project

This project is to help small-scale farmers to meet an increased demand for local grains, by designing a reaper machine to harvest grains more efficiently. Our research work will focusing on ease of harvesting operation to the small land holders for harvesting varieties of crop in less time and at low cost by considering different factors as power requirement , cost of equipment , ease of operation , field condition , time of operation and climatologically conditions. The operating, adjusting and maintaining principle are made simple for effective handling by unskilled operators.

❖ Reaper selection

Reaper is generally selected on the land holding of the farmer, greater the land holding, tractor operated vertical conveyer reaper is choose, for medium land holding power tiller mounted vertical conveyer reapers are preferred. When we started with the project manually operated reaper, we came across some problems. Due to those problems the machine was not working properly. The design of the machine was technically perfect, but due to some fabrication, material used and conveying mechanism problem, it was not giving satisfactory results. We observed and came to the conclusion that there are major problem of clogging and power requirement. We

solved the problem and got satisfactory result. We hope harvesting practices made easy by our some developments provide in this machine.

There are some different parameters which decide the selection and performance of reaper, they are as follows;

i. Should have the proper cutting speed of cutter bar.
ii. Should require proper crop spacing.
iii. Should require proper power.
iv. Continuous power transmission.
v. Proper registration and alignment of cutter bar.
vi. Should require less effort.

Objectives

1. To modify the manually operated Reaper.
2. To evaluate the performance of modified manually operated Reaper.

II. Review Of Literature

This chapter deals with research work done in past by various investigation on the performance,

Hadidi et.al (1984) stated that, the height of crop stubbles increasing as stalks moisture content increased and decreased with increasing of knife velocity. He added that the percentage of wheat and rice grain losses increasing as the machine forward speed increased. Increasing cutter bar speed leads to decrease the percentage of grain losses. Also, increasing forward speed leads to increase the number of uncut stalks.

Sahar (1988), reported that, the use of a large scale machine is inappropriate for the following reasons:- it needs high technical experience for operation and maintenance, high capital requirements. Low field efficiency is in small holding and losses of straw are high on irregular furrowed soils. The use of small machines is appropriate for small holdings, low capital requirements and low technical operations and maintenance experience. El-Sahrigi et.al. (1992), developed a front mounted repear. The design features included a flat belt mechanism conveying the crop to the side of machine, improve cutter bar star wheel assembly to minimize clogging, a bevel gear drive for power transmission, a robust frame, a header provide design that will not dig in to the soil and provision to covert the flat belt conveyor drivers to chain without frame modification.

Habib et.al (2002) stated that the parameters affecting cutting process are related to the cutting tool, machine specifications and plant materials properties. They added that, the cutting energy consumed in harvesting process. Badr (2005) compared the performance of three different combines in terms of harvesting time, grain losses, fuel consumption, energy required and total cost. He found that the highest field capacity of 3.02 acre/h and the lowest field efficiency of 70.5 % were obtained at forward speed about 4.0 km/h and grain moisture content of 22 %. D. N. Sharma and S. Mukesh, they studied on the designing of handle and in that study approximate 100 cm height is sufficient for pushing of any machinery.

Er. Prabhakar Dutt, Principal Scientist, studied star wheel, crop divider and conveyor design of reaper.

Er. Bedse Prasad A., Er. Dalvi Devdatta N., Er. Virkar Amol D.(2013) ,developed manually operated reaper and evaluated performance as well as its uses and drawbacks.

III. Materials And Methods

3.1 Materials: This chapter deals with material and methods with following heads.

Material is selected on the basis of strength requirement of various components of the mechanism and some

Table 3.1 Material used for various components

Sr. No.	Component	Material used
1	Frame	Mild steel
2	Ground wheel	Mild steel
3	Rotating Disc	Mild steel
4	Shafts: 1.Ground wheel shaft 2.Idle shaft (v-belt pulley shaft) 3.Rotating disc shaft 4. Rotating pulley shafts	High carbon steel
5	Crop divider	G.I. sheet
6	Star wheel	Wood
7	Cutter bar	High carbon steel
8	Handles	Mild steel
9	Chain	High carbon steel
10	Belt	Rubber
11	Shaft pulley	Cast iron and aluminium
12	Sprockets	Gun metal & Mild steel

3.2 Prototype Design of Manually operated Reaper
(a) Isometric View

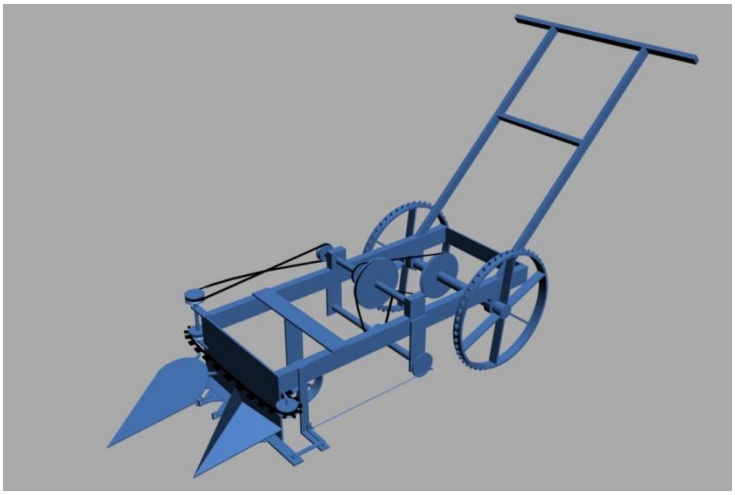

Fig. Isometric View of manually operated reaper (Right side)

3.2.2 Front view:

There are two wheels used to maintain the balance, connected to the frame by the shaft. Bearings are used for rotation of the shaft on which rotating discs are mounted in fig. 3.2.

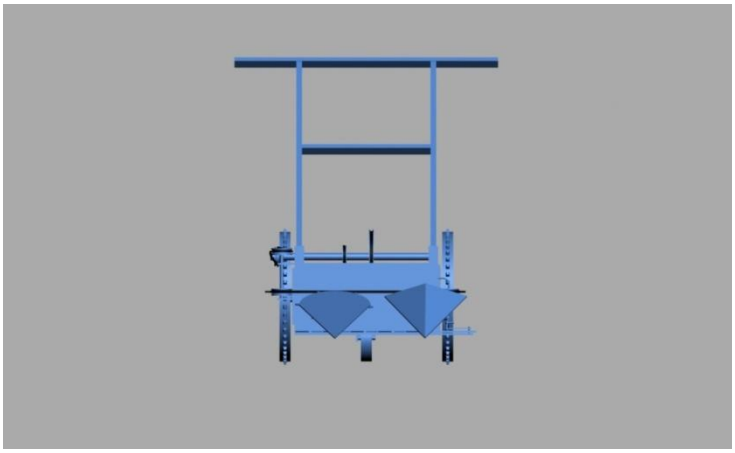

Fig.3.3: Front view of manually operated reaper

3.2.3 Side view: The shafts are containing larger and smaller sprocket connected with two end bearing at upper side and lower side respectively. Power is transmitted with the help of chains. A rotating disc is provided at lower shaft for giving power and speed to the cutter bar. The main shaft provides the whole power to the cutter bar as shown in fig.3.2.3

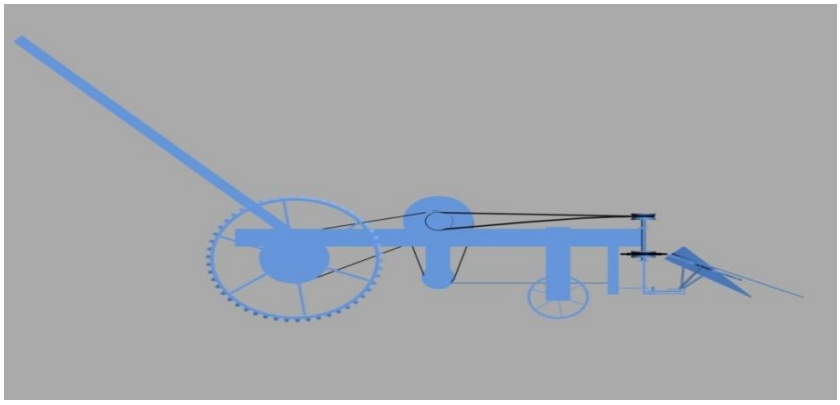

Fig.3.4 Side view of manually operated reaper

3.2.4 Top view: With the help of the two idler shafts whole transmission of power carried out with help of chain sprockets= mechanism of ratio of 1:9. The upper idler shaft contains the conveyer belt mechanism for conveying of crop.

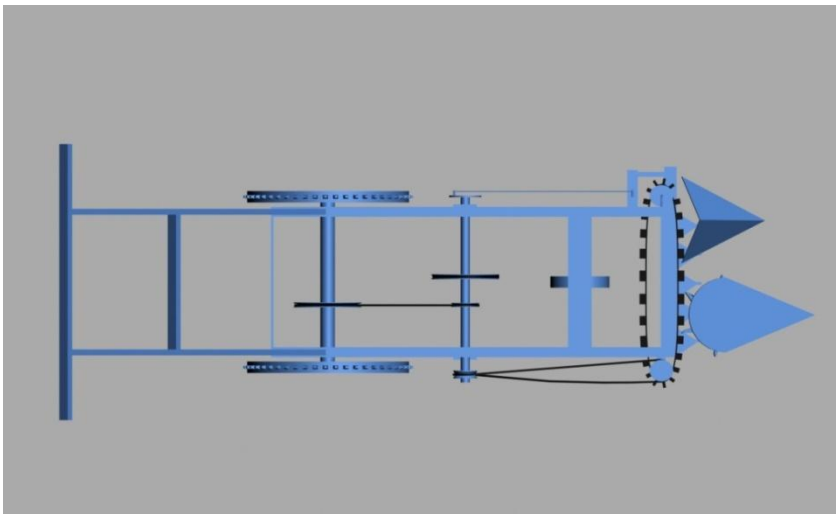

Fig.3.5 Top view of manually operated reaper

3.5 Modifications:

1. Adding a blade on cutter bar

The available speed of cutter bar is 8 reciprocating movement with one complete rotation of rear wheel. It works successfully but there was clogging due to less number of blades in pre design of reaper. Now, the clogging is not occurring as of a new blade is reciprocating at clogging area where, one guard is already available. Before adding one blade the extra guard is not included in working.

Plate. 3.14. Modification Cutter bar

The replacement of damaged cutting blades are also done for proper functioning of cutting of crops without any trouble in movement of cutting bar and it helps to reduce clogging and cutting losses.

2. Change in position of crop divider.

Angle of approach of divider is important as very high result in dozing of crop and flatter position of divider is not suitable for a lifting of even partially lodged crop. This angle has been optimizing at 22o.

During pre-design of manually operated reaper, the crop divider was having some errors. The crop was not divided properly. The crop was striking to side cutting mechanism. So the position of the crop divider is shifted little towards left side. Now crops are successfully divided without any damage to it.

Plate 3.14. Modification of crop divider

3. Add conveyor mechanism to conveying the crop to the side of machine:

For every harvesting machine, conveying mechanism is necessary for reducing losses during harvesting. In pre-design of machine, there was absence of conveying mechanism and due to this there was maximum harvesting losses occurred.

In new design of reaper, for reducing these losses the flat belt conveying mechanism is mounted as shown in plate no.3.15. Using rear wheel power, conveyor works successfully. Four pulleys are used for completing conveying mechanism and rubber belt is used for transferring the power from one pulley to second pulley. Third pulley attached to a same shaft of second pulley. The conveying belt is placed on third pulley and fourth as shown in plate no.3.15. The sheet metal is used for carrying blade as shown in plate no.3.15.

Plate 3.15 Modification of Conveyor

4. Star wheel speed and inclination:

The minimum required speed of star wheel based on simple geometry is expressed as

$$Vs = Vm \cos\alpha$$

Where,

Vs = average speed of star wheel, kmph

Vm= machine working speed, kmph

α = angle of inclination of star wheel.

Optimum value of to give inclination of star wheel to give angle of approach suitable for lifting of the crop is about 22o for this value above equation can be simplified as

$$Vs = 1.08 \times Vm$$
$$= 1.08 \times 1.8 = 1.94 \text{ kmph}$$

This optimize between shattering at higher speed and choking at lower speed. On the basis of this, we have design star wheel.

3.6 Pre testing observation

3.6.1 Field selection: The harvesting is done in well matured crop with maintained row to row distance. That is at least fine textured, smooth, relatively levelled soil.

3.6.2 Height of crop plant

For the cutting purpose, the height of crop plant must be more than 10-15cm.

3.6.3 Inclined angle of crop plant

Inclined angle of crop plant shows inclined angle from vertical line.

i. Moisture content of steam and grain at the time of harvesting

Moisture content of steam and grain at the time of harvesting must be measured.

ii. Area and shape of test field

iii. Soil moisture

iv. Condition of machine and operator

- Adjustment of working part of machine.
- Operating speed.
- Skill of operator

3.6.4 Working principle

When machine is push by the operator at the designed speed in the field, rear wheel rotation leads to reciprocate cutter bar with the help of sprocket and chain. The crop lifter guides the crop to the cutter bar and the crop is cut by the cutter. The cut crop is conveyed with the help of star wheel at one side by the lugged belt conveyer for easy collection and bundling.

3.6.1 Design Specification Of Reaper

Table no: 3.6.1 Specifications of reaper

1	**Type**	Manually operated
2	**Source of power**	One person
3	**Machine suitability**	To harvest cereal crop
4	**Machine dimensions** a. Length b. Width c. Height	 1700 mm 450 mm 900 mm
5	**Crop cutting unit**	
A	Type of cutter bar	Reciprocating knife section
B	Length of cutter bar	300 mm
C	Knife section	Standard
D	Type	Trapezoidal
E	Blade	Serrated
F	Length × height	76.2mm×85mm
G	Angle between cutting edge and axis of knife section(α)	31º
H	Rake angle	22º
I	Thickness of cutting edge	5-3 mm
J	Pitch of serration	1-1.2 mm
K	Clearance between knife and twine guard	0.5-1 mm
L	Material	high carbon steel
6	**Finger guard**	
A	Type	twine guard with lip
B	Overall length	110mm
C	Overall width	35mm
D	Lip spacing	50mm
E	Height of cutter bar above ground level	75 mm

3.6.2 Specifications of star wheel:

Table no: 3.6.2.Specifications of star wheel

Sr. no.	**Particulars**	**Specifications**
1	Outside diameter(Do)	200 mm
2	Inside diameter(Di)	152 mm
3	Internal diameter of star wheel(d)	25 mm
4	Material of star wheel	Wood

3.6.3. Specifications of Ground wheel

Table no: 3.6.3. Specifications of ground wheel

Sr. no.	Name of component	Size
1	Diameter	400 mm
2	Width	40mm
3	Thickness	5mm
4	Shaft diameter	25 mm
5	Length of shaft	400 mm
6	Distance between two wheel	360 mm

3.6.4 Specifications of Frame

Table no: 3.6.4 Specifications of Frame

1	Number of square pipes	8
2	Number of bearing	8
3	Length	700 mm
4	Width	250 mm
5	Height	260 mm

3.6.5 Specifications of Idler shaft

Table no: 3.6.5 specifications of Idler shaft

1	Diameter of shaft	12 mm
2	Number of sprocket	4
3	Number of pulley	3
4	Number of teeth on two larger sprockets	42
5	Number of teeth on smaller sprockets	14
6	Diameter of pulley	60 mm
7	Number of bearing	4
8	Diameter of disc	90 mm

3.6.6 Specifications of Handle

Table no: 3.6.6 Specifications of handle

1	Shape	Hollow square
2	Diameter of pipe	25 mm
3	Length	900 mm

B. Field performance

Table no.: 3.7.2 Field performance

Sr. No.		
1	Time of start	11:00 am
2	Time of finish	11.15 am
3	Actual field operation	15 min.
4	Time lost owing to a. Turning b. Clearing and clogging	 1 min. 4 min.
5	Actual area covered	100 sq. m
6	Effective working width	300 mm
7	Effective field capacity	0.055 ha/hr
8	Field efficiency	66.13 %
9	Speed of machine	0.5 m/s
10	Height of cut	75 mm
11	Labour required	2
12	Length	10 m
13	Width	10 m
14	Area	100 m^2
15	Type of soil	Black cotton soil

IV. Summary And Conclusion

4.1 Summary

The present work was carried out with objective to design, modification and evaluate the performance of Manual operated reaper.

Observations are carried out to calculate its performance like depth of cut, efficiency, labour requirement, overall cost etc.

4.2 Conclusion

After modification of manually operated reaper it work continuously and gives more efficiency than the machine before modify. Conveying mechanism now help to stop clogging and decreases the cutting losses. Continuous working leads to harvest crop in less time with minimum man power.

Based on analysis of results following conclusion are drawn:

The Manual operated reaper is high labor saving equipment requiring only 20 man-hr/ha.

The cost of harvesting with this manual operated reaper is 1250.4 Rs/ha and that with traditional method is 2000 Rs/ha.

The cost of reaper is low so it is affordable to small farmers.

The field efficiency is satisfactory which more than 66%, it increases from 59% due to its modifications.

4.3 Drawbacks

Based on analysis of results following drawbacks seen during operation:

1. It is not suitable for non-uniform land.
2. The power requirement is high due to its weight.