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Cost Effective Harvester for Small Scale Cultivators

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Abstract - *The aim of our project is to fabricate a crop harvester for farmers with land holding lesser than 5 acres or small scale farmers who cannot afford modern harvesting alternatives like combine or modern harvesters. The harvester we aim to fabricate will go easy on their pockets and will reduce the total harvesting time as compared with manual cutting of crops. The product will be capable of cutting various crops with cutter blades attachment cutting two rows at a time. Power will be supplied to the electric motor and then to shaft and blades using chain drive. The projects focuses on giving the small scale farmers the best alternative for their hardships faced because of unavailability of labours & high expenses of harvesting.*

Key Words: **Portable Harvesters, Cutter Blade, Small scale farmers, Chain drive, DC motor, Low cost fabrication**

1. INTRODUCTION

In India the majority of population in rural area is dependent upon agricultural activities. It consist a pivotal role in our country's economy. The given pie chart depicts the major problems of the farmers of our country

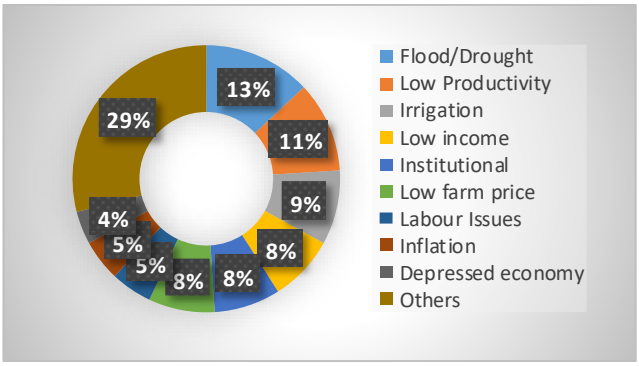

Chart -1: Major Problems

This table shows the Region wise problems faced by the farmers

Table -1: Region wise problems

Region	First Major Problem	Second Major Problem	Third Major Problem
North	Labour Issues	Low Productivity	Low Income
East	Irrigation	Flood/Drought	Low Productivity
Central	Irrigation	Labour Issues	Inflation
South	Low Productivity	Depressed Economy	Irrigation
West	Low Productivity	Low Economy	Flood/Drought

The main reason is low profitability and unavailability of high cost equipments. The labour availability issues also are a major concern for them.

With facing labour shortage, people have transitioned to using harvesters, combine harvesters but the majority of farmers in India (about 86.2%) are small scale farmers thus cannot afford these equipment because of their high cost. Even when they are available in regions on hourly basis, they generally do no require full featured combine harvesters.
Here the need of a low cost and efficient harvester is arrived which is more affordable & efficient for the use of small holding farmers. It will reduce the labour requirement and also time taken to harvest an acre of land manually will be reduced.

1.1 Methods of Harvesting

Currently in India there is two common methods of crop harvesting are available
1. Conventional Harvesting method
2. Mechanized Harvesting method

In Conventional method, harvesting is done manually with the help of human. There are various problems faced by farmers since this method is labour intensive there is shortage of labour at peak season, time required for harvesting is more and efficient work cannot be done.

In Mechanized method, various attachment to tractors are available in market for harvesting. This is not affordable for the small scale farmers due to its maintenance and high cost of machine.
Simply combine or modern combine harvester is also available. This machine is designed to be a multipurpose machine, it can do various harvesting operations like threshing, reaping and winnowing simultaneously. This can be used for variety of crops. Combine or combine harvester are also available for harvesting but the cost of machine is very high. However these are also available on hourly basis by various agricultural groups. But generally fully featured combines are not required by the small and marginal scale farmers and due to transportation and financial reasons these harvesters are not available at every part of country and the mechanism involved in combine harvester is complex.

1.2 Farmers by Land Ownership

According to tenth Agricultural Census (2015-2016) given by Ministry of Agriculture and Farmer Welfare of India, Small and Marginal holdings (Below two hectares) constituted 86.2% of the total land holdings with 46.94% of opearted area. The operational holdings of Semi-medium and Medium (two- ten hectares) were only 13.2% (approx) of the total land holding with 43.99% of operated area. The operational holdings of large (Above 10 hectares) were only .6% (approx.) of total number of holdings with 9.07% of operated area.
It is important to notice that marginal, small and medium land holdings constitute the large share of operated area. We should focus on the operational ease of small scale farmers since they cannot afford costly attachment and machines but they contribute most in operated areas.

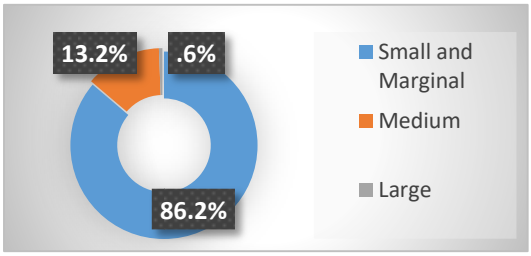

Chart -2: Number of Land holding

2. LITERATURE REVIEW

We should study the previous work done on that topic so far for designing any new component or system. Based on study of previous work that are present till now, their efficiency and their method of working we can then think what are the gaps that we could fill in existing methods and thereby develop a unique and economical way of crop harvesting.
G Maruthi Prasad Yadav, GMD Javeed Basha [1] mentioned the need to increase the productivity of agricultural techniques and reduce the cost. Hence develop an Ultraportable Crop Cutter to cut varities of crop. They use single nylon based rotary cutter attached at the end of handle rotating parallel to ground at high speed for cutting purpose. Drawback of this is labour has to carry its weight for cutting purpose.
N. S. Srivastava [2] this study shows the various aspects of farming and the difficulties faced by the farmers for harvesting and maintaining the agricultural field. This study gives the brief idea of the difficulties faced by the farmers and the conditions of farming.

Neha Kaushik et al., [3] review the existing agricultural techniques and compared it with the application of various technologies used in robots to enhance the productivity of agricultural techniques. Various robots are available for Ploughing, Sowing and Crop Cutting but use of automation in crop cutting increase the overall cost of harvesting which is not feasible for the small scale cultivators.
Yuming Guo's [4] this study shows the required cutting force for cutting the soybean using the relation between the cutting force and the stalk strength. This paper compares the strength of various crops with soybean. With the help of this relation we get the rough idea of required cutting speed for cutting the crop.
Dr. S.D Kulkarni Central Institute of Agricultural Engineering (CIAE) [5] discusses the various problems that the farmers face at the peak season of the harvesting. It specifically limits its results toward the labour scarcity in India, specifically in the peak harvesting season
After reviewing the available literature we can conclude that there are various lawn tractors and crop harvesters are available for harvesting but they may not cost effective and operational ease for small scale farmers. The main purpose of our project is to design a cost effective and operational ease harvesters for the small scale farmers who owns land less than 5 acres.

3. METHODOLOGY

The Problem was studied in a structured and conceptual manner under the following heads respectively.

- Present scenario
- Problem definition
- Field analysis
- Working principle of proposed crop harvester
- Comparative study

PRESENT SCENARIO :- A lot of time is taken by the manual harvesting which is not efficient as it takes a substantial portion of time of total agricultural operation even when the area of farming is small (less than 2 acres). The focus of this project is to make a crop harvester for the farmers who cultivate and harvest the crop in less than 2 acres of land holding to cut grain (soya bean, rice, wheat, maize) with efficacy. The level of mechanisation has gone up gradually in past few years by the collective effort of government and private sector but in rural and hilly areas with sloppy land, farm mechanisation is very low.
PROBLEM DEFINITION :- Heavy cost of machines, their maintenance, unavailability of up to the mark equipment that adheres to the necessity of small scale farmers, inadequacy and difficulty in getting loan from banks are some of the factors that obstructs farming, harvesting and mechanisation and compel farmers to stick with conventional ways of doing agricultural operations. The usage of farming and harvesting related machineries are mainly depend upon the availability of services and equipments in that areas. So the production of cheap and more accessible crop harvester is the need of small scale farmers that ends their harvesting or crop cutting related problems.
FIELD ANALYSIS:- For manual and machine method, the time and the number of labour's required for cutting different crops is tabulated below

Table -2: Cost Comparison

Method	Type of crop	Labours/acre	Time required for cutting (in hours)	Cost per acre in rupees
Manual	Rice	5-6	12	2500
Manual	Wheat	5-6	24	5000

Here we can see that a substantial portion of profit is taken away by labour and also the time required for cutting is more.

WORKING PRINCIPLE OF PROPOSED CROP HARVESTER:-
It is a small size harvester powered by 1.5 HP, 12 volts rechargeable DC motor running at 1250 rpm. The motor is started manually by on/off switch. The input shaft gets the power from motor and there is a cast iron chain drive on this motor shaft. At starting stage, the DC motor runs at 1250 rpm and we need a speed of 300 rpm for the harvesting operation. To achieve this we use gear drive for the reduction of speed from this motor shaft to the output shaft using chain drive mechanism and the power gets transmitted to the output shaft. Now we use two cutters for the purpose of harvesting. Between the motor shaft and the output shaft we fixed a 127 mm chain driven by the motor shaft. Using chain drive mechanism the power is being

transmitted to output cutter shaft from the motor shaft with the help of bevel gears and at this stage we achieved the required reduction in the speed that is 300 rpm which is favorable for cutting maize, bajra, soya bean, wheat, rice and consequently both cutters receive the required power and start rotating. At any instant only the half portion of cutter is used for cutting purpose and the other half is inside the length of casing and the harvesting operation takes place with minimum distortion of grains

Fig -1: Designed Model

COMPARATIVE STUDY:-

Compared with the manual method of crop harvesting, the machine harvesting method has proved to be more successful in terms of both labour and time required and thereby reducing the cost of cutting operation.

Comparative study is given as follows-

Table -3: Comparison for Rice

Parameters of comparisons	Manual	Machine
Labours required/acre	5-6	1
Time required for cutting (in hours)	12	2
Cost per acre	2500	1500

Total saving in cost in rupees/acre for rice = 2500-1500 = 1000 rupees

Table -4: Comparison for Wheat

Parameters of comparisons	Manual	Machine
Labours required/acre	5-6	1
Time required for cutting (in hours)	24	4
Cost per acre	5000	1000

Total saving in cost in rupees/acre for wheat = 5000-1000 = 4000 rupees

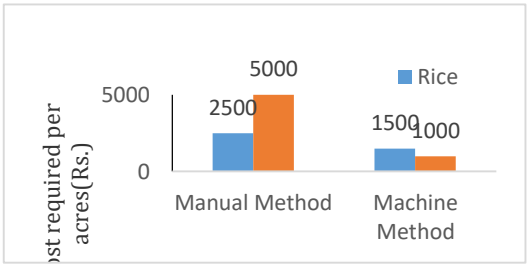

Chart -3: Cost required for different method

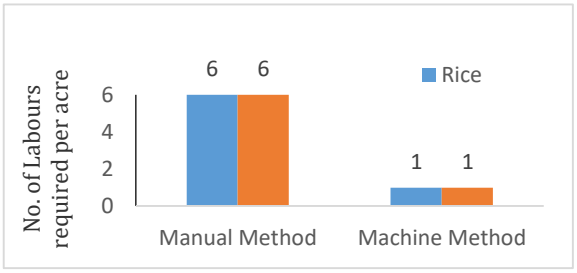

Chart -4: Labour required for different methods

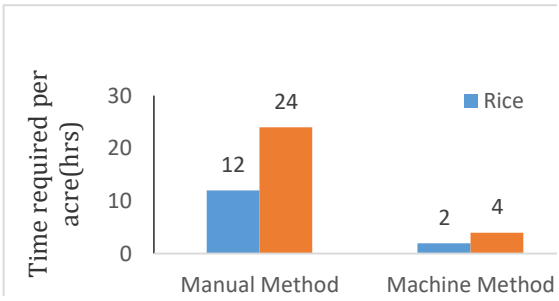

Chart -5: Time required for different methods

4. COMPONENTS OF DESIGN MODEL

The important component of design model is

1. DC Motor
2. Circular Cutter
3. Shaft
4. Chain
5. Sprocket
6. Gears

- *DC Motor*: It help to convert direct electric current into mechanical work or mechanical energy. When these two fields that is a magnetic field and electric field interacts, this generates the mechanical force. On this principal DC Motor or direct current electric motor works. This principal is known as motoring action.
- *Circular Cutter*: Circular cutter blades are very sharp, re-sharping of this blades can be done. They are available in different sizes in market. Mostly for cutting small curves smaller cutter is used while larger blades are used to and for cutting broad curves and straight lines larger cutter is used. In this project we are using blades having large sized tooth so that smooth cutting action can be take place and for completing the cutting action knife edges are provided between the cutters.
- *Shaft:* Shafts serves the function to support the rotating element and transmit the power and motion from one part to other. This is very important part in machine and the cross section of shaft is usually circular. The several other components such as gear, pulley, sprocket etc are mounted on it.
- *Chain:* A chain is used to connect the driver sprocket to driven sprocket so that they can transfer force and motion from one shaft to other with the help of sprocket attached to shaft and those chains that can transmit force and motion are also known as power transmission chains. Mostly chains are composed of alloy steel and plain carbon, but for preventing rusting some chain are made up of chrome-plated or stainless steel.
- *Sprocket:* A simple mechanical wheel with teeth or small notches which are designed to rotate and engage with the links of a chain is known as Sprocket
- *Gears:* Gears is very desirable for the compact transmission. The main requirement of this machine is its small size which can be fulfilled using gear drives since they take very small space for transmission. Gears can transfer large power efficiently and the velocity ratio remains constant and provides very reliable service. Spur gearbox consist of pinion with 19 teeth and gear with 68 teeth. To change the direction of motion by 90˚ bevel gearbox is used

5. COST ESTIMATION

Table -4: Cost of Machine

PART REQUIRED	COST
DC Gear Motor	1400/-
Battery 12 Volt	1260/-
MS Angle	1310/-
MS Plate	150/-
Shaft	210/-
Wheel	1080/-
Resistance	60/-
Diode	70/-
ON/OFF Switch	30/-
Push Button	30/-
NBC Bearing 628	140/-
Bevel Gear	280/-
Spur Gear	170/-
Cutter Blade	640/-
Chain	120/-
Nut and Bolts	60/-
Spring Washer	30/-
Hand Grip	35/-
Color	140/-
Board	70/-
Welding	850/-
TOTAL COST	8135/-

6. CONCLUSIONS

The prime most purpose of the project was to provide a cost effective and lesser labour intensive alternative to farmers having small land holding and lacking resources for modern farming. This was appropriately kept in mind while designing the harvester and the following were drawn.

- The harvester designed takes much lesser time and labour as compared to conventional manual harvesting.
- It goes easier on the pockets of small scale farmers.
- The refuse from the crop can be used as fodder for cattle's and domestic animals.
- The harvester is feasible for use and can work in varieties of conditions and crops all together

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