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Design and Fabrication of Low Cost Crop Cutting Machine

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Abstract
The problem faced by farmers who work on small fields while harvesting crops as it takes a lot of time, labor and effort to cut the crops manually. Although Harvesting machines are already available in the market but these are quite large and costly. Since farmers with small lands have no such large usage and also harvesting is done only twice or thrice in a year, it becomes difficult for small farmers to afford such kind of a machine. So, it becomes essential to make a portable and cost efficient semi or fully automatic crop cutting machine. To achieve this aim, a lot of ground research has been done in this project wherein various farmers of a village near Gurgaon were met and their problems were understood. Based on all the findings, a design for a crop cutting machine has been developed which is expected to help small scale farmer's big time. A prototype has been developed which is easy to operate and can be used for efficient and effortless harvesting of fodder crops. The model so constructed, can be used by small scale farmers for increasing their profits by decreasing labor and machinery cost. This model will offer a superior and cheap technique to decrease labor and endeavors required in collecting crops.

1. Introduction

In India, especially northern part of the country, agriculture becomes the new focus which can give many advantages and benefits especially to our economy, politics and society. Wheat is one of the new focuses in farming where still very little analysts and fabricators have shown interest. After market study, there were a few issues that emerged, for example, how to expand the benefit, how to build efficiency and how to decrease the expense. One of the imperative exercises in Wheat is harvesting. On the wheat crop, half percent of the speculation goes to gathering the yield and its transportation because of increase in wages of the workers and lesser accessibility of workers prompting the appeal of the work. So, with the idea to reduce the dependency on workers in harvesting, this project comes to solve all these problems where the new invention for machinery in harvesting will be able to reduce the dependency on workers. By using the tools like machinery, the dependency on the worker can be reduced, productivity can be increased, the cost can be reduced and the profit can be increased. From that, the main objective for this project was to design and fabricate the prototype of a motorized cutter to harvest crop for commercial use.

Products are reaped after development with the goal to take out grain, straw, tubers and so on . It includes cutting/burrowing/picking, laying, gathering, curing, transport and stacking of the yield. In crops like wheat and paddy, the plants are straight and smooth and ears containing grains are at the top which make issues in gathering by manual or mechanical means. According to Bureau of Indian Standards, the harvesting ought not to be more than 2 for every penny. The reaping of yields is customarily done by manual strategies. Harvesting of wheat grains is done by using sickle, furrow or spade. All these conventional strategies include drudgery and expend long time. Timeliness of harvest is of prime significance. Amid gathering season, frequently rains and tempests happen creating impressive harm to standing yields. Quick reap encourages additional days for area arrangement and prior planting of the following product. In this way, the utilization of machines can gather at legitimate phase of harvest development and lessen drudgery and operation time. Considering these, enhanced gathering devices, hardware, consolidates are being acknowledged by the farmers.

There are a few variables influencing execution of gathering machines, for example, Crop Factors which include product assortment, surrounding temperature, development of harvest, yield dampness, crop condition, crop thickness; Machine Factors which include shape and size of yield divider, reel position and speed, cutting edge shape and speed, transport speed, machine vibrations, machine settings; Operational Factors which include stature of cut, operation speed.

The objectives of this project were to make the review about other research and study relevance to the title, design the prototype of motorized cutter for harvesting crop using some criteria such as it minimizes cost of harvest, takes less time to harvest the crop, make harvesting process less laborious and use cheap machinery and thus, select suitable principle method for the fabrication and select the suitable material, components and parts for this new invention.

For the fulfillment of this aim, it was decided to follow certain steps which were Interviewing the local farmers who had small scale land holding and enquire about the harvesting practices and the crops produced and emerging trends in crop harvesting, Interviewing agricultural equipment manufacturers to get information about various equipment that are available and are in demand, Refer various international papers in small scale harvesters produced earlier and finally, designing of harvester.

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2. Design Methodology

The machine is a walk behind type of harvester which can be used for harvesting crops especially fodder crops such wheat, bajra etc. There are two cutter blades; one is moving and another is stationary. The slider crank mechanism was used to convert rotary motion to linear sliding motion. Scissoring action is obtained due to reciprocating movement of cutter blade over stationery blade was used to cut the crops.

The frame of the harvester with the dimensions 400 X 800 X 400 (l X b X h) mm was fabricated. The mild steel angle section was used to build the frame. Mild steel angle was used because they are light weighted and can be easily welded. The frame was fitted with 2 pair of wheels. Front pair is smaller in size whereas other one is bigger in size. Two pair of wheels was used for easy movement of harvester in the field. Two handles were provided at the end of the frame for pushing the harvester forward.

Diesel engine of 2.2 KW, 3000 rpm was used. It is a rope start type of engine. Diesel engine was selected because diesel engine has good efficiency, power and fuel is easily available in rural areas. Direct motor was not used because the electric wire from the motor to the power source would restrict the movement of the harvester and it can lead to some kind of accident. Moreover, in rural areas electricity is available for fixed number of hours so work would have to be done during those hours only.

Cutter assembly consists of two cutter blade plates. One of the cutter plates is stationary and other is sliding in nature. The cutters used are of triangular shape. In sliding cutter plate, cutter blade was riveted on 3mm plate and in stationary cutter plate; cutter blade was riveted on 5mm plate. The stationary cutter plate was directly welded and fixed on frame. Sliding cutter blade was provided with 2 slots of 80mm on its ends; it allowed sliding motion to be in straight line. The bottom of the sliding cutter plate was connected to the slider crank mechanism. The height of cutting blade is 90mm and has a base of 60 mm. The blades were made up of Mild steel.

Fig. 1 – Frame of Harvester

3. Fabrication

The main frame was brought in shape by welding. All the components were brought together and then bolted on the frame. The rear wheels were welded through an aluminium axle and front wheels were bolted on the main frame. Engine (here in the prototype is a 12V battery) was mounted on the frame using nut and bolts. The cutters were welded onto the front bottom of the main frame and the slider crank mechanism was bolted and welded. The engine runs the motor which starts the motion of the cutter blades via slider crank mechanism.

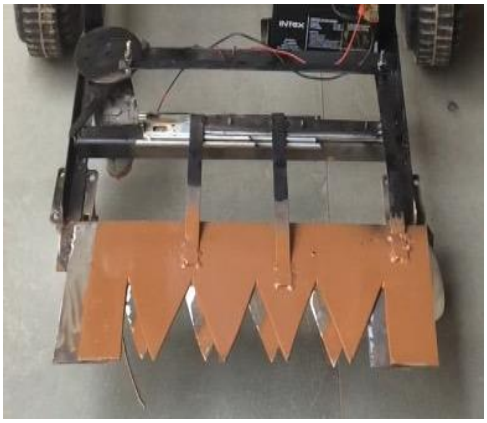

Fig. 2 – Cutter Blades and Slider Crank mechanism

Fig. 3 – Assembly of Frame, Cutter and Wheels

Fig.4 – Finished Assembly of Machine

4. Results and testing

The basic aim of the project was to design a harvester in such a way that it reduces cost of harvesting and have compact size so small farmer can use it effectively and efficiently. For this, a prototype was made on which stress analysis and cost analysis was done.

Table 1 – Comparison of Harvesting Cost by Traditional Method and Our Harvester

Harvesting done by manual process	**Harvesting done by machine**
Amount paid to the labour for 1 day = 300.00 Rs / labour	Expected quantity of diesel required for 1 acre = 4 litres
Total number of labour required in general to harvest 1 acre farm in a day = 6	Cost of 4litres of diesel = 240.00 Rs
Total amount paid to the labour = 6 x 300 = 1800 Rs / acre in one day	Amount paid to the labour = 300.00 Rs.
Therefore, total expenditure in one day is = 1800.00 Rs	Total expenditure = Total cost of diesel + Amount paid to the labour + Maintenance = 240.00 + 300.00 + 100.00 = 660.00

Amount saved by using the harvester = 1800.00 – 660.00 = 1140.00 per day per acre.

5. Force Analysis on Cutter Blade

The force analysis on the cutter blade was done using CAD software. A consistently circulated heap of 200N is connected on the cutter sharp edge. This power produced an anxiety of 7.2x 100 KN/m square. The yield strength of the cutter blade is 386 MPa. This rendered the cutter safe from the cutting force.

The stress analysis showed that the boundary or base of the cutter blade is subjected to minimum cutting forces and as shown by blue color. As we moved towards the tip of the cutting blade stress started to increase and became maximum at the tip of the cutter blade as indicated by red color. As a result of this, maximum wear would take place at this part of the cutter blade. So, whenever the blade will fail, we can simply replace that cutting tooth of the blade.

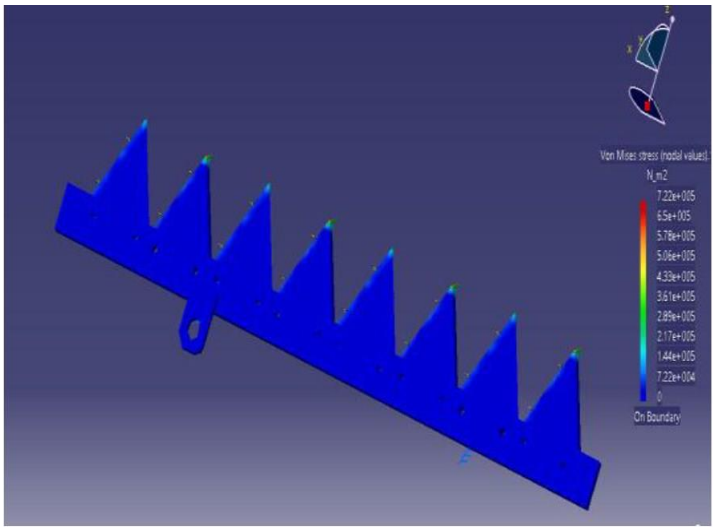

Fig. 5 – Force Analysis on Cutter Blade

6. Conclusions

The main focus of this project was to design and fabricate a crop cutting machine under certain constraints such as compact size, easy to operate, low cost etc. A model has been created within prescribed boundaries to meet the demands of the farmer and to make harvesting more flexible operation.

Based on the models and analyses presented in the previous sections, various conclusions can be drawn. A model which is easy to operate and manipulate has been developed which can be used for efficient and effortless harvesting of fodder crops. The model so constructed, can be used by small scale farmers for increasing their profits by decreasing labor and machinery cost. This model will offer a better and inexpensive method to reduce man power and efforts involved in harvesting crops.

Thus, the aim of this project to construct a realistic and practical crop cutting machine which can be used by farmers for performing harvesting operation with easy and good efficiency has been achieved.

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