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Design and Fabrication of Mini Harvester

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Abstract – ***The main purpose of our Project is to help small scale farmers who having land area less than 5 acres by designing small scale harvester machine to harvest grains very efficiently. Our project work will focus on ease of harvesting operation to the small scale farmers for harvesting varieties of grain in less time and at low cost by considering different factors such as cost of equipment, ease of operation, time of operation and climatic conditions. This machine has cutting blades which cut crops in scissoring type of operation can cut up to two rows of crops. The power unit for this machine is Petrol engine of 14.25 HP. This power is transmitted through gear box, sprocket-chain mechanism to the cutter blades and other power requiring mechanisms for performing cutting, harvesting, and separation operation. This harvester might be the best solution for the problems faced by small scale farmers relating with availability of labors and cost of harvesting.***

Key Words: *Petrol engine, cutter blade, gear box, sprocket chain.*

1. INTRODUCTION

Recently Maharashtra has seen a shortage of skilled labour available for agriculture. Because of this shortage, the farmers have transitioned to using harvesters. These harvesters are available for purchase but they are not affordable Recently Maharashtra has seen a shortage of skilled labour available for agriculture. Because of this shortage the farmers have transitioned to using harvesters. These harvesters are available for purchase but they are not affordable, because of their high costs. 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 Maharashtra due to financial or transportation reasons.

Thus, there is requirement of a compact and efficient combine harvester which would be more accessible and also considerably cheaper. The mission is to create a portable, user-friendly and low cost mini harvester. The idea was to create a machine which is cheap and will reduce the labour required to harvest crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings.

A. Conventional harvesting process:

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 and harvest the crops. After plantation of crops, if proper care is not taken then non-required plants also grows with crop. So, to separate this unwanted plant while harvesting is tedious work. Aim of our project is to target small scale farmers who's having land less than 5 acres.

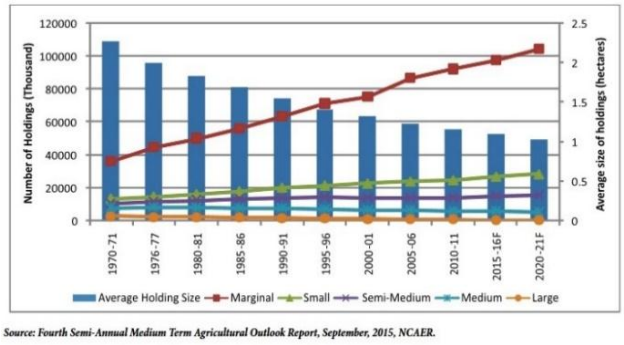
Fig.1: Manual crop cutting

Fig. 2: Conventional threshing method

From past few years, government and private sector working together to overcome the problem occurring in conventional process.

B. Land Statistics:

There are certain regions in Maharashtra where new harvesting methods are adopted, but these are not implemented at the ground level. The reason behind this is high cost of machines and its maintenance cannot be afforded by small scale farmers, even though these machines available on rental basis. Down the years, the agricultural land is decreasing and average land per farmers is also degrading. According to the survey of ministry of agriculture and farmer welfare of India, it states that, area of land hold by farmers is decreasing is explained in following graph:



Source: Fourth Semi-Annual Medium Term Agricultural Outlook Report, September, 2015, NCAER.

Fig. 3: Number of operational holding and average holding size in India

2. LITERATURE REVIEW

Laukik P. Raut's et.al [1] project made by student of GHRCE Nagpur. They made modern reaper at low cost which is beneficial and efficient for small land holder.

Indian Agricultural Statistic [2] paper made by ministry of agriculture and farmer welfare, India. It gave knowledge about current agriculture land structure and statistics of different landholdings.

Christopher Boyle's et.al [3] project made by student of Worcester Polytechnic Institute. They created reaper and binder which is compact in size and much more efficient.

Arvind C.'s et.al [4] paper made by student of BNM Institute of Technology, Banglore. They provided design concept of Paddy harvester and calculation between conventional and modern harvester.

NABARD's project report [5] project proposed by a NABARD for Model scheme of combine harvester. They provided detailed knowledge about all financial aspects regarding harvester.

3. AIM AND OBJECTIVE

Aim of this project is to design and develop small scale low cost compact harvester which reduce the overall cost of grain harvesting in the form of labour cost and harvesting cost.

- To provide proper utilization of wastage which is useful for cattle.
- To reduce overall harvesting time as that of traditional harvesting time.

4. METHODOLOGY:

As the requirement for grains is increasing is day by day, therefore the target was to create the machine which is affordable to each and every farmer, which is cheaper, efficient and will reduce the total harvesting cost.

To achieve this aim, it is decided to follow the following steps:

- To understand farmer's problem which they are facing about harvesting, for this it is decided to interview the farmers. So as decided we surveyed the farmers who are having land less than 5 acres.
- Design of small scale harvester.

A. Survey of problems which are farmers facing:

The design is based on the requirement and demand for compact efficient and affordable harvester. This demand could be seen only with interaction with farmers of having land less than 5 acres. The most of the farmers were from Wardha or near Wardha. The main moto of this survey was to see and collect information about harvesting methods which are being used by them, the problems are being faced while using these harvesting methods.

The following questions were asked to the farmers:

- machines available for harvesting?
- machines cost?
- Are these machines feasible for small scale farmers?
- traditional techniques used for harvesting?
- Can a small scale harvester be able to satisfy the increasing prices of labour?
- What is the labour cost for harvesting, as it is the most labour intensive work?

From these questions, we got the basic idea about the current situation of small scale farmers. We also found that there is essential to have small scale harvester with each farmers for reducing there harvesting cost.

B. The Machine Components:

The main components of small scale harvester are as follows:

1. Petrol engine
2. Cutting blade
3. Screw conveyor
4. Threshing unit

1. Petrol engine – the four stroke single cylinder petrol engine of Bajaj Pulsar 150cc having maximum Power of 14.9 BHP at 9000 RPM and maximum torque of 12.5 N-m. as the harvester is going to work in farm so there is speed limitation up to 2.77 m/s. this speed can obtain on 2nd gear with 3000 RPM.

Fig. 4: Bajaj Petrol 150cc engine

2. Cutting blade- Cutter blade assembly consist of a sliding cutter blade and a stationery cutter blade. The cutters used are of triangular shape. In sliding cutter blade, cutter blade is riveted on 3 mm MS plate and in stationery cutter plate; cutter blade is riveted on 5 mm plate. The stationary cutter plate can be directly bolted and fixed on frame. Sliding cutter blade is provided with 2 slots of 35 mm on its both ends; it allows sliding motion of moving blade to be in straight line.

Fig. 5: Cutting blade

3. Screw conveyor- when the dry crop cut by cutter blade then these crops get transfers with the help of guider to the screw conveyor. Screw conveyor collects the crops and transfers it for the further operation.

Fig. 6: Screw conveyor

4. Threshing Unit- This is the main component of small scale harvester. When the dry crop come in thresher unit the crop is Thresher, the small grains get separated from their chaff and straw.

Fig.7: Threshing Unit

C. CALCULATION :

A. Required power to run small scale harvester:

$$power = \frac{\text{weight} * \text{velocity} * \text{gravity}}{1000}$$

Where, Weight = weight of total assembly in kg=240Kg

Velocity= 10Kmph=10*1000/60*60=2.7m/s

Gravity = 9.81 m/sec^2

$$power = \frac{240 * 2.77 * 9.81}{1000}$$

$$power = 6.52\ KWatt = 6520\ Watt$$

Power= 6520/746=8.74 HP <14.6 HP

B. Required Torque:

$$Torque = \frac{9550 * \text{Power in KWatt}}{\text{RPM}}$$

$$Torque = \frac{9550 * 6.52}{3000}$$

$$Torque = 20.75\ N - m$$

C. RPM calculations in loaded condition:

1. Engine shaft :-

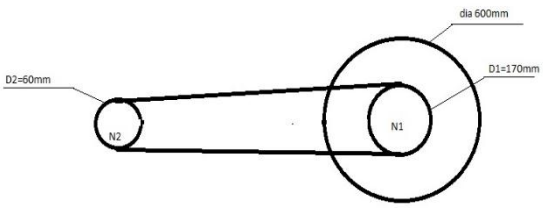


Fig.8: RPM calculation of engine shaft

During testing on bike it is found that:
3000RPM = 10 Kmph on 2nd gear
Wheel diameter Dw=600 mm
Circumference = ∏ * Dw= 1885 mm
Wheel Speed = 10Kmph= 10*1000/3600=2.77 m/s = 2.77*1000 = 2777.8 mm/s

RPS = wheel Speed in mm/s / circumference of wheel = 2777.8/ 1885 = 1.47 per sec.

RPM = 1.47*60 =88.44

i.e. speed of sprocket which is mounted on same shaft of wheel
To calculate engine shaft speed,
N1/N2 = D2/D1
88.41/N2 = 60/ 170
N2= 250.49 RPM
Where,
D1=Dia. of wheel sprocket
D2=Dia. of engine shaft sprocket
N1=Speed of wheel sprocket
N2= speed of engine shaft sprocket.

2. Cutting blade:
Cutter speed = RPS* (distance travelled in left + distance travelled in right)
To calculate RPS,
Here in this condition we have to put sprocket of 170 mm dia. As driver and 60 mm dia. sprocket as driven
Hence, N1/N2 = D2/D1
250/N2 = 60/170
Hence, N2 =708rpm
N2 in RPS = 708/60 = 11.8
From formula
Cutter speed = RPS*(distance travelled in left + distance travelled in right)
=11.8*(35+35)
= 826mm/sec
=0.826 m/sec

D. Working:

It is compact harvester which is having power unit Bajaj petrol engine having power 14.6 HP and torque 12.5 N-m. for regulating speed the gear box is used. Chain and sprocket mechanism is used to transmit the power to all operating components. It also consists of hydraulic jack having lifting capacity of 3 tons which help to lift reel wheel for bending of crops inward in counter clockwise motion. Reel wheel assembly is mounted with cutter at its bottom side the movement of cutter is managing from engine through chain and sprocket mechanism. Cutter moves in reciprocating motion. The reel wheel is rotated in clockwise direction which bend crops towards cutter blades due to which the crops get cut and this crops moves towards the screw conveyor with the help of guider.
Now, screw conveyor collects these crops centrally and move it further on conveyor belt which move the crops towards the threshing unit. The crops are get trapped in threshing unit because of this the grains are separated from their chaff and straw. These grains are stored in container having storage capacity of 20 kg to 30 kg and remaining wastage is also stored in another container for the utilization for cattle

Fig. 9: CAD model of small scale harvester

RESULTS

A. Harvesting done by traditional method:
Amount paid to the labour for one day= Rs. 300
Total number of labours required to cut the crops from 1 acres of farm = 4
Total amount paid to the four labours for one day= 4*300= Rs.1200
Thresher machine rent per 1 quintal =Rs.100
Total rent of thresher machine=10*100= Rs.1000
Therefore, total expenditure in one day per acre = 1200+1000= Rs.2200
B. Harvesting done by small scale harvester:
Quantity of petrol required to harvest one acre =3 litre
Cost of petrol per litre=Rs.75
Total cost of petrol for 1 acre = 3*75=Rs.225
Numbers of Labours required= 2 i.e. one operator and one helper.
Operator cost = Rs.300
Helper cost= Rs.200
Therefore, total labour cost = 300+200= Rs.500
Total expenditure paid per acre= 225+500= Rs.725
Amount saved by using harvester = amount paid by using traditional method – amount paid by using small scale harvester
=2200-725=Rs.1475 Per acre.

5. CONCLUSIONS

The main objective was to make simple, compact, efficient and low cost small scale harvester for small land holders. This machine fulfilled all objective and following conclusion were drawn on based of work:

- On the basis of literature review, all specification regarding small scale harvester were meet.
- After assembling the machine was tested on field for its efficiency and capability. the result got was as per our expectations from machine.
- It is also concluded that machine was easy to control on the field.
- As this harvester is made to work at any condition where mega harvester cannot be reach and it meet to work in any condition with proper transportation facility due to compact size.

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