A

Project Report on

MANUALLY OPERATED MINI PADDY THRESHER

SUBMITTED BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

Bachelor of Technology

In

INDUSTRIAL & PRODUCTION ENGINEERING

Under the guidance of

Dr. R. S. Jadoun

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DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINERING

COLLEGE OF TECHNOLOGY

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Uttarakhand, India

June 2019

DECLARATION

We hereby declare that the project work entitled 'MANUALLY OPERATED MINI PADDY THRESHER' submitted to G. B. Pant University of Agriculture & Technology during the academic year 2018-2019, is a record of original work done by us under the guidance of Dr. R. S. Jadoun (Professor & Head, Department of IPE). The result embodied in this project has not been submitted to any other university or institute for the award of any degree or diploma.

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APPROVAL

The project entitled 'MANUALLY OPERATED MINI PADDY THRESHER' is hereby approved as a creditable and commendable work carried out and presented in a satisfactory manner to warrant its acceptance as prerequisite to the degree for which it has been submitted by Taranjeet Singh (48721), Chandradeep Pokhariya (49249), Devdutt Tripathi (49268), Rajesh Bhatt (49291) .

The assistance and help received during the course of this investigation and source of literature have been duly acknowledged.

Dr. R. S. Jadoun
Project Guide
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CERTIFICATE

This is to certify that the project entitled 'MANUALLY OPERATED MINI PADDY THRESHER' submitted in partial fulfillment of the requirements for the degree of Bachelor of Technology in Industrial & Production Engineering, College of Technology, G. B. Pant University of Agriculture & Technology, Pantnagar, is a record of bonafide research carried out by Taranjeet Singh (48721), Chandradeep Pokhariya (49249), Devdutt Tripathi (49268), Rajesh Bhatt (49291) under my supervision and no part of the project has been submitted for any degree or diploma.

The assistance and help received during the course of this investigation and source of the literature have been duly acknowledged.

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ABBREVIATIONS USED

- **FAO** - Food and Agricultural Organization
- **IRRI** - International Rice Research Institute
- **USDA** - United States Department of Agriculture
- **ha** - Hectares
- **rpm** - Revolutions per minute
- **mm** - Millimeter
- **bpm** - Beats per minute
- **Kg/hr.** - Kilogram per hour

ABSTRACT

India accounts of more than 70% of its population involved in agriculture. Hence it is obvious for big companies and government organization to focus on big machines which can thresh in large amount. But in hilly areas where average farm size is less than 0.4 hectare, and it limit the product to around 400 kg per household, it becomes almost impossible for them to buy such machines. Considering all such conditions, we decided to make a Mini Paddy Thresher which can be operated manually and hence affordable to small scale farmers.

Prior to its design and analysis, we collected all necessary suggestions of small scale farmers. They were threshing efficiency, threshing rate, portability, ease of use etc. This paddy thresher contains a cylinder with spokes on it which is connected to shaft and a handle. The grains are separated by rubbing and impact action between spokes and concave.

This entire setup is very compact. So just by human effort one can use this thresher effectively without depending on external factors.

INTRODUCTION

CHAPTER 1 INTRODUCTION

Rice as a cereal grain is most widely and commonly consumed food while an enormous part of the world's population. Rice is a crop ranked third in world's most produced crops behind sugarcane and maze. The cycle for rice is 190 days with its harvesting season lasting for 30 days in mid-September to October. Rice is usually harvested when the rice grains reach a moisture content of about 25%. After harvesting, threshing of the rice is done usually within two days.

1.1 GENERAL OVERVIEW OF THE PROJECT

A threshing machine or thresher is a piece of farm equipment that threshes grain, that is, it removes the seeds from the stalk sand husks. It does so by beating the plant to make the seeds fall out. Before threshing machines were developed, threshing was done by hand with flails: such hand threshing was very laborious and time-consuming, taking about one-quarter of agricultural labor. Mechanization of this process removed a substantial amount of drudgery from farm labor. The first threshing machine was invented circa 1786 by the Scottish engineer Andrew Meikles, and the subsequent adoption of such machines was one of the earlier examples of the mechanization of agriculture. During the 19th century, threshers and mechanical reapers and reaper-binders gradually became widespread and made grain production much less laborious.

Few machines have been designed specifically for small farmers, and even when products are available, often farmers lack knowledge of or access to this machinery. Therefore, small machines have yet to be adopted extensively in many regions. Local conditions such as crop variety or the farming method used will also affect machine performance.

1.2 MOTIVATION

There are various ways of threshing involved accounting to the suitability of the regions where it is carried out. In North-Western Himalayan region (NWHR) of India, paddy is grown over in 0.6 million ha. producing 1.0 million tons of rice in the hilly and mountainous agro-ecosystem of the NWHR. The average farm size is less than 0.4 ha, and this limits rice production to around 400 kg per household. Due to the low production and income, farmers cannot afford costly and high-capacity paddy threshers. In view of the prevailing socio-economic conditions of farmers in NWHR, large-capacity threshers are inappropriate and even sophisticated. Considering all such conditions, we decided to develop a mini paddy thresher which can be operated manually and hence affordable to small scale farmers.

1.3 TYPES OF THRESHING METHODS

There are different types of threshing methods used in India since ancient time. But some methods are quite popular and used even in this modern era. With time passed, the methods and process remained same. They are very slow and labor consuming process. The harvested crop is dried and thereafter, is beaten either by stick or against the floor/wooden log/empty drum to loosen the grains from the paddy stack. Since these processes are labor intensive and therefore, they are adopted for very small quantity of harvest. Followings are the common type of threshing methods.

1.3.1 Traditional Paddy Thresher

This kind of thresher is huge in size and is not that efficient in separation of grains from the chaff. The thresher consists of wooden drums with nails stuck around it. This thresher is quite heavy and cannot operate in high speed. This structure is quite outengineered as it has very low grain output and laborious. These are still used by small scale farmers as it is quite cheap and can be manufactured at home. The picture below demonstrates the traditional kind of thresher very well.

Figure 1.1: Traditional Paddy Thresher [3]

1.3.2 Beating Method

Threshing by beating method especially against rocks is very old and common practice followed in villages. The dried crop stalks is spread and bundled. The crop is trampled in the rock continuously till a homogeneous mixture of grain and shaft is prepared. Later on the grains are separated from the straw by winnowing. This method of threshing is quite slow with low output. Hand beating methods are normally used for threshing rice that easily shatters. The figure shows the traditional way of threshing by beating method.

1.4 DEMERITS OF EXISTIING THRESHERS

Following are the demerits of the existing threshers,

- Unaffordable for small-scale peasants with small land holdings in the hilly regions.
- Require more than one person to carry out the process effectively
- Bulk
- Not portable
- Ergonomically not suitable, the operator is often tired after the process since no proper ergonomic considerations are taken while designing.

1.5 SCOPE

This project helps us achieve the following:

- Can be used by small scale peasants to save some time and increase their productivity.
- Being less expensive it would be procurable for large number of small scale farmers and more portable in remote areas.
- More comfortable to use as it is designed more ergonomically.

1.6 OBJECTIVES

The main objective of the project is to undertake a review of the designs of existing rice threshers and come up with prototype small threshers that are appropriate and affordable to poor – small rice farmers in hilly areas. The specific objectives are to:

- To determine the capacity and threshing efficiencies of the hand operated manual rice threshers.
- Review rice threshing by hilly rice farmers with the aim of identifying needs and requirements.

- To measure the drudgery associated with operating the hand rice threshers.
- To measure the threshing speed and losses during threshing by the hand rice threshers.

1.7 THRESHING SPECIFICATIONS

During farm testing and discussions with farmers, a number of key factors were identified which are important to consider when evaluating the suitability of a small-scale threshing machine.

1.7.1 Threshing Rate

The primary aim of threshing machines is to reduce the labor required for the threshing process. Farmers indicated that the overall threshing rate is more important than the rate per person, as paddy must be threshed as soon after harvesting as possible. Once threshing rate is accurately determined, this may be used for an economic analysis of the threshing method [4].

1.7.2 Threshing Losses

IRRI defines threshing losses as scattering loss, threshing loss and grain breakage. While these losses may be significant for industrial scale machines, it was found that detailed measurement of these factors was not practical or particularly informative when testing small-scale machines. The farmers themselves are a good judge of threshing quality and therefore can be asked to evaluate the output and threshing loss instead of using quantitative measurements.

1.7.3 Output Quality

Output quality is determined by the amount of chaff/straw and dummy grains mixed with the paddy. Generally, it was found that farmers do not mind additional dummy grains being mixed with the paddy, as these will absorb moisture during paddy storage and will not significantly increase winnowing time. However, machines which winnow out the straw will reduce the time required to collect the paddy post threshing.

1.7.4 Portability

Portability is a key factor for access to farms which may not have direct road access, and to enable farmers to share or lend out a machine. Since weight of the model plays important role in it's portability hence it has to be designed in such a way and with such a material that it should not effect it's movement in a major way.

1.7.5 Power Source

Electric motors are cheaper to run than diesel motors, and many farmers have subsidized electricity rates and single-phase supplies. Due to power cuts and off the grid farms, it is useful if the machine has a back-up power source, such as hand operated.

1.7.6 Ease of Use

Factors such as if women can use the machine, the ease of collecting the paddy (scattering) and the effect of the machine on the rest of the threshing process should be considered. For example, feed in threshers required sudis to be untied prior to threshing and output a pile of mixed straw. Some farmers may wish to maintain the sudis bunches as this is how straw is sold. Exposed rotating parts are common on threshing machines, and users should be warned to tie back loose clothing and take relevant precautions. Thresher has to be portable enough to carry it to inaccessible areas.

REVIEW OF LITERATURE

CHAPTER 2 REVIEW OF LITERATURE

Before we embarked on our study a lot of research papers were sorted and gone through by us related to our topic. Such studies were undertaken throughout the world by various scholars and different methodologies were adopted by them.

2.1 THRESHING OPERATION

Threshing operation involves the detachment of paddy kernels or grains from the panicle. Depending on the influence of agronomic, economic and social factors, threshing is done in different ways. It can be achieved by rubbing action, impact and stripping. The rubbing action occurs when paddy is threshed by trampling by humans, animals or tractors. The impact method is the most popular method of threshing paddy. Most mechanical threshers primarily are the impact principle for threshing, although some stripping action is also involved. The difficulty of the process depends on the varieties grown, and on the moisture content and the degree of maturity of the grain [15].

Paddy threshers may either be the hold-on or throw-in type of feeding. In the hold-on type, paddy straws are held stationary while threshing is done by the impact on the particle from cylinder bars spikes or wire loops. In the throw-in type of machines, whole paddy stalks are fed into the machine and a major portion of the grain is threshed by the initial impact of the bars or spikes on the cylinder. The initial impact also accelerates the straw and further threshing is accomplished as the moving particles hit the bar and the concave. The third type, stripping has also been used in paddy threshing. Some impulsive stripping occurs ordinarily with impact threshing in conventional threshing cylinders. In the throw-in type of thresher, large amounts of straw pass through the machine. The primary aim of threshing machines is to reduce the labor required for the threshing process. Farmers indicated that the overall threshing rate is more important than the rate per person, as paddy must be threshed as soon after harvesting as possible. Once threshing rate is accurately determined, this may be used for an economic analysis of the threshing method.

IRRI defines threshing losses as scattering loss, threshing loss and grain breakage. While these losses may be significant for industrial scale machines, it was found that detailed measurement of these factors was not practical or particularly informative when testing small-scale machines [12]. The farmers themselves are a good judge of threshing quality and therefore can be asked to evaluate the output and threshing loss instead of using quantitative measurements. Threshing force; which is the force that separates a grain from the panicle has a great importance in evaluating losses over design, application of harvesting and threshing machines.

2.3 MANUAL THRESHING

Traditional rice farmers carry out threshing in different ways. These methods are however local, inefficient and laborious; besides, they are only suitable for small scale farming, they include; beating on hard or wooden object or screen, sometimes pedal operated threshing drums are employed in fairly big farms. One of the simplest systems for threshing rice is to pick up the sheaf of rice and strike or beat the panicles against a hard surface such as a tub, threshing board or rack; or beating the sheaves spread out on a threshing-floor with a flail or a stick or tramples it underfoot. The threshing-floors on which the sheaves are spread must have a hard, clean surface. The pedal-operated thresher consists of a rotating drum with wire loops which strip the grains from the panicles when fed by hand.

By using one of these methods of hand-threshing, a worker can obtain 15 to 40 kg of product per hour. Rural women have primary responsibility of running\household, procuring fuel, fodder, water and care of children as well as other family members. Women play a significant and crucial role in agricultural operations; including different crop production activities, postharvest activities etc. [14].

If the paddy obtained contains too many unthreshed panicles and plant residues, a second threshing must be followed by an effective cleaning of the product. Use of these threshing machines may require two or three workers. The interesting characteristics of manual threshers are their ability to generate and sustain required torque for a reasonable length of time and they do not suffer appreciable mechanical damage. The foot pedal is able to deliver a velocity ratio of as high as 1: 10 reaching an average speed of between 150 – 200 rev/min. Speed delivered equals pedal speed x velocity ratio.

The manual threshers were developed with the aim of having a thresher that will not run on petrol engine or electric motor but rely solely on human power, the various manual threshers share similar characteristics judging by their advantages and disadvantages [13].

According to Adewumi *et al,* the results of the performance analysis showed that threshing efficiency increased with an increase in cylinder speed and threshing efficiencies was found to be in the range of 54.5% to 100%.

2.4 THRESHING WITH MOTORIZED EQUIPMENT

Although they are gradually being replaced by combine-harvesters, motorized threshing machine still have an important place in the post-harvest production process, especially for their convertibility. By the simple replacement of a few accessories and the appropriate changes in settings, these machines can treat different kinds of grain (e.g. rice, maize, sorghum, beans, sunflowers, wheat, soybeans, etc.) [12].

2.5 GENERAL FEATURES OF THRESHERS

Most, if not all powered paddy threshers are equipped with one of the following types of cylinder and concave arrangement: (a) rasp bar with concave (b) spike tooth and concave (c) wire loop with concave (d) wire loop without concave. Tests by the International Rice Research Institute, IRRI indicated that the spike tooth cylinders performed well both with the hold-on and the throw-in methods of feeding and its threshing quality is less affected by changes in cylinder speed. In the axial-flow thresher, the harvested crop is fed at one end of the cylinder/concave and conveyed by rotary action on the spiral ribs to the other end while being threshed and separated at the concave.

2.6 MECHANICS OF GRAIN THRESHING

The process of mechanical threshing involves the interaction of machine and crop parameters for the separation of the seed from the pod. Threshing is carried out between a stationary concave and a rotating cylinder. Different configurations of threshing devices have been used. The two types generally employed in present day stationary threshers and combines are rasp bar cylinders and spike tooth cylinders. The latter are used almost exclusively in pea threshers. Also, rubber covered flat bars have been employed on cylinders and concaves for threshing small seed legumes such as crimson clover, giving less damage and less unthreshed loss than the conventional spikes [6][4].

High-speed motion pictures have shown that the main threshing effect in peas or cereals results from the impact of the cylinder bars at high speeds with the pods. The primary function of the concave appears to be that of holding and presenting the material to the cylinder bar for repeated impaction. A spike tooth has been shown to have a more positive feeding action than a rasp bar cylinder does not plug easily, and requires less power. However, rasp bar cylinders are readily adaptable to a wide variety of crop conditions; are easy to adjust and maintain, and relatively single and durable.

Various parameters are in use for evaluating the performance of threshers and determining and retaining the quality of the through-put. The parameters include; threshing effectiveness, grain damage, sieve effectiveness, cleaning efficiency and seed loss. Studies have shown that threshing effectiveness is related to the peripheral speed of the cylinder, the cylinder-concave clearance, the number of rows of spikes, the type of crop, the conditions of the crop (in terms of the moisture content and stage of maturity), and the rate at which material is fed into the cylinder. Cylinder speed is the most important machine operating parameter that affects seed damage. Increasing the speed substantially increases seed damage. Reducing the cylinder concave clearance tends to increase seed damage but the effects are generally rather small in comparison with the effect of increasing cylinder speed. Susceptibility to damage varies greatly among crops.

Threshing trials conducted on soya bean and cowpea pods in a rasp bar cylinder thresher showed that visible grain damage was greater in cowpea for the same cylinder speed and concave clearance, and this affected seed germination. The seeds of some dicotyledonous plants such as beans may be damaged excessively at low cylinder speeds, whereas those of non di-cotyledons can withstand very high cylinder speeds without appreciable damage. It has been asserted in literature that mechanically damaged grains do not keep well in storage and are prone to fungal and bacterial infections when stored. The field emergence of such damaged seeds is generally poor [10].

2.7 DRUGERY

High work stress has repeatedly been associated with increased risk for cardiovascular disease. This association could derive in part from detrimental effects on blood pressure (BP) by recurrent autonomic nervous system reactivity to work-related stressors. Evidence for such work-stress effects comes from ambulatory BP studies, which show increased blood pressure levels in subjects with high work stress [8]. Work stress in these studies was usually defined as job strain according to the model of Karasek and coworkers. The commonly performed agricultural activities in India were weeding, cutting uprooting, transplanting, threshing and mannuring. Drudgery is generally conceived as physical and mental strain, agony, monotony and hardship experienced by human beings while all of women in this regard are alarming as they continue to be constrained by illiteracy, malnutrition and unemployment. Many believe that women's involvement in agricultural tasks and large is a source of heavy burden of drudgery on them. Observation of heart rate is a simple and a reliable method of analyzing the workload on the person. The physiological cost of work is expressed in terms of increased heart rate and oxygen consumption. The average working heart rate (HR work) of the subjects when the paddy threshing was done manually by beating ranged between 143 to 166 beats/min. with a mean HR value of 154.5 beats/ min. The corresponding HR values with the use of manual paddy thresher ranged between 120-125 beats/min. with a mean value of 122.5 beats/min [11].

MATERIALS AND METHODS

Considering all the objectives and scope of the project, we proposed a prototype which can overcome all the deficiencies existing manual threshing has. We begun with the materials required to fabricate the thresher and then applied various analysis for designing, which include designing of threshing drum, concave, shaft, gears and bearings.

3.1 MATERIALS REQUIRED

Followings are the materials used to fabricate the thresher, they are – pegs, cylinder, shaft, frame, metal body and concave. We used cast iron for fabricating threshing drums, pegs, handle and shaft. For fabricating frame and concave we used sheet metal.

Cast iron is a group of iron-carbon alloys with a carbon content greater than 2%. Its usefulness derives from its relatively low melting temperature. The alloy constituents affect its color when fractured: white cast iron has carbide impurities which allow cracks to pass straight through, grey cast iron has graphite flakes which deflect a passing crack and initiate countless new cracks as the material breaks, and ductile cast iron has spherical graphite "nodules" which stop the crack from further progressing.

Sheet metal is metal formed by an industrial process into thin, flat pieces. Sheet metal is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin sheets are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate steel or "structural steel."

Cast iron has major advantage over sheet metal. As the former has more castability, ease of machining, vibration damping, compressive strength, corrosion resistance, wear resistance and less cost, so we chose cast iron for fabricating threshing drums, handle, pegs and shaft.

3.2 METHODS APPLIED

For fabricating the model, we approached 'Jai Gurudev Industries' in Rudrapur. Machines used were lathe machine, plate rolling machine and welding machines. We used arc welding and stud welding to fabricate the prototype.

Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents. Arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work pieces. The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the join. Because the metals react chemically to oxygen and nitrogen in the air when heated to high temperatures by the arc, a protective shielding gas or slag is used to minimize the contact of the molten metal with the air. Once cooled, the molten metals solidify to form a metallurgical bond.

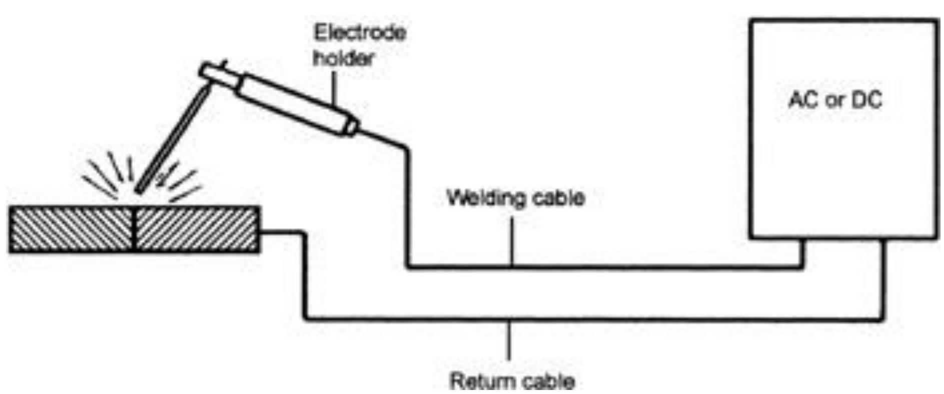

Figure 3.2: Basic arc welding circuit diagram [2]

3.3 PROPOSED MODEL

The given below diagram illustrates the proposed model and its CAD design. The model contains seven different parts. These are metal body, cylinder, shaft, pegs, concave, handle, and frame. We designed this model in CAD software SOLIDWORKS with all the parts designed with exact dimensions.

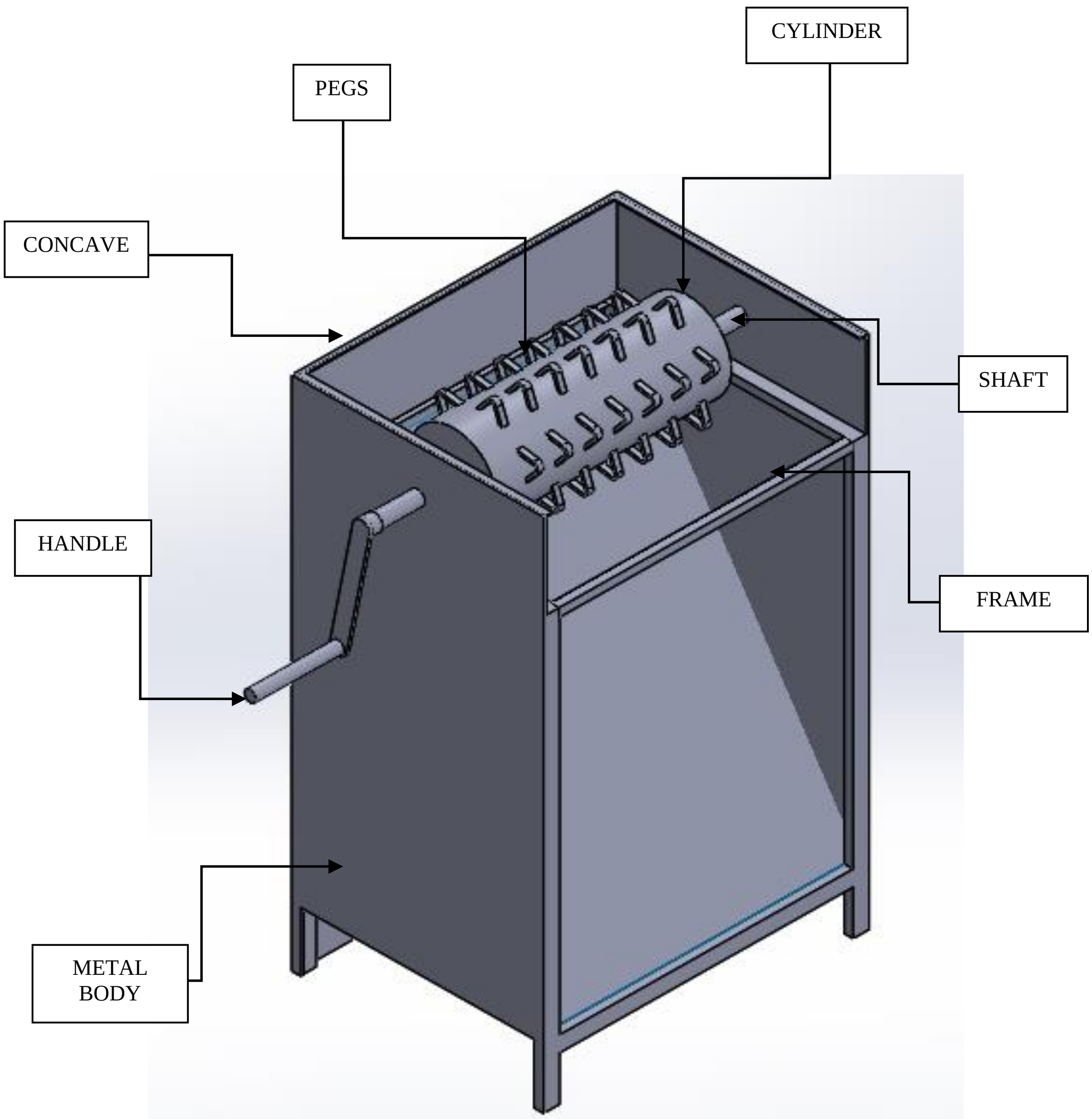

Figure 3.3: Proposed Design of Paddy Thresher

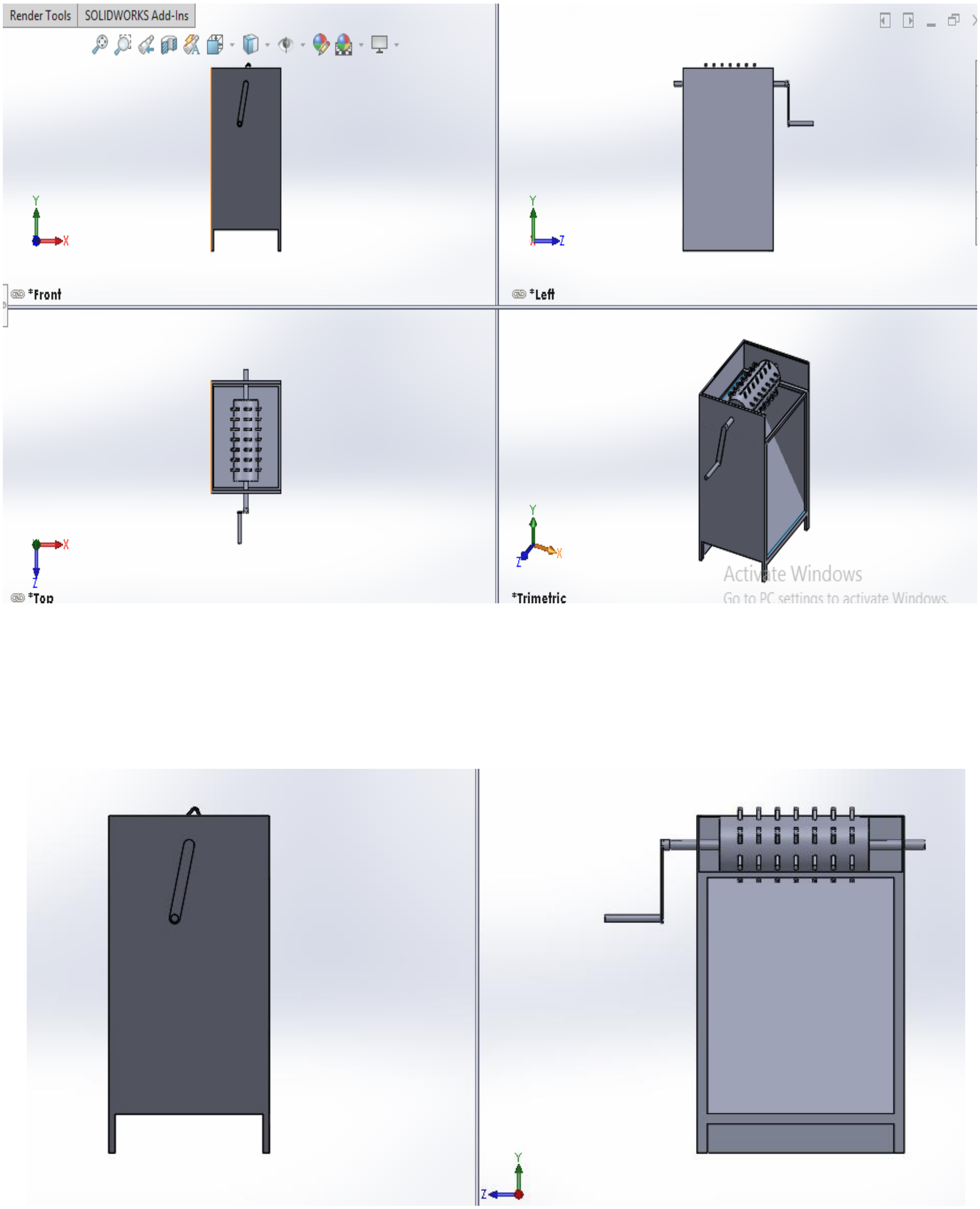

Figure 3.3: Top, Front, Side, Back view of the Thresher

3.4 DESIGNING

As we know that designing is a work process which has user perspective and drives development based on specific customer need, hence we considered all such parameters and analyzed it based on designing. Following are the designing of various components used in our proposed thresher.

3.4.1 Designing of Threshing Drum

Following are the key points we considered for designing the threshing drum and its parts.

The diameter of the threshing drum is 250mm.

- The length of the drum is 500mm.
- The entire threshing drum has pegs all over it. The pegs are welded on to the drum.
- The height of each peg is 50mm.

Revolution of threshing drum:

$$N = \frac{(60*(v))}{(\pi*D)}$$

v is peripheral speed

D = diameter of cylinder;

Where, N = revolution of threshing drum in rpm

Diameter of threshing drum (D): $D = \frac{(\,peripheral\ speed}{(\pi*N)})$

3.4.2 Designing of Concave

The dimensions of concave significantly affect the threshing of the crop, grain slippage and the breakup of straw. When the length of the concave is increased, the under milling decreases since the number of impacts sustained by the same portion of the crop and the length traversed by it increases [16].

A longer concave increases grain slippage, reducing grain loss and load on the straw rack. In modern combines, the length of the concave is 400 to 600 mm. The concave sieves 60 to 85 % of the grain through its apertures.

3.4.3 Designing of Shaft

When the shaft is subjected to combine twisting moment and bending moment, then the shaft must be designed on the basis of the two moments simultaneously. Various theories have been suggested to account for the elastic failure of the materials when they are subjected to various types of combined stresses [17].

To calculate combined stress, two theories are important that are:

- Maximum shear stress theory or Guest's theory. It is used for ductile materials such as mild steel.
- Maximum normal stress theory or Rankine's theory. It is used for cast iron as well as for brittle materials.

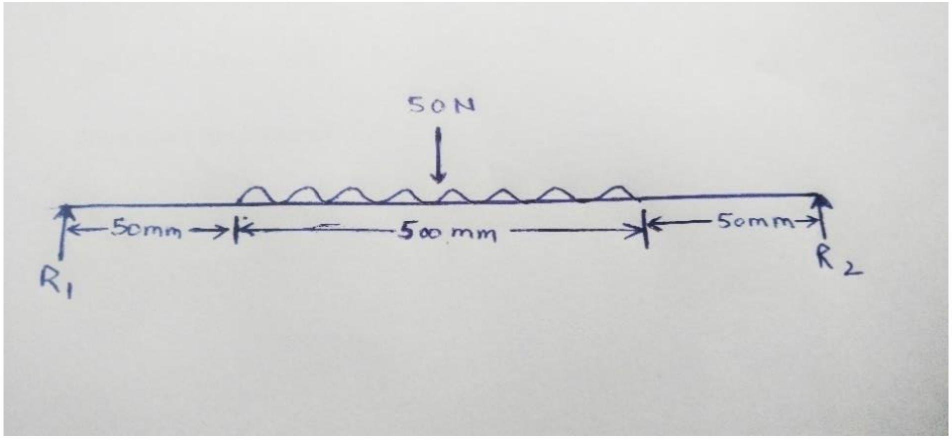

Figure 3.4: Shaft and forces on it

$$d^3 = \frac{16*\{(k1*M)^2+(k2*T)^2\}^{1/2}}{\pi*S} \qquad \text{----------------(1)}$$

Where [18],

d = Shaft diameter, k1=k2=2,

M = bending moment, T=torque in the shaft,

S = Allowable stress = 40*10^6 N/m^2

R1 = R2 = 25 N

M = (25*0.3) -100*(0.25/2)
= 12.5-7.5
= 5 Nm

$$T = \frac{60*P}{2*\pi*N}$$

$$= \frac{60*100}{2*\pi*120}$$

= 7.95 Nm

Putting back in equation 1 we get,

d = 2.98cm ~ 3cm

3.4.4 Designing of Bearings

A bearing is a machine element that relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least three races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling, they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

3.4.5 Designing of Gears

The purpose of gear is to increase the drum speed. This can be helpful as more the speed of the drum, more is the efficiency of thresher.

The working principle of gear is that if two gear mesh together, one revolution of larger gear provides more than one revolution in smaller gear. That depends on the number of teeth both the gears have. The speed of peg drum can be increased by using two gears. One gear of larger diameter than the other. The gear with larger diameter is connected to the axis of handle, and this larger gear meshes with smaller gear that is connected to the axis of peg drum.

Keeping the gear ratio, $\frac{N1}{N2} = \frac{d1}{d2} = k,$

Now, $$\frac{rpm\ of\ gear\ 1}{rpm\ of\ gear\ 2} = \frac{speed\ of\ handle}{speed\ of\ peg\ drum}$$

$$\frac{d2}{d1} = \frac{speed\ of\ handle}{speed\ of\ peg\ drum}$$

Speed of peg drum = k*speed of handle

3.5 THE FINAL FABRICATED MODEL

After designing of all the components, they were collected and brought together with the help of arc welding, stud welding, bolts and nuts, and set screws. First of all, threshing frame was welded with the help of arc welding and then drum and other components were assembled into the frame to get the final fabricated model.

Figure 3.5: The final fabricated model

3.6 BRIEF WORKING

This paddy thresher of hand operated type consists of mainly a well-balanced cylinder with a series of wire loops fixed on the rotating cylinder.

While cylinder is kept in rotary motion at high speed, the paddy bundles of suitable sizes are applied to the teeth. The grains are separated by combining as well as by hammering action of threshing teeth.

Paddy is threshed due to impact and rubbing action between threshing drawn loops and concave screen. The grains are cleaned with the help of a fan and cleaned grain goes down through the grain outlet at the bottom of the thresher.

3.7 CALCULATIONS OF DIFFERENT PARAMETERS

There were different parameters which were considered and calculated to get the insights about our proposed thresher. These parameters include loss percentage, capacity, efficiency, and drudgery.

3.7.1 Determination of Loss Percentage

The following relationship was used to calculate the percentage losses of the hand operated rice threshers:

Scattering losses percentage= $\frac{scattered\ grains(kg)*100}{Total\ seed(kg)}$

Un-stripped grain percentage = $\frac{unstripped\ grains(kg)*100}{total\ seed(kg)}$

Hence, total loss %= Scattering losses percentage + Un-stripped grain percentage

3.7.2 Determination of Capacity

The following relationship was used to calculate the capacity of rice threshers.

Threshing capacity= $\frac{total\ grain\ output(kg)*60}{total\ time\ in\ minutes(hr)}$

3.7.3 Determination of Efficiency

The following relationship is used to calculate the efficiencies of the hand operated rice threshers

Threshing efficiency= $\frac{threshed\ seed(kg)*100}{total\ seed(kg)}$

3.7.4 Drudgery determination

The relationship below is used to calculate the drudgery in using the hand operated rice threshers.

$$\Delta \text{HRKG} = \frac{\Delta HR}{C} * 60$$

Where,

ΔHRKG = Increase HR/kg of grain threshed, beat/kg

ΔHR = (Mean working HR- Resting HR), beats/min

C = Capacity of the thresher, kg/h

3.8 COST ANALYSIS

The details of components used in fabrication of paddy thresher have already been discussed. This has been the endeavor of the project to keep the total cost to be minimum. Most costly component among all was the threshing drum. We choose the least expensive materials possible for constructing our proposed model. A break up of cost of individual component is represented in the following table.

Table 3.1: Cost Analysis of different materials

S. No.	Item- Number	Cost of the component (Rs)
1	Bearings	360
2	Rotating Drum	600
3	Rotating Shaft	500
4	Frame	1700
5	Overhead Cost	560
	TOTAL COST	**3,720**

Total cost of Portable thresher as we can see is very low as compared to other machines for threshing whose prices can go upto 1 lakh. Also, if mass production of such paddy threshers is carried out the cost will come to Rs. 1500-2500 per thresher.

RESULTS AND DISCUSSIONS

CHAPTER 4 RESULTS AND DISCUSSION

After the paddy thresher was fabricated and installed the threshing efficiency, threshing speed, drudgery and losses involved were measured recorded and compared with traditional manual threshing. Before these processes of threshing were carried out, the initial pressure readings of the farmer were taken and an amount of 1kg of rice was threshed for 10 trials using the hand operated rice threshers each, within which initial and final pressure readings were taken as well as the speeds of the threshing drum, with the aid of a tachometer. Rest times were taken to be 3 minutes between trials and the total time used in threshing were also recorded using a stop watch, which aided in determining the threshing rate for the processes.

4.1 THRESHING SPEED

During the experiment, the threshing speed of the hand operated rice thresher ranged from 113rpm to 152rpm with an average speed of 136.6rpm for ten test trials, while the threshing speed of traditional hand operated threshing was found to be 65rpm to 85rpm indicating that the hand operated rice thresher was able to keep threshing speeds constant for test trial compared to the traditional one [19].

Table 4.1: Readings of Threshing Speed

Threshing speed	138	142	121	143	125	127	120	110	142	140
Trials	1	2	3	4	5	6	7	8	9	10
Time Duration (min)	5	5	5	5	5	5	5	5	5	5

4.2 DRUDGERY

Before the experiments were carried out, the initial systolic pressure reading of the 45-year-old operator was 72mmHg. During the experiment, the systolic pressure readings recorded in using the hand operated rice thresher ranged from 101mmHg to 120mmHg for ten test trial whereas systolic pressure readings recorded in using the traditional hand operated rice thresher ranged from 120mmHg to 135mmHg. Since systolic pressure indicates a measure of stress, it shows that the traditional hand operated thresher could be more stress inflicting over a number of test trials [19].

Table 4.2: Readings of Systolic Pressure

Diastolic pressure (mmHg)	115	105	102	116	112	120	112	105	100	105
Trials	1	2	3	4	5	6	7	8	9	10
Time Duration (min)	5	5	5	5	5	5	5	5	5	5

During the experiment the heart rate was also measured and compared with the heart rate during traditional manual threshing. The heart rate in using the hand operated manual threshing was ranged from 69bpm to 86bpm while traditional hand operated manual threshing was ranged from 75bpm to 90bpm.

4.3 THRESHING CAPACITY

From the experiment the hand operated thresher had an average threshing capacity of 43.25 kg/hr. after 10 test trials, with readings ranging from 29.5 kg/hr. to 48 kg/hr., indicating that the hand operated rice thresher will be able to thresh 39 kg of rice in an hour, whereas the traditionally hand operated thresher will thresh 31 kg of rice in an hour [19].

Table 4.3: Readings of Threshing Capacity

Threshing Capacity (Kg/hr.)	41.5	44	41.5	40	37	38	42	29	29	43
Trials	1	2	3	4	5	6	7	8	9	10

4.4 THRESHING LOSSES

The threshing losses for the hand rice thresher was calculated. The hand operated rice thresher recorded scattering losses of 5% after 10 test trials, whereas the traditional method recorded the threshing losses of 8% to 9% indicating that the latter method gave more room for scattering losses to occur.

Table 4.4: Summary data showing measured variables

PARAMETERS	HAND OPERATED THRESHER
Amount(kg)	10
Total Losses (%)	12
Efficiency (%)	88
Average Speed (rpm)	136.6
Capacity (kg/hr.)	39
Output (kg)	3.5
Systolic Pressure (mmHg)	101-120
Pulse (bpm)	69-86
Heart rate/kg (beats/kg)	35.8
Diastolic pressure (mmHg)	71-81

4.5 COMPARISION OF TRADITIONAL & HAND THRESHING

After our various calculations of different parameters, we compared our results with traditional threshing. In majority of parameters handle operated threshing dominated the traditional one.

Table 4.5: Comparison of traditional & hand operated threshing [19]

PARAMETERS	TRADITIONAL THRESHING	HAND OPERATED THRESHING
HR Avg. (beats/min)	141	134
Energy Expenditure (kJ/min)	19.34	17.71
Efficiency (%)	76	88
Average Speed (rpm)	65	136.6
Capacity (kg/hr.)	31	39
Systolic Pressure (mmHg)	110-130	101-120
Pulse (bpm)	75-90	69-86
Mean Pulse (bpm)	82.5	76.8
Diastolic pressure (mmHg)	75-90	71-81

CONCLUSION

CHAPTER 5 CONCLUSION

The entire setup of this system is very compact. Also, the machine weighs 35-40 kgs which is very light as compared to other existing threshing machines already in use and can be handled by a single person. Hence, making it portable for use. We have designed this thresher keeping in mind the needs of the people living on hills who now by using this thresher can thresh their paddy economically. This eliminates the use of electricity which is one of the major problems in the remote areas. So just by human effort, one can use this thresher effectively without depending on external factors.

5.1 OUR CONCLUSION FROM THIS PROJECT

Hence, we conclude that this manually operated paddy thresher has the following key points.

- The efficiency of the machine is high.
- The bullocks being used for threshing can be used for another farm operation.
- It ensures the threshing in time so which minimized the post-harvest losses.
- The machine is environmentally friendly, as it is hand operated and socially acceptable by the farmers.

5.2 FUTURE SCOPE

After design analysis and conclusions, we came to the result that there are enormous possibilities of changes which can be done in this project in order to increase its reliability and efficiency.

- Detachable motor assembly can be introduced as to make it more mechanized and make the working of thresher more efficient.

- Further studies can be carried out to fabricate a thresher having gear assembly. The gear should be adjustable and the speed of peg drum can be adjusted according to the need.
- Replaceable peg drums for different purposes can also be used in thresher to make it more versatile in terms of uses and functionality. Various peg drums can be designed for various crops, e.g. Wheat, barley, soybean etc. The peg drums can be sold as addons so that farmers don’t have to buy whole new machinery for other operations. Further studies can be carried out for design of pegs for each individual need.

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