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Grain Collector Technology –A Review

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ABSTRACT: After the harvest of any crop, drying them is always a pivotal process. The custom of sun-drying or solar drying is a practice performed since many decades because of its effectiveness and being economical without the need for any tools, so it would not be feasible to consider other alternative process for drying. At the terminal point of solar drying process it would be necessary to accumulate the far-flung grains from the ground before further processing. To alleviate this arduous task several grain collecting machines have been designed and developed in the recent years, Every grain collector has been designed and fabricated such that they expedite the task whilst being simple to operate. A single grain collector would be a substitute to several human laborers, The purpose of a grain collecting machine is to quickly hoard all the grains into piles or sacks ere processing. Several expedient mechanism ideas such as sweeper wheel collection, tossing collection, vacuum collection have been implemented and meliorated. The literature review is conducted of all the grain collectors with their resulting performance, cost effectiveness and other prospects shall be analogized..

KEYWORDS: sun-drying, grain collector, design, sweeper wheel, tossing, vacuum

I. INTRODUCTION

Agriculture is the largest industry in the world with over a billion people in it, yet today it faces the tremendous problem of significant decrease in the number of manual labourers in the occupation of farming and milling. Even during the Covid-19 pandemic the global demand for food and agricultural crops kept multiplying because of the deficient supply of grains and lack of labourers. Such disorders brought up the ineluctable need for machines as a substitute for human labourers. Grain collector is one such machine which has been designed and fabricated for the purpose of stacking or piling of the grains quickly after threshing and field drying. An detailed literature survey unveils that several types of grain collectors have been successfully developed, tested and used. Hence a research shall be carried to find scope of improvement and also to overcome the drawbacks of all the grain collectors that have been developed till date. The grain collectors have been classified based on their fundamental principle and the working mechanisms, Id est sweeper wheel type grain collector, hopper type grain collector, engine driven vacuum type grain collector, electric powered vacuum type grain collector. Authors are cited for every design referred throughout the literature survey.

Sweeper wheel type grain collector, It is a simple design. Confecting it out of the basic available materials and with no complex mechanism involved makes it easy and economic but but it still consumes a considerable amount of time because of the partial manual force requirement. The factor of self working makes it convenient for small scale work in remote areas without the requirement of any power source for the functioning of the machine. [1]

Hopper type grain collector, like the sweeper wheel grain collector even this is a manual driven grain collector, this model is equipped with a hopper which should be lifted to transfer the grains from the hopper to the container. Being economic and simple to operate this model has a bag that is attached to it which reduces the bagging time compared to the previous design. With all the jostle the rate of grain collection still remains a drawback with this development. [2].

Engine driven vacuum type grain collector, This is more fledged design with immense changes in the design and the operating principle. This model uses vacuum suction generated by using an centrifugal blower powered by an Otto engine thereby collecting the spread grains rapidly. The addition of cyclone separator makes it furthermore reliable because of reduced efforts with satisfying results. The use of an diesel engine makes the grain collector expensive and could not be relied long by using exhaustible sources of energy. [3]

Electric powered vacuum type grain collector, This model of grain collector is quite similar to the engine driven vacuum grain collector but the prime mover used here is an electric motor instead of an diesel engine to run the centrifugal blower which generates the vacuum pressure for the suction of the grains. This makes it widely convenient in different areas of application. But the absence of the cyclone separator which deaerates the dust particles mixed with the air and grains would be a considered limitation with this model. The present survey work is done to look for any scope of revitalization or speculation of an alternate approach of grain collection being cognizant to the revolutionary needs of the modern industry. [4]

II. GRAIN DRYING

Grain drying could be simply be described as the process of removal of the moisture content from grain. It is an ancient process used to preserve agricultural grains. Most of our agricultural crops contain high amount of water content in them which needs to be removed for long term storage. [5] Study reveal that the higher the level of moisture or water content present in a grain greater would be the number of microorganisms growing on it. When the moisture content is less than 10%, the possibility of any microorganism growing on it is close to nil. [6]. Drying consists of many different ways. Both natural and forced methods of drying are practiced in different regions of the world. In India sun drying is the most common practice followed. [7]



Fig 1, Sun drying (Ref.7)

Solar drying and sun drying are the most economic processes of all. It can be practiced by almost anyone without the use of any special instruments. With a very low investment large amount of grains can be dried at a time. [8]. The traditional method of sun drying has only one considerable limitation that is removal of grains from the ground. Every day during nightfall the temperature drops sharply and humidity increases. [9]. So the need to remove the open grains has become evident. So for the same purpose several grain collectors have been designed and fabricated and also developed to ease the process.

Grain Harvester

Grain Harvester is a device which is used to harvest the grains by cutting the stalk of the plant during the harvesting process. Since manual harvesting is time consuming and requiring a lot of laborers the concept of harvesting machines has been introduced and it has proven to be successful. [10] Grain harvesters were the basic considerations that were looked upon while the modern grain collectors were designed and fabricated. Several other similar machines have been thoroughly studied and described in detail below for better understanding of grain collecting machines and the sources of various principles that have been considered and implemented in different grain

collectors. A harvester designed for small-scale farmers with less than 2 acres of land. This equipment is small and can chop two rows of soybean plants at a time. It features scissor-like cutting blades that slice through the crop. It is powered by a three-horsepower two-stroke petrol engine, which sends power to the cutter through a pulley and gearbox combination. After cutting, a collecting device is supplied to collect the crops to one side. This device is similarly driven by a pulley system. This tiny harvester is made with readily available spare components, making it simple to maintain. This harvester might be the answer to a small farmer's difficulties with cost and labour implementation. After testing this equipment on a farm, it was discovered that harvesting using this harvester is far less expensive than harvesting by hand. [11]. To harvest various grains in less time and at a lower cost by taking into account many criteria such as equipment cost, ease of operation, time of operation, and meteorological conditions. This machine includes cutting blades that can chop up to two rows of crops in a scissoring operation. This machine is powered by a 14.25 HP Petrol engine. This power is delivered to the cutter blades and other power-demanding processes via a gear box and sprocket chain system for cutting, harvesting, and separating operations. [12]. A leaf collecting machine operates after being mounted to the tractor. The worker directs the leaves into the machine by adjusting the pipe direction. The leaves are then taken into the suction box, by the pressure impact of the fan leaves are then directed to the tank through the directing pipe. Finally, a hydraulic jack in the tank compresses and empties the leaves. For the fabrication of the leaves collector with suction system, various factors on power consumption, and the capacity of the tank. [13]. A pedal operated sweeper is designed using a cycle as reference. It is used as a machine for cleaning roads and it can also be used in public transports like trains and buses which are usually littered with plastic and edible wastes like biscuits. The setup contains a sweeper brush attached to the front end of the bicycle and it uses a specific gear mechanism to operate both the wheels and the sweeper brushes simultaneously. [14]. The harvester model is a remote operated mid range harvester that can harvest various types of crops such as rice, barley etc and collect clean grains in the collection bag. The machine can run smoothly on uneven plains without disrupting the course of the harvester, the top contains the electrical components and crawler mechanism is used for the wheels [15]. The machine works as the switch is turned on, the motor starts, the shaft connected to bearing starts to rotate giving a wiping mechanism for the blades. One blade is fixed and the other blade moves back and forth which therefore cuts the crop. A bevel gear mechanism is used for activates the shaft in which a collecting setup is fixed. This pulls the crops and gets collected in the framework. Later the harvested crops can be removed from the framework. [16]. Power is supplied to the circular blade which is directly supplied from engine. Mechanism is a single slider crank mechanism having two cranks. The two blades rotate in opposite directions. The cut paddy spreads on the both the sides. The power to the blade is supplied from engine shaft. Two blades are provided which act like diver and driven gear respectively. [17]. The machine conducts two operations that is 'Harvesting and Collecting'. Two blades with one moving and other in stationery. The slider crank mechanism is used to convert rotary motion to linear sliding motion. This creates a scissoring action due to reciprocating movement of cutter blade over stationery blade which is use to cut the crops. [18]. The harvesters used in farming must have a specific cutting force to cut the stems of the crop. With that the angle at which the blade is placed in the harvester is also important. If the blade angle is not calculated properly the efficiency of the harvester decreases and that equals more power consumption. The different factors that were taken into consideration which caused drawbacks were the strength of the stem and the wetness. The harvesters use fossil fuels and the modern grain collector is focused more on eco-friendly ways and delivering higher efficiency at lower cost. [19]

Farm operations require different sources and modes of power to work smoothly, they are mainly divided into two namely mobile power and stationary power. Mobile power equipments are usually human power, livestock animals and manual ploughs. Stationary power equipments are the ones which produce electricity or run on electric power such as diesel generators and pumps. This vacuum grain collector is a stationary equipment and helps the farmers to collect grains at a faster and costs less than manual labour. [20]

III. GRAIN COLLECTORS DESIGN REVIEW

The general requirements to be achieved are as follows:

- To fabricate and assemble small machinery for efficient collection of all types of small size grains.
- The machine has a simple construction work and light in weight to handle.
- Reduce the manpower and hard work for farmers.
- Reduce the time for collecting grains.

The Hopper design

It is a manually driven grain collector which is supported by wheels for the movement. The collecting part of the work is done by using metal hopper which is in front portion and back end consists of a base plate, frame, handle, wheel and collector bag. The frame at the back which provides flexibility to withstand increased loads and provide support for remaining parts of the collector. Two handles or holders are welded to the upper back end of the frame. Base-plate will consume the overall weight of the bag and it is welded to the frame

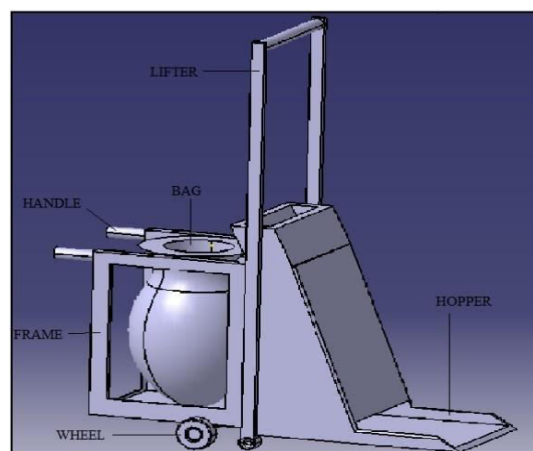


Fig 2. Design and Fabrication of Grain Collector (Ref.2)

Two wheels are attached at the bottom of the collector makes it easier to move the load with minimal effort. The grains which are spread over the floor for drying is collected by moving this collector manually. Hopper at the front will collect the grains. As the grains starts to fill, handle is made downwards. Whatever the grains present in the hopper will be lifted up and the grains from the hopper will be moved down to the bag. This process would be continued until the collector bag is full. [2]

The sweeper wheel design



Fig 3 Grain collector (Ref.1)

The components of the grain collector are wheel, sprocket, brush, frame, chain drive, conveyor belt. As the machine is moved manually, the grains are collected at the front portion using the rolling sweeper. A parallel shaft is

connected adjacent to the preceding shaft by mechanical means using chain and gear. This shaft has sprocket attachment. The centre part of the shaft consists of sweeper. As the shaft rotates, the power is transferred to the sweeper by chain drive. Collected grains are moved to the conveyor belt by means of sweeper and collected in the bag. This machine can be operated by the forward movement of the wheels. When the rear wheels rotate the grains will be carried up as the wheel shaft is connected to the conveyor belt with the use of gear and chain. [1]

Metal ridge plated sweeper design

This design is similar to the sweeper wheel design. The components of this model include belt, brush strips, metal ridges, conveyor. L-bars are used as conveyor flaps with brush strips at the longer side. These brush strips are secured by rivets. As it moves forward tedding process takes place. This means function of spreading the heaped grains into an uniform layers of grains. The model not only distributes the grains but also used for collecting the grains when moved in the opposite direction. [21]



Fig 4. Design Implementation of a Tedding Mechanism for Grain Sun Drying (Ref.21)

Harvester design

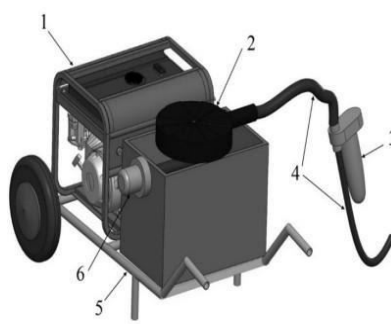


Fig 5. Design and fabrication of grain collecting (Ref.13)

During the harvesting process certain number of grains are spilt on the ground. Hence to collect the spilt grains from the field, such machines are used. The grain collector in the fig consists of power generator, air filter, cyclone filter, transitional pipes, chassis, suction pump. The grains collected is dependent on the parameters like speed of the engine, length of suction pipe and the type of grain to be collected. It uses motor to suck the grains by creating low pressure within the chamber. A small generator powers the motor. The sucked grains from the ground first enter the cyclone separator where an air filter is present which and the dust particles sucked gets filtered. The structure was specially designed to be able to move in uneven terrains and fields unlike the grain collectors that can only work on concrete grounds. [22]

Electric powered vacuum type grain collector



Fig.6 design and fabrication of vacuum based grain collector with load cell (Ref.3)

A vacuum based grain collector which collects the grains from concrete area or ground by suction process. The important components are Frame, V-plate, vacuum cleaner, load cell and wheel. Machine is electrically operated. As the machine is moved, grains are collected by V-plate. Due to vacuum, hose sucks the collected grains and are filled in the dustpan. When the machine is switched off, valve fixed below the dustpan gets opened and grains directly fall into the collecting bag. Load cell fixed below the load bag will determine the weight and displayed automatically in the LED display. [4]

Engine driven vacuum type grain collector



Fig.7 Design, Fabrication and Performance Evaluation of Mobile Engine-Driven Pneumatic Paddy Collector (Ref.4)

An engine driven pneumatic paddy collecting machine which runs on diesel powered engine. Radial flat bladed centrifugal blower, cyclone separator, frame and wheels are the major components of the paddy collector. The centrifugal fan provides suction to collect the paddy and conveyed by an intake air stream through suction nozzle. As the air-paddy mixture enters the cyclone separator through flexible hose, they get separated. Paddy moves downwards

due to its weight and also the centrifugal force. Air and dust particles are drawn to the inlet of the centrifugal fan. The check valve at the bottom of the cyclone separator is initially kept closed and is opened when sufficient amount of the grains are collected. The unloaded grains are then bagged at the bottom. [3]. The Vacuum pressure must be calculated such that it shall not be either too high or too low. With higher vacuum pressure the grains tend to get damaged and with lower pressure the suction won't take place. So for maximum precision the vacuum pressure must be moderately sufficient. [23]

IV. CONCLUSION

The literature study clearly indicates that all of the different types of grain collectors designed and fabricated have been able to collect grains in an effective way, which could be viewed as the goal of reducing human effort and saving time has been achieved. Where in other factors each grain collector has an edge over others in several specific ways. The literature survey is intended to promote fabrication of a further more developed grain collector so that grain collecting machines could be dependable by every farmer and every agriculture practitioner.

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