

Conceptual Design and Development of Shredding Machine for Agricultural Waste

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ABSTRACT: The scope of this work is to conceptually design and develop a Shredder machine focusing on chopping of dry leaves, areca leaves, this chopped powder to prepare the vermin compost. The work began with collection of information and data on user lifestyle and current process by which they perform their job. A concept was developed with reference of four different shredder machine and operating processes. Concept was developed considering the safety factor users operating environment and maintenance. The machine consists of Three-phase motor, spur gear, bearings, structural frame, cutter and dual shaft. The machine frame is can be built using mild steel and High Carbon steel used for cutter tip preparation. Sixteen cutters are mounted on two shafts, which rotate parallel driven by a spur gear. The power from the electrical motor is transmitted to cutter shaft through a belt drive. Cut is made inside the chopping house due to the effect of tensile, friction, and impact effect in chopping process. The dry leaves get chopped and powder is collected at the bottom.

KEYWORDS: Agro Waste, Shredding Machine, Cutter, Spur Gear, Three- Φ Motor, Shaft, Compost.

I. INTRODUCTION

Agriculture is a highly intensified industry in many parts of the world, producing a range of waste waters requiring a variety of treatment technologies and management practices. The Basic occupation of about 70% of population in India is agriculture. A variety of crops are cultivated in India. But after harvesting them the crop residues are either burnt out or thrown as waste without taking into consideration their nutritive value. With the increase in population our compulsion is not only to stabilize agricultural production but also to increase it further in sustainable manner.

Excessive use over years of agro-chemicals like pesticides and fertilizers may affect the soil health and lead to declining of crop yields and quality of products. Hence, a natural balance needs to be maintained at all cost for existence of life and property. The obvious choice would be judicious use of agro-chemicals and more and more use of naturally occurring material in farming systems.

AGRO-WASTE Agricultural waste, which includes both natural (organic) and non-natural wastes, is a general term used to describe waste produced on a farm through various farming activities. It has variously been estimated that these wastes can account for over 30% of worldwide agricultural productivity. Shredder machine is used for shredding i.e. converting macro agricultural waste products into small or micro easily decomposable form, which can be used as organic manure. Any Organic matter which is considered to be a waste is not at all a waste. It can convert to any type of farm waste, garden. The boundaries to accommodate agricultural waste derived from agriculture and farming activities are identified in this. Examples will be provided of how agriculture and various practices adopted at farm-scale impact on the environment. When discharged to the environment, agricultural wastes can be both beneficial and detrimental to living matter and it will therefore also address the pros and cons of waste derived from agriculture in today's environment. Given agricultural wastes are not restricted to a particular location, but rather are distributed widely, their effect on natural resources such as surface and ground waters, soil and crops, as well as human health, will also be addressed.

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Figure 1: Pits filled with Shredded Crop Residues to decompose & obtain Compost

II. RELATED WORK

Agriculture is now one of the most important sectors it plays a vital role Indian economy. In order to further develop this sector technology has become one of the main components. Typically, dealing with the agriculture sector can entail difficulties relating to a number of factors. Consequently, to overcome such problems, farmers are being encouraged to adopt innovative technology that suits their farm. Survey was carried out through product study, market study, literature review and user study etc. In the beginning the crop residues were cut manually by the farmers after harvesting their crop. They simply used their hands and knife to cut the plant residue. The chopped organic output got from this method, was very low, time consuming and very much hectic and it does not fulfil the demand of fertilizer required for the farm. It was also a boring work for the worker or farmer. Traditional method of shredding the dried stems by putting them in a cloth bag and rolling over it with a bullock cart or thrashing it on the ground was also a boring job. This technique did a good job of chopping the stems (avoiding the painful fingers problem), but we still had to pick up the cloth now & then & to turn it to avoid it from tearing out since the stems used to come out thereby tearing the cloth. Also the stems were thrashed by bamboos by the farmers which served as a Herculean Task. Thus these are not reliable method for shredding crop residues to obtain good compost in appropriate duration of time. Thus it brings to our knowledge that the traditional methods are not sufficient & satisfactory for chopping the crop residues. Due to these manual processes, some major problems are identified & to over-come these problems some idea or concepts are developed and adopted.

Kishan Naik et al, they focused project on fabrication of areca fibre extraction machine. This is basically removing fibre from areca husk. This machine consists of 3 phase 5 hp ac motor which is directly coupled to drive shaft. The driven shaft is enclosed in a casing which is designed in such a way that only dust is removed and fibre comes out of rectangular duct at lower side of casing. The driven shaft is supported by two bearings and has blades which are designed by modifying the blade design of coconut husk decorticating machine.

Mohamad Khatib Iqbal, proposed "Development of coconut leaves cutter "A shredder machine mainly consists of cutter, mounted on dual shaft, motor is attached at the base, smaller pulley at the motor end gives drive with the help V-belt to bigger pulley which is connected to gear. One gear will give drive to other gear, and Barrel rotates in opposite direction with the help of these gears. Shaft it rotates at 520 rpm at this time coconut leaves fed into the hopper for high rotational speed of cutter assembly coconut leaves get convert into powder.

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Figure 2: Coconut leaves cutter

The outcome is in the stick form and later it must be crushed to obtain in powder form and the feeding of the coconut leaves in the existing model is of vertical type, which is difficult to feed the coconut leaves. It requires tractor PTO (Power take off shaft) machine cost also very expensive. To overcome from these problems the proposed model is developed.

In this machine, the coconut dry leaves are fed, into the machine vertically through hopper. The motor is rotated at certain speed 1440 rpm. But maintain the speed ratio about 1: 3 so driven shaft rotated at 520 rpm Cutter are mounted on shaft one shaft driven by belt and pulley another shaft driven by spur gear both shaft rotated in opposite direction. Due to the high rotational force, the coconut leaves get chopped and get into powder.

P.B. Khope and J.P. Modak Proposed the “Design of experimental set-up for establishing empirical relationship for chaff cutter energized by human powered flywheel motor” This system for pumping using muscular energy in the flywheel is feasible and then the energy stored in flywheel can be used for different applications. Accordingly, it was decided to work on chaff cutter with this concept and to establish an empirical relationship for human powered chaff cutting process. Since this is a man-machine system, it is rather difficult and unreliable to adopt total theoretical approach for the development, thus, the experimental approach was adopted.

This set up consists of three subsystems namely.

- (i) Human powered flywheel motor (HPFM) i.e. energy unit.
- (ii) Torque amplification gears and clutch unit
- (iii) Process unit i.e. chaff cutter.



Figure 3: Establishing empirical relationship for chaff cutter energized by human powered flywheel motor

This paper reports the design of experimental setup for carrying out the experimentation to establish empirical relationship for chaff cutter energized by human powered flywheel motor.

This machine used to chop the forage into small pieces for easy consumption by the animals. In the human powered flywheel motor concept, the bicycle mechanism for converting and transmitting human energy through paddling to rotational kinetic energy of flywheel is hereby proposed. The energy stored in the flywheel can be used for actual cutting process. The driver paddles for 1 minute and it was noticed that the flywheel shaft reached a speed of 350 RPM with a gear ratio of 1:2. The paddling was stopped after one minute and the set-up was checked for its free running. The flywheel shaft came to rest after 25 minutes.

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Ajinkya S. Hande et al, in their research work carried out project on “Methodology for Design & Fabrication of Portable Organic Waste Chopping Machine “.



Figure 4: Portable Organic Waste Chopping Machine

Organic waste is fed uniformly through feeding drum and tray. Then the Shaft rotated at 1440 rpm through electric motor by means of pulleys makes the chopping drum to cut the waste by the effect of impact shear obtained from the shearing blades. The cut is also made inside the chopping house due to the effect of tensile, friction, and impact effect in chopping process. Then the cut pieces pass through the concave holes of the sieve & come out of the machine. The sieves of different sized holes can be used.

III. CONCEPT DESIGN OF THE SHREDDING MACHINE

The below figure shows the various parts associated with shredding machine they are hopper, housing, motor, bearings, spur gears, pulley, belt drive and frame.

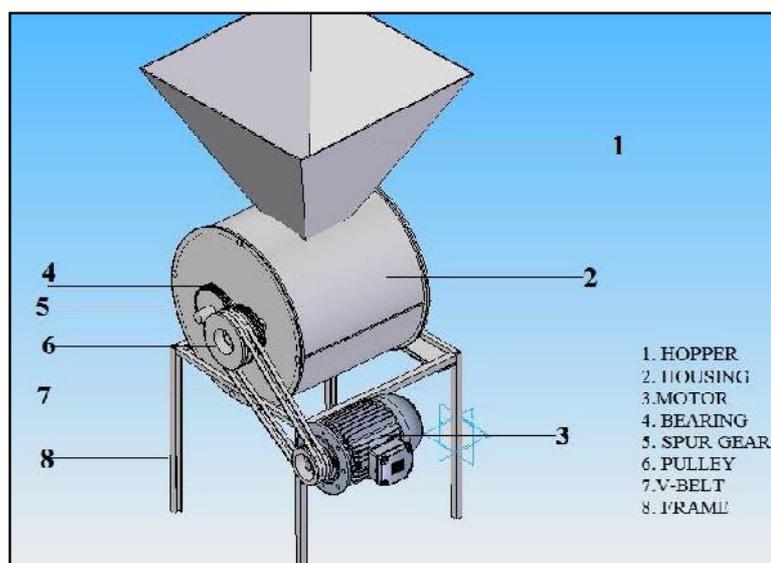


Fig 5:3D view of an assembled shredder

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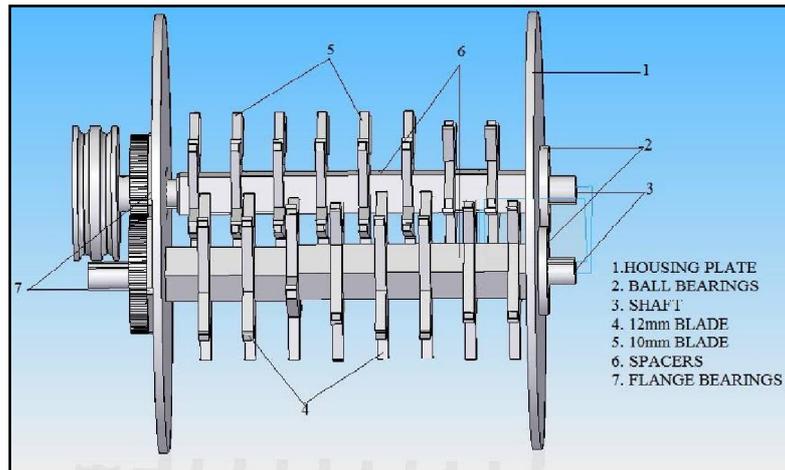


Fig 6: 3D view of cutter blades arrangement (inside view of the shredder)

Product Design Specification

The following table describes the specification of the shredding machine.

SL. No	Description	Specification
1	Name	Agricultural waste shredder machine
2	Mechanism	Gears and Pulley with belt drive
3	Target Customer	Farmers
4	Shredder Process	Motor operated
5	Material	Mild steel for Shaft, high carbon steel for Cutting tips, Mild steel for Structural frames
6	Manufacturing	Machining, Indexing, Bending and Fabrication
7	Safety	Avoid sharp corners,
8	Life of the product	8-12 years
9	Motor Specification	3 HP Three phase AC motor, 1440 RPM
10	Bigger Pulley diameter	152 mm
11	Smaller Pulley diameter	100 mm
12	Bearing	Flange and block bearing
13	Pulley Ratio	1:2
14	Working RPM	750 RPM
15	Weight	250 KG
16	Production Rate	100-120 kg of leaves powder per hour

IV. EXPERIMENTAL RESULTS

The developed model of dry leaves shredder machine is subjected to performance test. The shredder machine performance was measured using of total quantity of powder chopped for different time duration. Machine has a capacity to cut 70-100kgs of wet leaves powder and 100-150kgs of dry leaves powder per hour with considering allowances such as machine set up time, jamming of cutter assembly whereas manually to cut leaves requires many labours and very time consuming. The performance test was conducted on the agro waste shredder machine developed to ascertain its suitability and function ability. The graph 8 shows Time V/s weight of powder. The graph clearly shows

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that the amount of powder collected with respect to time. The test is conducted for 4 different intervals of times.

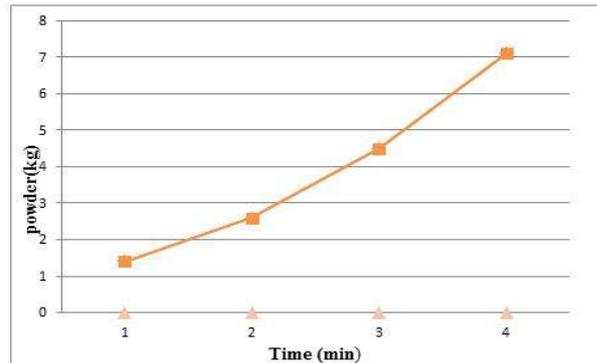


Figure 7: Graphical representation of time (min) v/s weight of powder (kg)

- ✓ Shredder machine reduces the amount of agro-wastes from the farm and make the farm neat and clean.
- ✓ It converts the solid wastes which are too hard to decompose and digest to very small pieces and it will decompose easily.
- ✓ The agro waste causes so many environmental issues like Health hazard. It produces harmful substances such as sulphur dioxide (SO_2), silicon dioxide (SiO_2) and inhalable articles are emitted into the air in burning straws, that can be prevented it by shredder machine.
- ✓ Smog, as a result of straw burning gives rise to decrease in air visibility which has adverse impact on environment road traffic and aviation safety. This can be prevented it by using shredder machine.
- ✓ The output of the wastes is good for vermin-compost and it's a good bio fertilizer for cultivation.
- ✓ By growing the plants using this type of natural compost we can decrease the usage of chemical fertilizers which are harmful to health and also we can decrease failure of kidneys.
- ✓ The bio-waste outputs can be used as a nutrient food for cattle and other domestic animals.

V. CONCLUSION

Proper evaluation of the design is performed and created something even better instead of simply manually operated operations. Finally we conclude that atomize machine is better option to use by the farmer instead of manual operations of chopping the organic residues. The machine is designed taking into consideration the various demands of farmers & other customers. Since this machine is made for small businessman or for farmers, therefore the work carried out by this machine is less. The capital required for purchasing the bigger size crop residue shredding or chopping machine is very high & also the substitute way of using chemical fertilizers is also very costly.

The following important point drawn from our work

- ✓ Machine cost is very low as compared to other shredder machines.
- ✓ Easy to manufacture move i.e. portable
- ✓ Blades can be cleaned easily.
- ✓ Highly skilled lab-ours are not required.
- ✓ Less area occupied by machine.

The machine will be ideal equipment for chopping the crop residues to obtain organic compost. In the process of completion of the work our ideas and thought are development towards the mechanisms and technologies of the equipment.

Similarly we can say that for the purpose of shredding the organic waste this is economical and ideal machine which can bring a drastic change in the economic condition of farmers thereby improving their standard of living. The Shredding Machine can be used in a commercial as well as helping point of view for farmers by setting up small business, providing organic compost to various other farmers which due to their poverty think of taking a drastic & senseless decision of

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committing suicide as they are poor & are not self-sufficient to make their own organic fertilizer & neither are able to buy chemical fertilizers to increase & meet their minimum crop yield demand, thereby providing a helping hand to farmers to meet their never ending demand of fertilizer.

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