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Design and Fabrication of Organic Waste Shredding System

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Abstract: *Organic composting forms the backbone & basic necessity of a poor farmer. The traditional methods are not sufficient & satisfactory for chopping the crop residues. Whereas buying the chemical fertilizer is not possible for every farmer due to its high cost and also food waste contains high calorific and nutritive values. In all the cities and places, organic waste is dumped or disposed in landfill or discarded, which causes the public health hazards and diseases like malaria, cholera, typhoid. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences. Shredding machine is used for shredding and converting macro organic waste products into small or micro easily decomposable form, which can be used as organic manure. Organic waste shredder designed should perfect to shred all kinds of waste products. The organic waste shredded will be in small pieces to enable the farmer to make use of it as feed for manure or organic manure and biogas feed. This shredder can be operated with a motor.*

Keywords: Low price, Environment pollution free, Motor, Macro organic waste, Organic manure, shredding machine

I. INTRODUCTION

Organic waste, or green waste, is organic material such as food, garden, agriculture and lawn clippings. It can also include animal and plant based material and degradable carbon such as paper, cardboard and timber. Burying organic waste in landfill is a big problem. Hence first we have to know the necessity/reasons for solid waste management. Food waste is the organic material having the high calorific and nutritive values to microbes, that's why efficiency of methane production can be increased. In all the cities and places, organic waste is dumped or disposed in landfill or discarded, which causes the public health hazards and diseases like malaria, cholera, typhoid. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences. It is not only polluting ground water and surface through leachate but also promotes the breeding of flies, mosquitoes, rats and other disease bearing vectors. Also, it produces unpleasant odour and methane which is a major greenhouse gas contributing to global warming. Agriculture is the major occupation in many parts of the world and producing a range of waste waters requiring a variety of treatment technologies and management practices. The basic occupation of 70% of the population in India is majorly dependent on Agriculture. A variety of crops are cultivated in India. But after harvesting them the crops wastages are either burnt out or thrown as waste without taking into consideration of their nutritive value [1]. With the increase in the population our aim is not only to stabilize agriculture production but also to increase it further in sustainable manner. Excessive use of agro-chemicals like pesticides and fertilizers over years may affect the soil health and lead to declining of crop yields and quality of the products. Hence, a natural balance needs to be maintained at all costs for existence of life and property.

II. LITERATURE SURVEY

In the pursuit of designing and developing an Organic waste Shredding System, several research papers and studies have provided valuable insights and guidance. This section highlights some of the key contributions in this field.

[1] Design of experimental set-up for establishing 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 animals. In the human

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powered flywheel motor concept, the bicycle mechanism for converting and transmitting human energy through padding to rotational kinetic energy of flywheel is hereby proposed. The energy stored in the flywheel can be used for actual cutting process [1].

[2] Ajinkya s. Hande et al. (2014), carried out project on Methodology for Design and Fabrication of 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. Then the cut pieces pass through the concave holes of the sieve & come out of the machine [2].

[3] Design of waste shredder machine. The waste shredder machine is an attachment as like a ploughing attachment. Shredder can be operated with Tractor- power take off shaft. The power from the Tractor is transmitted to the assembly. The assembly consists of one fixed blade and five circular blades. The organic matter shredded will be in small pieces to enable the farmer to make use to prepare for vermin compost [3].

III. OBJECTIVES

- To Reduce Volume: Shredding organic waste reduces its volume significantly. This is particularly important for waste management facilities with limited space, as it allows for more efficient storage and transportation of the waste.
- To Maintain Uniformity: Shredding creates a more uniform and consistent material, which is easier to handle and process. This uniformity can lead to more efficient and predictable waste management operations.
- To Improved Aeration: Shredding organic waste can enhance aeration within compost piles or aerobic digestion systems. Adequate aeration is essential for maintaining optimal conditions for microbial activity and preventing the formation of odours.
- To Reduced Landfill Usage: By shredding organic waste and diverting it from landfills, it contributes to the reduction of landfill waste and associated environmental issues.

IV. PRODUCT DESIGN AND DEVELOPMENT

Customer Survey and Analysis

The process of identifying customer needs is an integral part of the larger product development process and is most closely related to concept generation, concept selection, competitive benchmarking. And the establishment of product specifications. The customer needs activity can be collectively thought of as the concept development phase.

As per instructions from references customer needs are found out and their ratings were found as found in following table.

Table 1: Needs and their ratings

Need	Rating
Ease of operations for both skilled and unskilled labour	4.4
Costing should be range at 10000/- to 15000/-	4.6
Less Capacity	4.7
Less human interaction	4.5
Less maintenance	4.4
Good safety	4.5
Less power consumption	4.3
High efficiency	4.2
Aesthetic design	4.1

Mind mapping

Mind mapping is a versatile tool extensively used in product design and development. It facilitates idea generation by visually organizing concepts, features, and requirements. Through concept visualization, it aids in clarifying complex

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design elements and technical specifications. Mind maps also serve as effective workflow planners, outlining project milestones and tasks. They play a crucial role in problem-solving by breaking down challenges into manageable components.

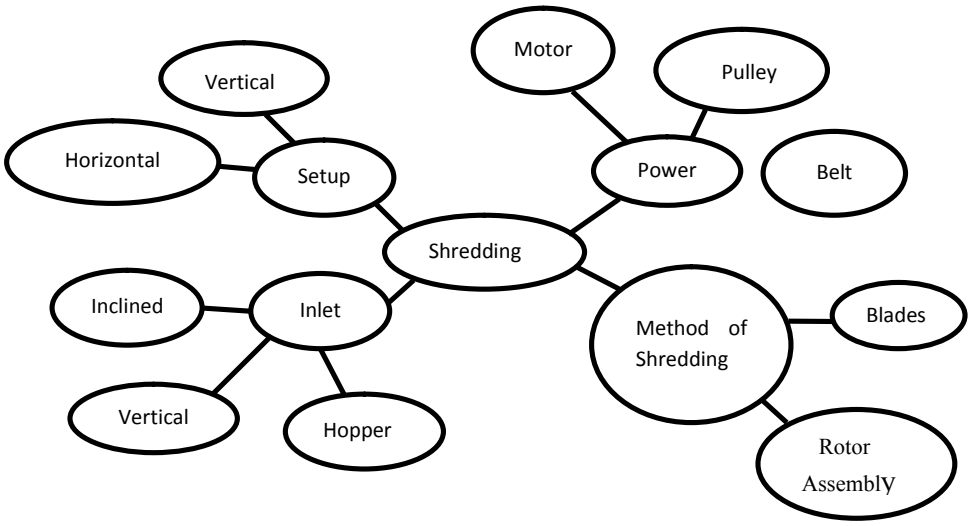

Fig No 1: Mind Mapping

After mind mapping, we will get multiple options to fulfil each objective. In order to generate concepts options are arranged in tabular format and combinations are created as shown in figure no 2. This diagram helps us to generate a greater number of combinations for rethinking about project.

Power supply for motor	Blade assembly	Power transmission	Inlet & Outlet Setup
Solar	Circular	Gear Drive	Horizontal
Electricity	Curved & Linear	Chain Drive	Inclined
Generator	Flat & Linear	Flat Belt Drive	Vertical
Battery	Meshing Blades	V-Belt Drive	

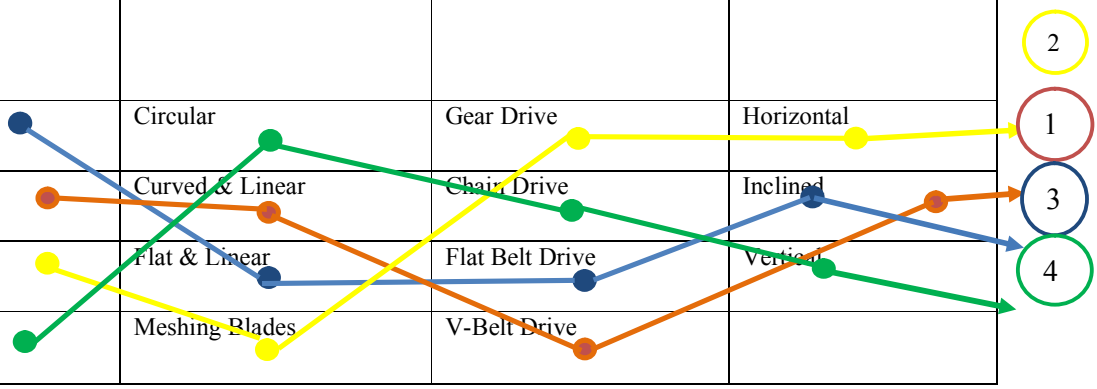

Fig No 2: Concept Combination table

Concept Selection

Early in the development process the product development team identifies a set of customer needs. By using a variety of methods, the team then generates alternative solution concepts in response to these needs. Concept selection is the process of evaluating concepts with respect to customer needs and other criteria, comparing the relative strengths and weaknesses of the concepts, and selecting one or more concepts for further investigation, testing, or development.
Above procedure carries in two phases namely concept screening and concept scoring.

Concept Screening

Concept screening is a critical phase within the product design and development process, aimed at identifying the most promising ideas for further refinement and implementation. To begin, clear criteria are established, encompassing

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factors such as feasibility, market potential, technical viability, and alignment with strategic objectives. These criteria serve as benchmarks for evaluating a range of generated concepts, which are derived from methods like brainstorming, user research, and market analysis. During preliminary evaluation, concepts are scrutinized for their feasibility, potential risks, and benefits.

Table no 2: Concept Screening

Selection criteria	A Vertical setup of Hopper & Blade	B Horizontal setup of both Motor & Blade using coupling	C Vertical setup of belt & pulley & Inclined Hopper	D Hopper with two blades meshing together
Ease of handling Ease of use Adjustability of hopper Capacity of hopper Durability Ease of manufacture	+ - - + 0 0	0 0 0 + + -	+ + + 0 0 +	0 0 + + + -
Sum +'s Sum 0's Sum – 's	2 2 2	2 3 1	4 2 0	3 2 1
Net score Rank Continue?	0 4 No	1 3 No	4 1 Yes	2 2 Yes

Concept scoring

concept scoring is used when increased resolution will better differentiate among competing concepts. At this stage, the team weighs the relative importance of the selection criteria and focuses on more refined comparisons with respect to each criterion. The concept scores are determined by the weighted sum of the ratings. The table is represented below:

Table 3: Concept Scoring

		C Vertical setup of belt and pulley & Inclined Hopper		D Hopper with two blades meshing together	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score
Ease of Handling	10%	3	0.3	2	0.2
Ease of use	20%	3	0.6	3	0.6
Adjustability of Hopper	5%	2	0.1	2	0.1
Capacity of Hopper	30%	3	0.9	3	0.9
Durability	15%	3	0.45	3	0.45
Ease of Manufacture	20%	3	0.6	2	0.4
	Total Score Rank	2.95 1		2.20 2	
	Continue?	Develop		No	

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From table it clear that concept C need to be develop.

Assembly and components **Blade Assembly Selection:**

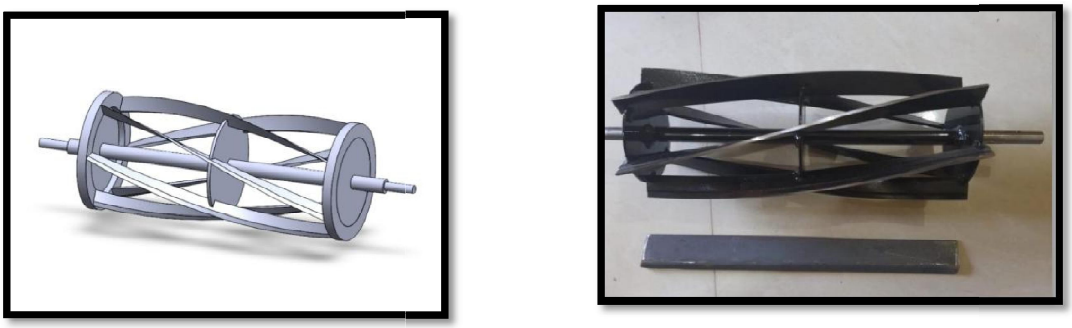

Figure no 3: Blade Assembly

The cutter assembly which is the main part of the machine which will be used to shred the waste. The blades are chosen with respect to the overall assembly which we have chosen in a horizontal type. So, the rotation is horizontal. So, the blades used in this are sharp curved and of linear shape as shown in the figure.

The blade material is steel, specifically a high-strength carbon steel. This material composition is chosen for its durability and resistance to wear and tear. Steel blades can withstand the impact of cutting through tough grass, solids such as stems, and other debris without bending or breaking.

The blade is of curved and linear shaped because it cuts the material gradually and minimized sudden impact and vibration.

Size: Length - 200 mm
Width - 50 mm
Diameter of shaft - 15 mm approx.

Motor Selection

Figure no 4: 1HP Motor.

τ(breaking) Leaf = 80MPa
We have considered 90MPa for safety.
Cutting Force Required:

$= \tau(br) \times (\text{Area of blade})$
$= 90 \times 5$
$Fc = 450N.$

Torque exerting on the blade:
$T = \text{Force} \times \text{Perpendicular distance (r)}$
$= 450 \times 40$
$= 18000 \text{ N.mm}$
$= 18 \text{ N.m.}$

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Power required:

$P = 2 \times \pi \times N \times T \times (\text{No. of blades})/(60) \times 1000)$

$= 2 \times \pi \times 50 \times 18 \times 6/60000$

$P = 0.565$ KW.

As per these calculations we select Power as 0.75 KW, with motor 2748 RPM (1HP) …. PSG 5.125

CAD Model

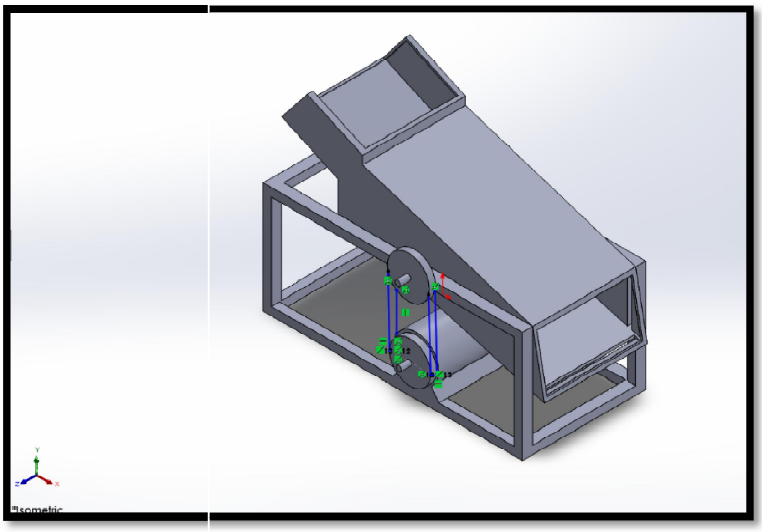

Fig No 6: 3D CAD Model of Machine

Final Fabricated model

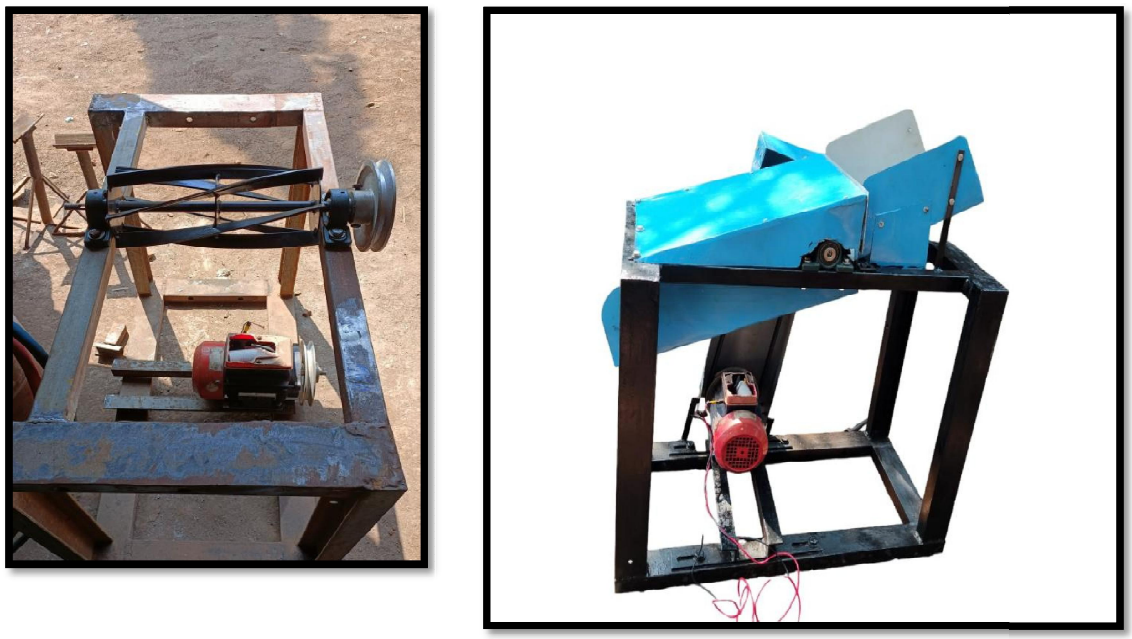

Fig No 7: Final Fabricated model

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Operation

In this Shredding machine, the Organic waste like Agriculture waste, natural waste, foods etc. are fed into the machine vertically through hopper on to the cutters. Cutters are mounted on shaft supported by bearings which is mounted on the machine frame. One shaft driven by motor and another shaft driven by spur gear both shafts rotated in opposite direction. The motor is rotated at certain speed and with it coupled with gear box to reduce the speed and to increase the torque.

When the crop or waste come in contact with the rotating cutters or blades then the shearing action takes place. Due this shearing action, the large size waste converted into small micro size. This small size wastage will decompose faster than the macro size. The clearance between the rotating blades depends upon the size of the organic waste used for chopping. The chopped organic waste comes out of the machine and undergoes decomposition

Before Operation:

Fig No 8: Collecting of farm waste

Fig No 9: Collecting of tree waste

After Operation:

Fig No 10: Farm wastage in shredded form

Fig No 11: Tree wastage in shredded form

V. CONCLUSION AND FUTURE SCOPE

Conclusion

After the preparation of the report, we conclude that atomized machine is better option to shred the organic waste instead of using manual operated shredder. In this we designed the machine by considering the various factors into consideration. The machine is made for small businessman, therefore the work carried out by this machine is less.

The capacity of the shredder machine is calculated by testing the machine. It gives the capacity of 7.5-8 kg of dry and also the wet waste per hour has been achieved.

The following are the important points drawn from our work:

- Machine cost is less compared to others shredder machine.
- Less capacity machine is easily available for local farmers.
- Easy to assemble and disassemble.
- Highly skilled labours are not required.

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VI. FUTURE SCOPE

The fabricated machine is sufficient for the general purpose and for the main task of shredding. Although, some features maybe included as ergonomic considerations which are:

- The wheels for carrying machine easily can be designed to enhance the portability of the machine will improve the ergonomics.
- The waste as an input is needed to be pushed by own in the fabricated machine but some pushing mechanism such as roller that can be added. It will push the waste and move the waste towards the blade assembly for the operation.
- The vibration which is causing due to high power and speed can be enhanced by putting vibration absorbing material to the frame.
- The sheet metal used in fabricated machine is selected due to its light weight and for cost cutting. Although, the sheet metal quality or the thickness can be improved by using thick metal sheets of GI for fabrication which will result in less vibration and noise.

REFERENCES

[1]. P.B.Khope and J.P.Modak [1] "Design of experimental set-up for establishing empirical relationship for chaff cutter energized by human powered flywheel motor" Journal of Agricultural Technology 2013.

[2]. Ajinkya S.Hande [2] "Methodology For Design & Fabrication of Portable Organic Waste Chopping Machine To Obtain Compost -A Review" IJIRST –International Journal for Innovative Research in Science & Technology| Volume 1 | Issue 7 | December 2014 ISSN.

[3]. S.Nithyananth [3] " Design of Waste Shredder Machine" Libin Samuel et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 3(Version 1), March 2014.

[4]. Y. Prashanth [4]. "Design and Development of Coconut Fiber Extraction Machine" Department of Design, M. S. Ramaiah School of Advanced Studies, Bangalore - 560 058 Volume 13, Issue 1, April 2014.

[5]. G. Boothroyd, P. Dewhurst, and W. Knight, Product Design for Manufacturing and Assembly, Marcel Dekker, New York, 1994