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DESIGN AND FABRICATION OF CHAFF CUTTER CUM FLOUR MILL, FOR SMALL FARMERS

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Abstract:

The optimization of a combined chaff cutter and flour mill machine involves enhancing efficiency and performance. This abstract focuses on refining the design, materials, and operational parameters to achieve maximum output and resource utilization. Through systematic experimentation and analysis, the study aims to identify optimal configurations, minimizing energy consumption while maximizing chaff cutting and flour milling capabilities. The results contribute to the development of a more sustainable and effective agricultural processing solution, catering to the needs of farmers and promoting resource- efficient practices in food production. The scope of chaff cutter focuses on the chopping of agricultural wastes such as coconut leaves, areca leaves, etc., and this chopped waste can then be used to prepare vermin compost, cattle feeds, and floor stuff for cattle huts. The scope of the flour mill is to grind the grains used for daily purposes. It uses combined blades for grinding. The friction generated between the blades and casing results in grinding the grains into powder. At last, it can be stored for the daily use.

Keywords: Fodder, Cutter, Uniform chopping, Grinding

1. Introduction

Small-scale agriculture plays a crucial role in feeding populations and supporting rural economies worldwide. Among the various challenges faced by small farmers, efficient livestock feed

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management is of paramount importance. Chaff cutters, simple yet indispensable machines, are commonly used by small farmers to convert crop residues into livestock feed. Optimizing chaff cutters for small-scale agriculture is essential to enhance productivity, reduce labor, and improve the overall livelihood of these farmers. In the olden days, chaff cutting was done manually or by non-motorized machine which would consume more time and also less on the safer side. But today chaff chaff-cutting machines are available in various sizes and construction from manual-operated to engine-driven machines. Chaff cutters are mechanical devices designed to cut and shred crop residues, such as straw, hay, and stalks, into smaller, more manageable pieces for livestock consumption. These machines are especially beneficial for small farmers who rely on livestock for their livelihood, as they help ensure animals receive proper nutrition while minimizing waste.

Optimizing chaff cutters for small-scale farming involves addressing several key aspects:

Cost-Effectiveness: Affordability is an important issue for most small farmers who run their establishments on limited budgets. Chaff cutters ought to be cheap in terms of their acquisition, operation as well and maintenance for the sake of making more farmers afford them.

Energy Efficiency: Most of these smallholder farmers depend on human manpower or diesel engine-driven machine cutters. Instead, optimized designs might use cheap energy alternatives like wind and biomass among others, to reduce the total operating cost and eco-footprint of facilities.

User-Friendly Design: It should also be easier to use chaff cutters for those who don’t have any technical backgrounds. Small farmers will only adopt and be successful in using such machines if they have user-friendly designs and clear instructions.

Durability: Maintenance and repair services are hard to come by for small-scale farmers who sometimes operate under harsh conditions. Chaff cutter optimization should provide robustness against adverse conditions minimizing stoppages and maintenance expenses.

Output Quality: The quality of the chopped feed is also crucial. Cutting must lead to constant and regular results which are significant in livestock wellness and the whole farm efficiency.

Adaptability: This residue is diverse and usually depends on various crops cultivated by small farmers. Well-optimized chaff cutters must have the ability to work with various crop species and different crop residues.

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Local Sourcing: The availability of spare parts and after-sales service is also a very important factor. Encouraging local manufacturing and support chains could provide small food producers with the ready availability of inputs necessary for production and development.

Training and Education: Small farmers should be properly trained on the usage of chaff cutters and also provided with other relevant educational materials to enable proper usage and realization of all advantages of chaff cutters.

Optimizing chaff cutters for small-scale farming is not only a technological endeavor but also a socioeconomic one. It involves understanding the specific needs and challenges faced by small farmers and designing solutions that empower them to improve their livestock management practices, increase crop utilization, and enhance their overall economic sustainability. By addressing these key factors, we can contribute to the well-being of small farmers and the global food supply chain, promoting a more sustainable and efficient agricultural system. Therefore, by concentrating on all the key factors mentioned in the above paragraphs, we planned to fabricate a budget-friendly & easily-handled chaff cutter and it should cut both wet and dry livestock.

2. Literature Review

Farming is one of the foremost vital segments of the Indian economy. In arrange to encourage the creation of this sector, technological help may be a much-required calculation. Since there are boundless issues related to agrarian preparation the farmers are ruined each day. To overcome such issues, ranchers must be energized to embrace innovation that suits their cultivation. Agro waste and agro-products administration is one such region, which is slacking due to the nonappearance of mechanical help. So, a mechanized feed master will be the radiant response for this difficult issue.

Mahadev et al. [2], designed and developed a Shredder machine focusing on chopping agricultural wastes such as coconut leaves, areca leaves, etc. Fabricated equipment was successfully tested and was much better resulting in chopping the wastes as per requirement. Compared to safety which gives a very smooth working operation with no hazards to the operator. Based on work, a conclusion was made this machine can operate with a low feed rate and manual feed operation only. It also required high power for the operation.

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Kankal et al. [3], the experimentation was carried out on a fodder cutter energized by electrical power. Fodder-cutter machines are used every day by farmers and their families in India for the preparation of fodder for the livestock they own. This paper discusses the procedure of the testing of fodder cutter machines. From the study, it can concluded that the performance of the chaff cutter is better in high moisture-holding crops.

Sarak et al. [4], carried out a performance study on an existing chaff cutter and modified the existing chaff cutter to overcome the problems that arise while using the old machine. During the study, they found that chaffed food also saves chewing energy which will increase the rumination process. So this machine is affordable and beneficial for small farmers. It gives better results, uniform cutting size, and works well with less effort.

Sankpal et al. [5], developed the machine from the basic machine into a commercial standard machine that can be electrically driven to achieve various lengths of cut of chaff as per the preference. The new chaff cutter machine is modified for its compactness and to avoid blockage of grass.

From the above discussion, it can be concluded that, while designing the machine concentration should be given to the parameters such as power required, productivity to be achieved, and the cost of the machine. Using very little power input will not result in chopping action and at the same time using high power to cause chopping makes the process to be very costly. Hence an optimum power has to be selected so that it satisfies the chopping action and makes the process economical. Therefore, this project aims to solve these issues and gaps by developing and evaluating a dual-purpose forage machine for chopping and crushing operations to achieve both operations more efficiently and at a lower cost.

3. Objectives of the project

The following are the objectives which are to be achieved by the completion of the project.

1. The primary objective of this project is to fabricate of Chaff cutter machine to provide a practical and efficient tool for local farmers.
2. Optimizing the machine performance to achieve Improve the quality of feed, and save labour time compared to the manual cutting method.

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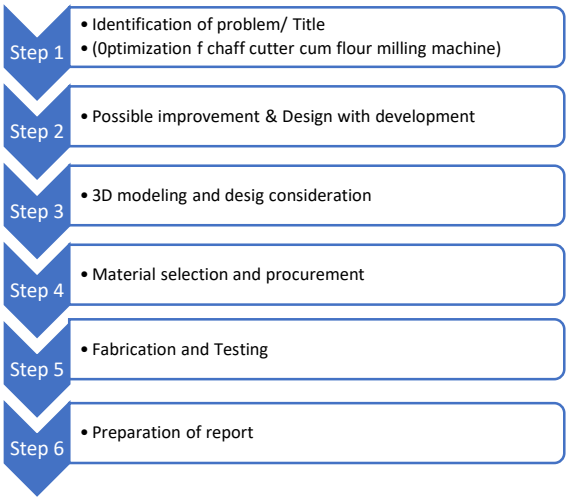
3. The Secondary objective of this project is to fabricate flour making machine that is to be operated with the help motor of a chaff cutter machine.
4. More productivity than the present machine with less power input has to be obtained by optimizing the existing machine by changing the cutting blade, its material, and the position of the cutting blades.
5. Both machines should contribute significantly to agricultural and food processing practices, impacting both livestock nutrition and human food preparation.

4. Project plan



Stage 1:

After the initial selection and screening of title and work, it was decided to take up an improvement on the existing chaff cutter machine

Stage 2:

Stage second, discussion was done on the possible improvement that could be made on existing chaff cutter, and making it to meet our expectation. Accordingly, the rough drawing of the machine was done.

Stage 3:

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Here the 3D modeling of chaff cutter with milling machine was done considering the required objectives and finalizing the appropriate design.

Stage 4:

For the fabrication selection of material, in which cost effective, light weight and durable type of material finalized and purchasing of suitable motor, blade & electronic components are done.

Stage5:

By the reference of the 3D model & dimensions, fabrication process is done . After the final assembly, the machine was done with testing for several time. Some of modifications are done here.

Stage 6:

After the all procedure, final report were done under the mentorship of our guide. Here we maximized the information our project.

5 Design Calculations

RPM of Cutting Blade:

Motor rpm, N_1= 2800 rpm

Diameter of smaller pulley = d_1= 5 cm

Diameter of bigger pulley =d_2= 13 cm

Relationship between pulley diameter and rpm:

$N1/N2=d2/d1$

Rpm of cutting blade, $N_2= [d1/d_2]\times N_1$

$N_2 = (5/13)*2800$

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N_2 = 1077 rpm

Input Power of Motor:

Efficiency of motor = 85 %

Input power = (output power)/(efficiency)

= (torque *speed/9.55)/(0.85)

= (4.94*1440/9.55)/(0.85)

Input power = 0.876 KW

Chaff Cutter Calculation:

For 1 hour: 200 to 500 Kg

For 1 minute: ((200+500)/2)/60 = 5.8 ≈ 6 Kg

Power consumption for an hour: 0.746 KW

= 0.746 KW × 1 hr = 0.746 KW/hr = 0.746 units

Flour Mill Calculation:

For 1 hour: 20 to 25kg

For 1 minute: ((20+25)/2)/60 = 0. 400kg

Power consumption for an hour: 0.746 unit

6. Design of the machine

The model is design educing Solid works. This model is just an idea made into 3-D, therefore the fabricated one has a lot of changes due to feasibility of the design.

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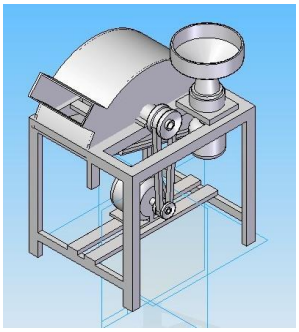

Fig 1. 3D model of proposed project (with casing)

This is the proposed design. The machine frame is made up of rigid mild steel. Based on the design calculations and literature survey following CAD models are made, which is as shown in Fig1. The 3 dimensional view of the proposed project and its blade as shown in Fig 2. The required CAD model was developed using 3-D modelling software (i.e. Solid Edge V18).

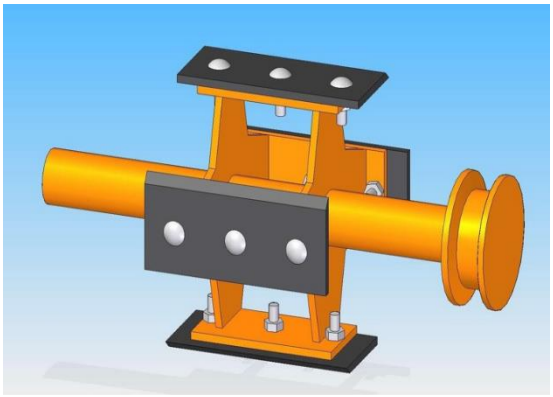

Fig 2. 3D model of cutting blade assembly

7. Machining & Fabrication Processes Undertaken

Machining Processes Undertaken:

The cutting and drilling operations are used to give the shape and dimension. The welding and fasteners are used to join two surfaces together. The finishing operation is used to give the required surface finish to the machine. These operations are discussed briefly below,

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Cutting:

Cutting is a collection of processes wherein material is brought to a specified geometry by removing excess material using various kinds of tools to leave a finished part that meets machine specifications. The net result of cutting two products is the waste or excess material and the finished part.

Drilling Process:

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole in solid materials. The drill bit is a multipoint end cutting tool, which cuts by applying pressure and rotation to the workpiece, which forms chips at the cutting edge. By drilling proper-sized holes in the frame as well as on other components, the parts are assembled with the help of fasteners.

Fasteners:

Fasteners are used to fix the base to the frame, hopper to the base and plumber block to the base. Since the welded joints form permanent assembly, fasteners are used to form temporary assembly. The main advantage of fasteners is that the assembly can be easily dismantled.

Arc Welding Process:

Welding is a fabrication process that joints two metals by causing coalescence. This is often done by melting the workpiece and adding a filler material to form a pool of molten metal that cools to form a stronger joint, with or without pressure in conjunction with heat, or by itself to produce the weld.

Grinding Operation:

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. Grinding practice is a large and diverse area of manufacturing and tool making. It can produce very fine finishes and very accurate dimensions. Grinding is a subset of cutting, as grinding is a true metal-cutting process. Each grain of abrasive functions as a microscopic single-point cutting edge. A

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grinding wheel is an expendable wheel used for various grinding and abrasive machining operations. The fabricated model is shown in below Fig 3.

Fig 3. Fabricated Model

8. Components

Chaff Cutter

1. Motor
2. Plummer Block
3. Bearings
4. V-Belt
5. Pulley
6. Shaft
7. Hopper
8. Cutting Blades
9. Supporting Frame

Flour Mil

10. Grain Hopper
11. Stone Burr
12. Power Switch

9. Working principle and procedure

Working Principle: An electric motor drives the main shaft with the help of a belt drive. Pulleys and blades are mounted on the main shaft. The main shaft drives the blade mounted on it. Fodder

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is entered through the hopper to the feeding roller. The feeding roller moves the fodder to the cutting blades. Blades cut the fodder into small pieces and throw the final product through the fodder collector. The Fig 4 shows the view of blade in chaff cutter. We use a good, effective, properly designed closed bag to collect the small pieces of fodder minimizing the possibility of major dust and pieces of fodder explosion.

Fig 4. Inner View of Blade and stone Burr

Working Procedure:

Supply power source to an electric motor: In this machine, we are using a single-phase power supply with a single-phase 1 H.P. motor. The input speed of our electric motor is 2800rpm. To rotate the fodder-cutting blades we have to rotate them by using power drives.

For the Flour Mill, a small 0.5HP motor is attached to the chaff cutter machine to reduce time while changing the belt from the chaff cutting side to the flour mill side. To rotate the stone burr we have to rotate them by using the direct coupling technic.

Power transmission through V belt-pulley drive: Selected a belt & pulley mounted on the shaft as a power drive to transmit the power. This pulley belt arrangement is coupled to cutting blades by using a coupling shaft. Hence rotation of cutting blades occurs.

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Feeding of food material: The feed is fodder through the hopper. The designed fodder provides a guide to fodder and grass materials like dry wheat stalk, corn straw, and grass, which reduce the manual work of the farmer and help to increase fodder production. Fig 5. shows the chopped grass in chaff cutter.

For the flour mill, feeding is done through a hopper from the top end. It will guide the grains towards a stone burr for the grinding purpose.

Fig 5. Finely chopped grass

Collect fodder and powder: When we feed fodder through the hopper, the rotating blades can cut the supplied fodder into small pieces as per requirement and throw them away from the fodder.

In the flour mill, as soon as the grains are grounded, they will fall on the mesh where it is sieved to a fine size and comes out from the outlet of the mill. The Fig 6. shows the grinded rice flour.

Fig 6. Rice Flour

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10. Results and Discussion

To study the performance of newly fabricated machine. The machine is introduced into chaffing work and milling works, under various conditions. Based on performance results, the discussions were made in this chapter. The below Table 1 and Table 2 shows the results of the machines.

Table 1. Experiment on chaff cutter

Wet grass	Kg/Min
Jowar	4
Napier	6
Elephant grass	5

Table 2. Experiment on flour mill

Grains	Kg/Min
Rice	0.450
wheat	0.300
Corn	0.350

1. In this fabricated machine, the human effort consumed is less
2. It can be easily carried from one place to another
3. The fabricated machine can be easily cleaned
4. The fabricated machine is a simple mechanical system, which can be easily repaired and maintained
5. Detail the daily or hourly production capacity of the flour mill and how it compares to expectations
6. Describe the quality of the flour produced, including factors like fineness.
7. The efficiency of the milling process, considering factors such as energy consumption, wastage and milling.

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11. Conclusion

The chaff cutter cum flour mill combines two functions into one machine, offering convenience and efficiency for farmers or small-scale millers. Its conclusion would depend on factors like its performance, cost-effectiveness, durability, and user satisfaction, which could vary based on individual experiences and specific models on the market. In addition to its dual functionality, the chaff cutter cum flour mill may offer benefits such as space-saving design, reduced labour requirements, and potential cost savings compared to purchasing separate machines for cutting chaff and milling flour. However, its effectiveness would also depend on factors like maintenance requirements, power consumption, and the quality of output. Conducting thorough research and considering user reviews would be crucial in determining the overall suitability and value of this machine.

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