

## Design and Fabrication of Equipment of Plants Waste as Fertilizer

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**Abstract:** This paper is all about developing an equipment to utilize plants waste as fertilizer. 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 most of the places organic waste is dumped or disposed in landfill or discarded, which causes the public health hazards and diseases like malaria, cholera, typhoid. Equipment to utilize plants waste as fertilizer is used for chopping and converting macro organic waste products into small or micro easily decomposable form, which can be used as organic manure.

**Keywords:** AC Motor, Blades, Grinding wheel, Pelletizer, Sieve plate

### I. INTRODUCTION

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. 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. The obvious choice would be judicious use of agro-chemicals and more and more use of naturally occurring materials in farming systems. Agriculture waste which includes both natural and non-natural wastes. The conventional agro waste disposal is a traditional and oldest method of waste disposal in which agriculture wastes are dumped as it is to degrade in a particular place for decomposing. As the wastes are dumped, it takes more time to degrade and it causes environmental pollution.

### II. LITERATURE SURVEY

Khope and Modak [1], Proposed the 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 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. It proved that the alignment of bearing and other parts of the experimental set-up was satisfactory.

Kishan Naik et al. [2], They did project on fabrication of areca fiber extraction machine. This is basically removing fiber from areca husk. This machine consists of 3 phase 5 HP AC motor which is directly coupled to driven shaft. The driven shaft is enclosed in a casing which is designed in such a way that only dust is removed and fiber 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. The areca fiber obtained was of good quality with diameter varying from  $0.39 \pm 0.12$ mm and length varying from 50mm-60mm. Thus this machine will be helpful for rural entrepreneurs and farmers.

Ajinkya and Hande [3], In their research work 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.

Mohamad Khatib Iqbal [4], 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.

Ikebudu et al. [5], presents the design of pelletizing machine for the production of pellets from a mixture either in its powder or molten form. This idea came up during the process of producing pellets for the purpose of strength measurements of powder agglomerates/pellets for good handling of powder materials for usage and during transportation. The machine consists a mixer. This machine is mainly found in production industries, railway/coal corporations and steel industries.

### **III. OBJECTIVES**

The main objectives behind this project are listed below:

- To prepare organic fertilizer to farmers at feasible rates.
- To make the machine portable so as to be easily movable at any place.
- To reduce the power consumption.
- To reduce the floor space required.
- To make available the machine at low cost so as to make it affordable to the farmers.
- To make sustainable use of agricultural & rural waste.
- To increase the efficiency.
- To make the farmers self-dependent for their everlasting requirement of fertilizers

### **IV. WORKING PRINCIPLE**

The working principle makes use of motors, blades, grinding wheels and pelletizing disc for making fertilizer. The different plants wastes are utilized so as to keep our environment free from pollution and utilize them to reduce the use of the chemical fertilizer in farming land. The main purpose of this equipment is to change plants waste into useful fertilizer which can be transported to different farm land without loss in the waste energy. The working of the machine is based on the rotational force of the blades. The blades exert hammering effect on the waste which reduce the size of the waste material. The hammering effect is achieved by the rotation of the blades at high speed enough to form small chips which can be easily grinded to the micro size waste. For chopping of plants waste, first of all, the plants waste coming for different plants are collected. The collected plants are then need to cut into the smaller pieces by the blades and the grinder to grind into the powder. The collected waste is feed through the hopper which helps plants waste to move easily inside the machine and pass through the blades and the grinding wheel.

The blades and the cutter mounted on the shaft and connected to the first motor which rotates the cutter and blade assembly at high speed cuts the waste into the small pieces called chips. These chips are rotated inside by the centrifugal force of the blades. The process continues until the size of the chips are reduced to the size smaller than the hole size of the screening plate used which allows only the required size of the chip to pass for the next stage of machine. The screening plate also called as the sieve plate helps the small particles to pass through it, remaining waste are chipped by the blades inside the frame and smaller chip are continuously the passed through screening plate to the next step for the grinding of the chip to powder form.

The grinding wheel is placed after the screening plate which is connected to the cutter shaft and rotate at the same speed as that of the blades. The grinding wheel present in it grinds the small wastes into micro sized powder form which can be transferred for the next step. The final power from the first machine is passed into the pelletizing disc connected to the second motor. The pelletizing disk rotates at slow speed which is obtained by use of the gear reducer. Certain amount of water is sprayed manually in the pelletizing disc so as to form the pellets. Due to slow speed of rotating disk and inclination of the disk to certain angle forms the pallets by action of centrifugal force and friction force. This Pellets form which can be transported without loss of waste energy are collected in the bucket to use it as fertilizer which decompose faster. Fig. 1 shows the working of equipment to utilize plants waste as fertilizer.

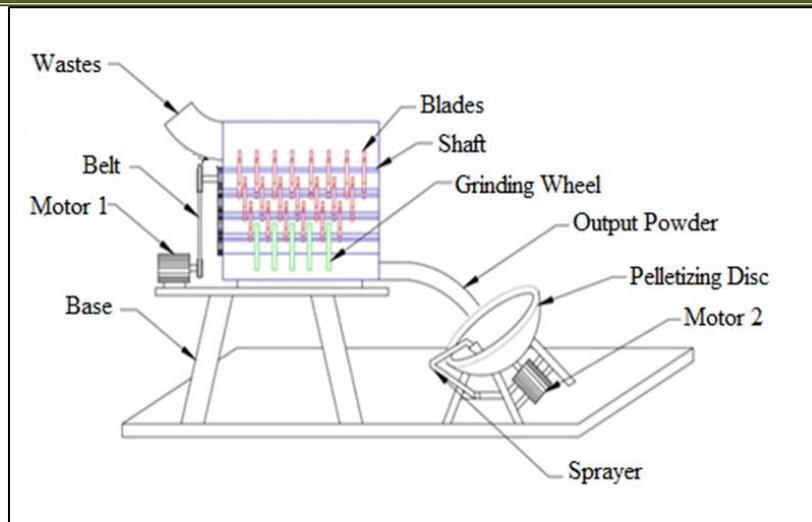


Fig. 1 Working of Equipment to Utilize Plants Waste as Fertilizer

## V. METHODOLOGY

Basically in this machine, operation takes place in three stages i.e. first stage, second stage & third stage. In first stage, plant wastes are chipped into small pieces which can be feed to next stage. Then, in second stage the chipped wastes are grinded with the help of grinding wheel to form a powder which can decompose faster. Finally, in third stage, the grinded wastes are placed into pelletizing disc in which powder are changed into pellets that can be transported without any loss of waste energy.

The plant wastes collected are placed into the hopper to feed inside the cutter. Different plant wastes are chopped into small pieces because blades exert hammering effect on the wastes inserted in it. The blades are attached to the shaft which is driven by the motor-I. The blades are rotated to high speed with the help of first motor produce enough force to chip the material into smaller size. Fig. 2 shows the block diagram. As the motor is switched on the plant wastes from the input are chipped into small pieces by the blades which is cause by hammering effect. Then, the chipped material is filtered by the screening pate placed in semicircular fashion below the blade and cutter assembly. This plate also helps to produce centrifugal effect on waste so they can be reduced to smaller chip which can easily pass through the screen hole. This allows only the required size of the chip to pass for the next stage. The next stage of machine makes use of the grinding wheel where powder is formed out of the waste chips. The chip from the screening plate is passed to the grinder connected to the shaft of the cutter and rotates at the speed similar to the blade speed. As the chip enters into the grinding wheel, the wheel due to its rotation grinds it into the micro size which is a powder form. This powder formed cannot be transferred to the land due to chances of loss of waste energy by wind. Once the wastes are grinded, the waste materials are placed into the pelletizing disc which is the next stage where the pellets are formed from the powder waste.

The third stage of the machine uses a disc which is connected to the motor-II which rotates at slow speeds. This pelletizing disk is a separate machine where the powder from the first machine is transferred for next operation. The disc is kept at a certain angle which is necessary to form the pellet. A gear motor is used for pelletizing disc which reduces the rotational speed of the disk so that the pellet can be formed at low speed. The speed of the pelletizing disk is reduced as per the size of the disk used. Smaller the size of the disk lower the power is required to rotate the disk at slow speed and vice versa.

Material in a powder form from the first machine is fed onto the disc/pan, where it is taken up by the rotation. As material is wetted by spraying the water at the startup, a coating will form on the pan. This coating prevents water from coming in direct contact with the pan, which would cause powder to form on the plows, creating very large, uneven pellets or lumps. These pellet is formed due to the centrifugal action and the friction force. The water sprayed binds the powder to form a pallet. Centrifugal force causes the pellets to self-classify themselves based upon size. The pallet formed can be transferred to the require place without any loss of fertilizer. In the different stages different setup is done to obtain the final product.

After the pellets are formed it can be directly used in farm land for the decomposition or it can be stored where it gets decomposed over a time and can be used during the time of requirement. The decomposition rate is very fast compared to the directly dumped waste. This decomposed waste provides most of the nutrient required by the crops reducing the use of the chemical fertilizer. Methodology used for whole processing of

equipment to utilize plants waste as fertilizer is given below; this methodology gives way about how work is to be carried out in systematic way. It is standard process of describing process, how it is done in simplest manner.

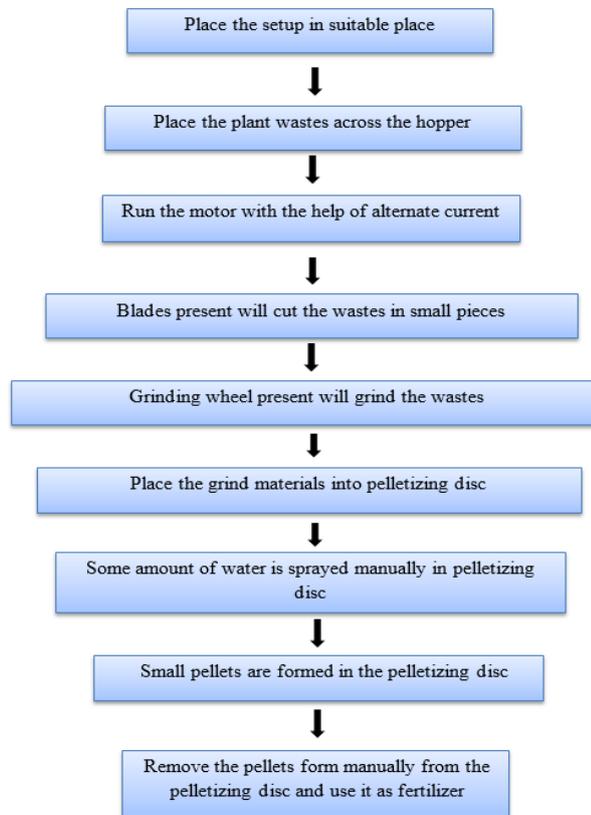


Fig. 2 Methodology

## VI. DESIGN AND CALCULATIONS

The machine was designed as per the procedure. The power requirements and torque were calculated through the design procedure.

The torque developed on a shaft is calculated by the Eq. (6.1).

$$\text{Torque (T)} = F \times r \quad \dots (6.1)$$

Where,

T = Torque in Nm

F = Force in N

r = Perpendicular distance in meters

The force required to generate a require torque can be calculated by the Eq. (6.2).

$$F = (2\pi mNr)/60 \quad \dots (6.2)$$

Where,

N = Speed of motor in rpm

M = Mass of shaft in Kg

r = Distance of blade end from centre of shaft

The power requirement of the motor is calculated by the Eq. (6.3).

$$P = (2\pi NT)/60 \quad \dots (6.3)$$

Where,

T = Torque in Nm

N = Speed of motor in rpm

Actual Readings

The standard specifications of motor-I is:

- Speed of motor = 1360 rpm
- Power of motor = 1 HP

Theoretical Readings

Let,

$N_1$  = Speed of the motor-I

$N_2$  = Speed of the shaft

Diameter of smaller pulley ( $d_1$ ) = 7.5cm

Diameter of larger pulley ( $d_2$ ) = 12.6cm

Assume,

$N_1$  = 1360 rpm

The output speed of the shaft for the belt driven machine is calculated by the Eq. (6.4).

RPM Output/RPM Input = Smaller Dia./Larger Dia. ... (6.4)

$N_2/N_1 = d_2/d_1$

$N_2 = N_1 \times d_2/d_1$

$N_2 = 1360 \times 12.6/7.5$

$N_2 = 2284.8$  rpm

Therefore, the output speed of the shaft for the belt driven machine is 809.5 rpm.

Force can be calculated from the Eq. (8.5).

From Newton's second law of motion,

$F = (m \times v)/t$  ... (6.5)

Linear velocity and angular velocity is calculated by the eqn. (6.6) and Eq. (6.7) respectively.

Linear velocity,  $v = \omega \times r$  ... (6.6)

Angular velocity,  $\omega = 2\pi N/60$  ... (6.7)

Torque is calculated from the above Eq. (6.1).

$T = F \times r$

We know that, the force required to generate a require torque can be calculated from Eq. (6.2).

$F = (2\pi \times m \times N_2 \times r)/60$

$F = (2\pi \times 10 \times 2284.8 \times 0.11)/60$

$F = 263.2$  N

We know that,

Torque ( $T$ ) =  $F \times r$

$T = 263.2 \times 0.11$

$T = 28.95$  N-m

Therefore, the torque generated by the machine is 28.95 N-m.

The power required is calculated from the above Eq. (6.3).

Power ( $P$ ) =  $(2\pi NT)/60$

$P = (2\pi \times 2284.8 \times 28.95)/60$

$P = 6924.5$  watts

The power required to rotate to the shaft is 6924.5 watts.

## VII. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

### 1. Advantages

- It converts the solid wastes which are too hard to decompose and digest to very small pieces and it will decompose easily.
- This machine reduces the amount of agro-wastes from the farm and make the farm neat and clean.
- The agro waste causes so many environmental issues like health hazard. It produces harmful substances such as Sulphur Dioxide (SO<sub>2</sub>), Silicon Dioxide (SiO<sub>2</sub>) and inhalable particles are emitted into the air in burning straws, that can be prevented it.
- 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 this machine.
- Beneficial for small and medium scale farmers.
- Area occupied by the machine is less.

### 2. Disadvantages

Due to lower weight of the base vibration is the main disadvantage.

- Corrosion may take place.
- Since 1 HP motor is used working hour is reduced to 1 hour, later on the motor gets heated up.
- Wet areca leaves are little difficult to powder.
- Noise level is high compared to manual operation due to rotation of blade at high speed.
- Since the chip formation is done by hammering effect of blades machine produces more noise compared to manual method.

### **3. Applications**

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### **CONCLUSION**

Generally, in the line of sustainable agricultural production along with preserving the environment, it is necessary to recycle the wastes or by-product from plant origin. The wastes can be converted to pellets and can be used as fertilizers for agricultural production. Composed wastes used as organic fertilizer can supply essential plants nutrients, improve physical, chemical and biological properties of soil. 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 and other customers. Since this machine is made for small businessman or for farmers, therefore the work carried out by this machine is less.

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