International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 4, July-Aug-2021, ISSN (Online): 2395-566X

# Design and Development of Multipurpose Agricultural Machine

**Dhairyasheel Patil, Ruturaj Khot, Saikrishn Gajula, Tamajid Shaikh, Asst. Prof. Hrishikesh Jadhav**
Department of Mechanical Engineering
D. Y. Patil College of Engineering and Technology,
Kolhapur, Maharashtra.
Dhairyasheel.patil1599@gmail.com

**Abstract- The scope of this project is to design and development of a portable multipurpose agricultural machine; focuses on shredding of sugarcane leavings, coconut leaves, Areca leaves and paddy straw, later this chopped powder is a source to prepare the vermin compost. The task started with the accumulation of information and data, through survey in agricultural and literature studies. Existing models are hand wheel operated, vertical and horizontal electric chopping shredder is prone to have problems like large space requirement, uneven cutting, and manpower requirement. Hence traditional methods are not sufficient and satisfactory for chopping the crop residues. Considering the user's needs and buying capacity a prototype was designed and constructed. The proposed prototype is so designed to guide materials in different compartments by power driven transmission through chain, belt, pulley and spur gear attachment to have a chopped and powder materials. The overall operation of the proposed shredder, running at a cutting speed of 700 RPM nearly has a cutting efficiency up to 90%.**

**Keywords- Multipurpose Agricultural Machine, Portable shredder, Weeder, Fertilizer.**

## I. INTRODUCTION

In India more than 70% of the population is depending on agriculture, it contributes around 17% to the gross domestic product (GDP) of the Indian economy. Basic needs of agriculture are sand, land, seeds, water, machines, fertilizers – organic or inorganic in nature, and so on.

In that inorganic fertilizer use in the long term make the land to lose their pH, upset beneficial microbial ecosystems also causes of the greenhouse issue.

Hence an attention on organic fertilizers based on agriculture wastes include crop residues such as corn stalks, sugar cane leavings, nut shells, paddy straw, wood chips, sawdust, banana stalk, etc., are concentrated which are biodegradable, releasing nutrient fertilizers, and improve the structure of the soil. But after harvesting them the crop residues are either cut out or shed out as a waste without getting into consideration their nutritive value.

It assists in sustaining agricultural production at a higher point and makes it sustainable. It amends the soil physical properties such as granulation, and good tilt, good aeration, easy root penetration and improves water-retaining capability.Hence an attempt is needed in planning a portable organic shredder, which speeds up the process of composting by increasing the open field of harvest residues for aerobic degradation thereby reducing the time to hold the compost. [1-2] The current backpack sprayer has lot of limitation and it required more energy to operate.

The percentage distribution of farm holding land for marginal farmers is percentage, for small farmers 22.6 percentage, for small and marginal farmers 61.7 percentage, for semi- medium farmers 19.8 percentage, for medium farmers 14 percentage and for large farmers 4.5 percentage in year 1960-61. Clearly explain that the maximum percentage of farm distribution belonged to small and marginal category. [3]

Considering the drawbacks of older mechanisms, in account to that problem we are proposed to develop the new mechanism that includes, v-belt drive mechanism, multiple dumping system, multiple blades & multiple shafts in one system and using electric motor & this mechanism is portable in nature, so that this machine is used in all the agriculture fields to convert the agriculture waste into useful Eco friendly manure, so that the produced manure is of low cost when compared to other inorganic fertilizers & also economically cheap for poor farmers.

## II. LITERATURE REVIEW

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. Quality function deployment (QFD) was prepared where the customer voice was converted into technical voice. Detailed product design specification (PDS) was created as per the data's from QFD.

**P.B. Khope et. al (2013). Volume.9 (4):779-791:** 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.[4]

**Nitin Kumar Mishra, et. al., (Feb 2017).** Modern technology to achieve the level of comfort but cost concern is more. The factor which controls pesticide and fertilizer quantity are control, pressure and velocity at output, rpm of wheel, rolling resistance of the field, mechanism and weight on the wheels. Most of the projects are based on slider crank mechanism, belt and pulley or motor for motion.

The multipurpose pesticides spraying machine is, use of solar energy i.e., using non- conventional sources for charging the batteries for driving the pump. The same energy has been used for driving the machine. Though it is a one-time investment and decreases operational and labour cost but increases the maintenance and individual parts cost. The space requirement is more which makes this equipment not preferable where the space between the two lines of the crop is less.[9]

**Sawpnil V. Ghinmine, et. al., (2019) [1],** Weed management is one of the tedious operations in vegetable production. Because of exertions costs, time and tedium, manual weeding is unfavourable. A mechanical weeding actuation system was designed, and a prototype turned into constructed. This actuator became advanced to mechanically manipulate intrarow weed plants. The mechanical weeding actuator consisted of a belt drive machine powered by using an integrated engine and a rotating tine weeding mechanism powered by way of engine energy. Weed manage is one of the most difficult duties on an agricultural farm. Three methods of weed control are commonly known in agriculture.

These are mechanical, chemical and biological control. Mechanical weed manipulate is without problems adopted via farmers once they get convened of its advantages. Mechanical weed control not handiest uproots the weeds between the crop rows however also keeps the soil surface loose, ensuring better soil aeration and water intake capacity.

Various forms of mechanical weeders have been evolved. In human operated weeders, muscle energy is required and so it can't be operated for long time. The traditional approach of hand weeding is time consuming. In order to assess the opportunity of mechanization of the weeding operation, the energy operated single row energetic weeder is to be designed and developed.[12]

## III. PROBLEM STATEMENT

Observed that labour is widely used for shredding agro waste, and cost of the existing machine also expensive. The farmers who use conventional backpack sprayer faces many types of problems like fatigue, tiredness, pain in spiral cord and muscles. Burning of agriculture waste leads to air pollution.

## IV. OBJECTIVE OF PROPOSED WORK

To reduce human effort in agriculture field with use of agriculture vehicle. To reduce the cost of shredding, weeding and fertilizing, and increasing the economic standard. To take a step forward in reducing agricultural air pollution caused by burning of agricultural waste. To produce an agricultural machine that performs three operations at cheaper cost.

## V. METHODOLOGY

- Market Survey
- Problem Statement
- Objective
- 2D Drawing & 3D Modelling
- Design of Components & Analysis
- Fabrication
- Assembly of Components
- Testing Actual Model
- Modification If Necessary
- Final Model

## VI. DESIGN CALCULATIONS

**Engine Selection**
**1. Requirements:**
Required output power = 6 HP. [4*]
Output torque = 8Nm.

Output Rpm = 800 – 2000 rpm.

**2. Engine specifications [5*]:**

- Primary Reduction – 1.1364
- Final Reduction – 4.1667
- Max Engine Torque = 12.1 Nm
- Gear Ratio –
  1st = 4.75
  2nd = 3.117
  3rd = 2.3416
  4th = 1.4
- Engine sprocket teeth = 15
- Rear wheel sprocket teeth = 42
- Diameter (D) = 155
- Module = Diameter (D) / Teeth (T) = 155/42 = 3.6904
- Horse Power = 7 HP

**3. Torque Calculations:**

- Maximum Torque on wheels

= Max Engine Torque * Primary Reduction
* Final Reduction * 1st Gear Ratio [5*]
= 12.1 * 1.1364 * 4.1667 * 4.75
= 284.25 Nm - (In actual 10-12% transmission loss)

**4. RPM Calculations:**

- To find RPM at 1st Gear –
- HP = Torque * RPM / 5252
- RPM = HP * 5252 / Torque
  = 7* 5252 / 284.25
- RPM = 129.33

**5. Number of teeth and diameter calculations:**

- N1 = Engine sprocket speed at 1st gear =
- 129.33 RPM
- N2 = Rotor shaft speed = 800 RPM (Assume
– Trial And Error)
- Velocity Ratio = N1 / N2 =129.33/ 800 = 0.16
- Relation between RPM and number of teeth:
- N1 / N2 = t2 / t1

0.16 = t2 / t1
0.16 = t2 / 50
t1 = 9 teeth

- t1 = Sprocket teeth at speed distribution shaft
= 50
- t2 = Sprocket teeth at rotor shaft = 9
- Diameter of engine output shaft sprocket = m
= d / t1

3.6904 = d / 9
d = 33.21 mm.
d=34 mm

**Linear velocity (V)** = (3.14*34*129)/60 = 229.5 mm/s
=0.229 m/s.

Engine selected from above requirements and calculations:
**Engine – Bajaj RE 12V Electronic 145.45 CC.**

**6. Shaft calculations:**

- **Speed distribution shaft –**

**Power = T × ω**
5.15 × 106 = T × 2π × 239.8265 / 60
T = 205.06 × 103 Nmm
Mt max = 205.06 × 103 × 1.1
= 225.57 × 103 Nmm
**τ = Mt × r / J**
61.67 = 225.57 × 103 × 16 / πd3
d = 26mm.

- **Rotor shaft –**

**Power = T × ω**
5.15 × 106 = T × 2π × 800 / 60
T = 61.47 × 103 Nmm
Mt max = 61.47 × 103 × 1.1
= 67.62 × 103 Nmm
**τ = Mt × r / J**
61.67 = 67.62 × 103 × 16 / πd3
d = 18mm.

**7. Bearing selection**

- From calculation of torque of speed distribution shaft, we get;
- Shaft diameter = 26mm
- From SKF bearing catalogue we get;
- Required bore diameter – 26mm
- The Outer diameter is not required more than 45mm.
- So, from the above considerations we select the following bearings:
  1. 2204 ETN9 Bearing
  2. 1216 K Bearing

## VII. ANALYSIS

**1. Chassis Analysis Using Ansys R18.1:**

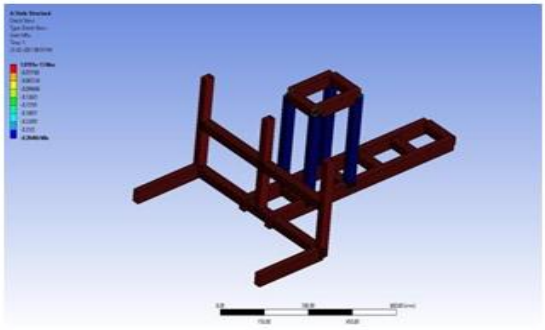

Fig 1. Direct Stress Analysis.

Table. 1 Result

| | |
|---|---|
| Required Yield Stress | 310 MPa |
| Obtained Yield Stress | 1.9195 MPa |
| Conclusion | The design is safe |

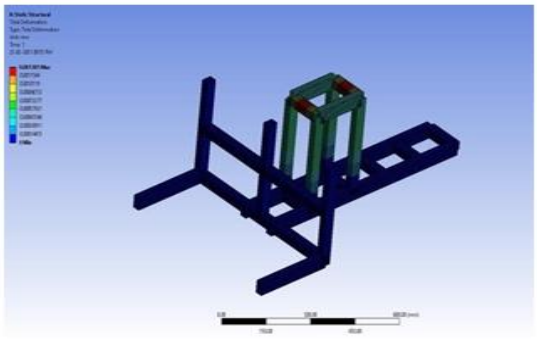

Fig 2. Total deformation Analysis.

| Table 2. Results. | |
|---|---|
| Max Deformation | 0.001301 mm |
| Conclusion | The design is safe |

**2. Fertilizer Plate Analysis Using Ansys R18.1:**

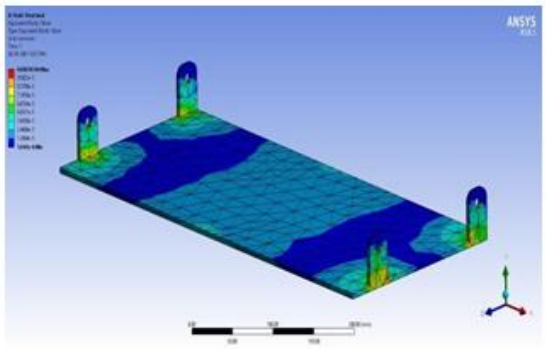

Fig 3. Von Misses Stress Analysis.

| Table 3. Results. | |
|---|---|
| Required Strain | 410 MPa |
| Obtained Strain | 0.00010744 MPa |
| Conclusion | The design is safe |

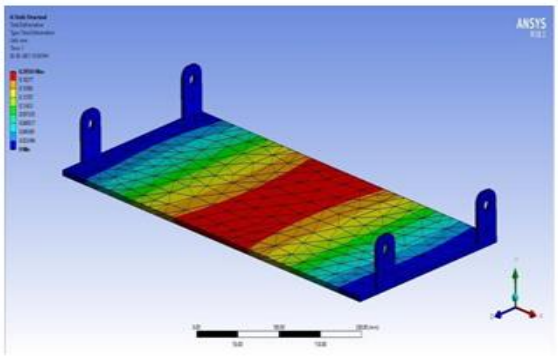

Fig 4. Total Deformation Anlysis.

| Table 4. Results. | |
|---|---|
| Max Deformation | 0.20561 mm |
| Conclusion | The design is safe |

## VIII. ASSEMBLY OF COMPONENTS USING SOLID WORKS 2019

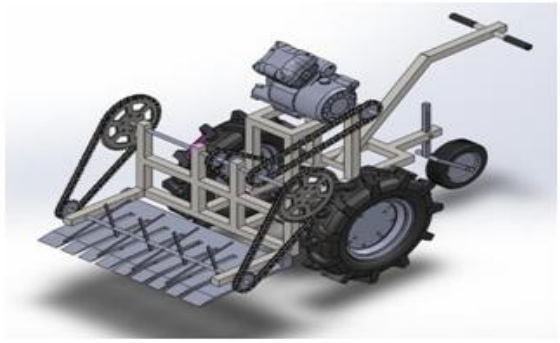

Fig 5. Machine with Shredder Attachment.

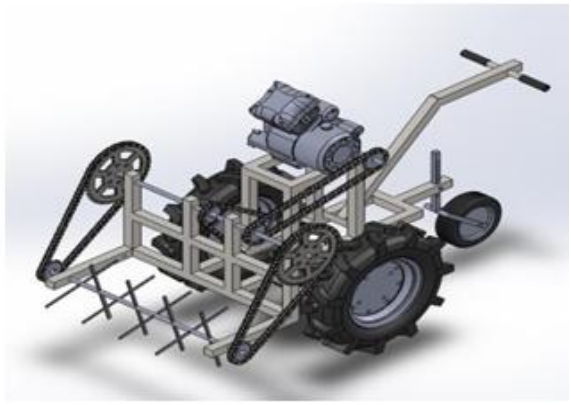

Fig 6. Machine with Weeder Attachment.

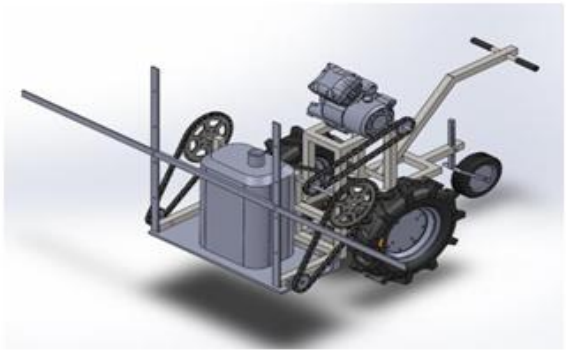

Fig 7. Machine with Fertilizer Sprayer Attachment.

## IX. CONCLUSION

The waste shredder machine will reduce the agro waste and convert it into useful nourishing fertilizer. Power input is taken from the power take off shaft (PTO). Three-point linkages provide rigid support and reduce the vibration. It can also be used for the mobility of shredder machine. Power from the PTO shaft is transferred to the shredder machine by using guarded shaft. Speed can be increased by changing the gear ratio and it is possible to transfer power by using pulley and belt system.

Various kinds of blades can be used for the chipping and powdering operations like sawing blades, rotatory blades, and triangular shape blades.

The design of machine is for easily eliminating the weeds in the cultivated lands. The weed elimination also increases the productivity of the food sources. The time is saved by the farmers by the usage of our design. Similarly, by using the machine design can eliminate intermediate unwanted plants between the growths of plants.

The suggested model has removed the problem of back pain, since there is no need to carry the tank on the backbone and solder. More no. of nozzle which cover maximum area of spray in minimum time at maximum rate. Proper adjustment facility in the model with respect to crop helps to avoid excessive use of pesticides which result into less pollution.

## REFERENCES

[1] Asst Prof. S Nithyanath, Libin Samuel, Nitin Mathew, and S. Sura, "Design of waste shredder Machine" ISSN: 2248-9622, Vol.4, Issue 3 (version 1), March 2014, pp. 487-491.
[2] Jibrin M.U., Amonye M.C., Akonye N.S. and Oyeleran O.A, "Design and Development of a Crop Residue Crushing Machine" International Journal of Engineering Inventions e- ISSN: 2278-7461, p-ISSN: 23196491 Vol 2, Issue 8 (May 2013) PP: 28-34.
[3] R. Joshua, V. Vasu and P. Vincent. (2010) "Solar Sprayer - An Agriculture Implement", "International Journal of Sustainable Agriculture 2 (1): pp. 16-19, ISSN 2079-2107"
[4] P.B.Khope and J.P.Modak "Design of experimental set- up for establishing empirical relationship for chaff cutter energized by human powered flywheel motor" Journal of Agricultural Technology 2013 Vol. 9(4): 779-791.
[5] Ajinkya S.Hande et al. "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 (online): 2349-6010.
[6] Krishna Naik et al. "Design and fabrication of Areca fiber extraction Machine" International Journal of Emerging Technology and Advanced Engineering ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 7, July 2014.
[7] Y. Prashanth et al. "Design and Development of Coconut Fiber Extraction Machine" Department of Design, M.
[8] S. Ramaiah School of Advanced Studies, Bangalore - 560 058 Volume 13, Issue 1, April 2014.
[9] S.Nithyananth " 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, pp.487-491.
[10] Nitin Kumar Mishra, Shashwat Khare, Sumit Singh, and Mithun Dabur, Multi-Purpose Agriculture Machine International Journal of Advances in Science Engineering and Technology, ISSN: 2321- 9009, Vol-5, Iss-1, Spl. Issue-2 pp 40-43, and Feb.2017.
[11] Pavan B. Wayzode, Sagar R. Umale, Rajat R.Nikam, Amol D.Khadke, Hemant, et, al., - "Design Fabrication of Agricultural sprayers, weed with cutter". (April 2016) E-ISSN: 2321-9637.
[12] Laukik P. Raut, Smit B. Jaiswal, Nitin Y. Mohite, Design, development and fabrication of agricultural pesticides sprayer with weeder, International Journal of Applied Research and Studies (IJARS) ISSN: 2278- 9480 Volume 2, Issue 11, pp 1-8, Nov. 2013.
[13] Sawpnil. V. Ghinmine, Abishek B. Tiwari, Aditya. D. Shinde Pawan. A. "Development of double heeded multipurpose weed remover," vol. 5, no. 2, 2019.
[14] Bibliography-https://www.tractorjunction.com/tools/ shrachi/105g- petrol/power-weeder/124/
[15] https://www.tractorjunction.com/implement/maschio-gaspardo/paddy-185/
[16] https://dir.indiamart.com/search.mp?ss=knapsack+farm+ mist+16l+sprayer&prdsrc=1&mcatid=182737&catid=1 50
[17] https://www.hondaindiapower.com/product-detail / fj 500
[18] https://www.indiamart.com/proddetail/bajaj-re-2-stroke- auto-e-rickshaw-15162054873.html