International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Design and FEM Analysis of a Feed Mixer Machine

Dr. V. D. Dhopte[1], Dr. P.G. Mehar[2], Dr. S. R. Ikhar[3], Dr. A.P. Ninawe[4], Mr. Ratan R. Meshram[5]

[1,2,4] Assistant Professor, Department of Mechanical Engineering, KDK College of Engineering, Nagpur, Maharashtra.
[3]Associate Professor, Department of Mechanical Engineering, KDK College of Engineering, Nagpur, Maharashtra.
[5]PG Scholar, Department of Mechanical Engineering, KDK College of Engineering, Nagpur, Maharashtra.

Abstract-

An animal feed mixing machine was designed, fabricated, and tested to enhance feed production efficiency. The machine is capable of handling 50 kg of feed, ensuring proper mixing with a high-power motor within minutes. It features a simple mechanism, integrating a chopper on the same shaft as the mixer, driven by a single 2HP motor using a V-belt drive. The machine reduces time, cost, and manpower, making it suitable for large-scale feed production. Constructed with a rectangular mild steel chamber with a semi-circular lower section (15-inch diameter), the design prevents feed spillage. The 28 mm shaft, equipped with mixing blades, ensures uniform distribution of feed components such as rice powder, wheat powder, maize bran, and sunflower cake. Additionally, cutting blades allow simultaneous grass processing. This efficient, cost-effective solution benefits the feed and food industries, reducing manual labor and optimizing production, particularly in countries like Ghana, Nigeria, Tanzania, and India.

Keywords: *Animal Feed Mixer, Feed Production Efficiency, Motorized Mixing Machine, V-Belt Drive Mechanism, Design and Analysis etc.*

1. Introduction

In cattle farming, manpower plays a critical role in ensuring smooth operations. However, labor-intensive tasks such as feed preparation can be time-consuming and inefficient. Properly mixing cattle feed, which includes ingredients like grains, premixes, and moisture content, requires significant effort to achieve a uniform blend. Traditional manual methods not only demand more time but also result in inconsistent mixing, affecting the nutritional balance of the feed. To address this challenge, an innovative feed mixing machine has been designed and developed to automate and streamline the process. This machine integrates two essential operations—mixing and chopping—into a single unit, significantly improving efficiency and reducing labor requirements [1].

The feed mixing machine incorporates a high-power motor that ensures rapid and thorough mixing of feed ingredients. Additionally, a chopper system is integrated into the machine, allowing for simultaneous grass cutting. The chopper mechanism is positioned on the outer side of the machine, operating in sync with the mixing process. This dual-functionality makes it a highly advantageous tool for cattle farms, as it eliminates the need for separate machines for feed preparation and fodder processing. The chopper blades, designed for high-speed rotation, ensure fine and uniform cutting of grass, improving digestibility for livestock. The combination of these two processes in a single operating cycle enhances overall productivity and minimizes manual effort [2].
Material selection for the machine was carefully considered to ensure durability, cost-effectiveness, and local availability. The components were chosen based on factors such as strength, economic feasibility, and serviceability. The main body of the machine is constructed from mild steel, providing structural integrity while being cost-efficient. The rectangular chamber with a semi-circular lower portion is designed to prevent feed spillage during mixing. The shaft, measuring 28 mm in diameter, is equipped with mixing blades to ensure even distribution of feed ingredients. A V-belt drive system is used to transmit power from the motor to the shaft, optimizing performance and reducing energy consumption. With a 2HP electric motor, the machine efficiently processes up to 50 kg of feed in a single batch [2][3].
The design and development of the mixer were carried out using Creo software, which enabled precise modeling and analysis of the machine components. The use of computer-aided design (CAD) ensured optimal performance and structural stability. This machine is suitable for both small and large-scale farms, as well as industries requiring mixing processes, such as the food and chemical industries. Its versatility extends beyond cattle farms, making it a valuable addition to various agricultural and industrial applications [4].
The adoption of automated feed mixing technology is particularly beneficial in regions with high agricultural activity, such as Ghana, Nigeria, Tanzania, and India. By reducing the dependency on manual labor, the machine enhances operational efficiency and productivity in livestock farming. The ability to perform two tasks simultaneously—mixing feed and chopping grass—sets this machine apart from conventional models, making it an essential tool for modern cattle farms. With its efficient design, cost-effectiveness, and ease of operation, this machine addresses the challenges associated with feed preparation and contributes to the sustainable growth of the livestock industry [5].

2. Research Methodology

The proposed system is a multi-functional feed mixing machine designed to enhance efficiency in cattle farms and feed industries. Unlike conventional mixers, this system integrates a high-speed chopper and a feed mixer on a single shaft, powered by a 2HP motor. The V-belt drive mechanism ensures smooth operation while maintaining low power consumption. The

rectangular mixing chamber with a semi-circular lower section prevents feed spillage and improves uniformity in mixing.
To optimize performance, the machine is designed using Creo software for precise modeling and simulation. Locally available materials, such as mild steel for the chamber and stainless steel for the blades, are selected for durability and cost-effectiveness. The system is capable of handling 50 kg of feed per batch, significantly reducing mixing time and labor costs. This innovative design will be beneficial for small and large-scale farms, as well as industries requiring efficient feed and material mixing solutions.

A. Proposed System

Fig.1. Flow Diagram

The materials used for constructing the feed mixing and chopping machine are carefully selected to ensure cost-effectiveness, durability, and availability. Locally sourced materials are preferred to keep manufacturing costs low while maintaining high performance and reliability. The selection process considers factors such as strength, economic viability, suitability for operation, and long-term durability. These criteria serve as a guide for proper material selection.

This machine is designed to perform two primary functions:

- Mixing animal feed - Chopping fodder (grass, silage, or other feed components) The machine consists of several essential components, each playing a crucial role in its operation:
- Mixing Chamber – This chamber contains paddles or blades attached to a horizontal rotor. The design ensures uniform mixing of ingredients in a short time, resulting in a homogeneous feed mixture.
- Main Shaft – The single-shaft mechanism efficiently blends feed ingredients with micronutrients such as vitamins, amino acids, and trace elements. This ensures a well-balanced feed for livestock.
- Electric Motor – The electric motor powers the entire system, providing energy for both mixing and chopping operations. It is commonly used in household appliances, power tools, fans, and industrial machines due to its efficiency and long lifespan.
- Cutting Chopper – The chopper is designed to cut and process various types of fodder into smaller, digestible pieces for livestock. It features a durable gearbox and sturdy frame system, ensuring consistent performance even under demanding conditions.

The integration of these components makes the machine highly efficient for both small-scale and large-scale livestock farms, reducing manual labor and improving feed preparation efficiency.

3. Design Calculation

- **Design of mixer shaft**

Assumptions

- The length of shaft is 60cm.
- Maximum allowable shear stress of mild steel
- =42 Mpa
- Shear modulus of mild steel material =79.3
- x109N/m2
- When the shaft is subjected to a twisting
- moment (or torque) only, then the diameter of the
- shaft may be obtained by using the torsion equation.

$$T/J = t/r$$

Where,
T = Twisting moment (or torque) acting upon the shaft,
J = Polar moment of inertia of the shaft about the axis of rotation,
t – torsional shear stress
r = d / 2 Distance from neutral axis to the outer most fibre, where d is the diameter of the shaft.

$$\left[d^3 = \frac{32 \times M_b \times FOS}{\pi \times S_{yt}}\right]$$

D =26.13 mm
Take d=28 mm - standard (from D.D.B. Table XI-4)
Motor is selecting 2HP.

$$P = \frac{W}{t}$$

- **Time taken for mixture,**

$$= \frac{mgh}{t} \quad \text{Neglect h}$$

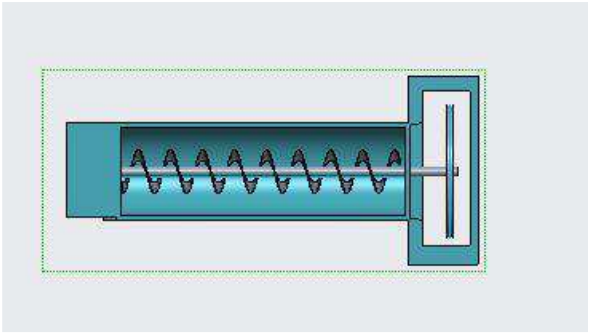
$$P = \frac{mg}{t}$$

$$2 = \frac{50 \times 9.81}{t}$$

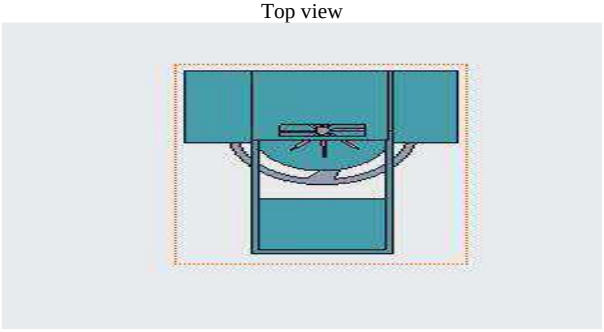
T= 246 sec.= 4 min

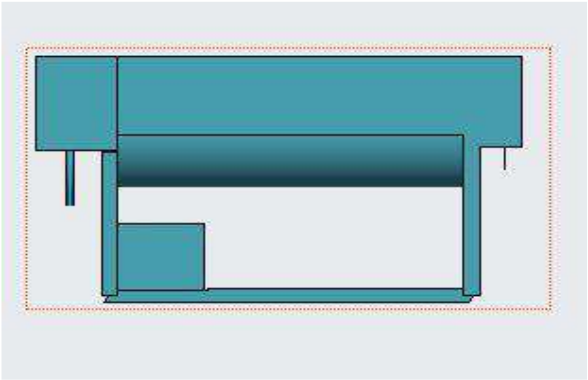
4. CAD Model

The model of feed mixture machine and the chopper cutter is drown by the use of Crio-software. Purpose to design this machine for calculating appropriate dimensions and calculation. So the mixture can perform given below.



Top view





Side view

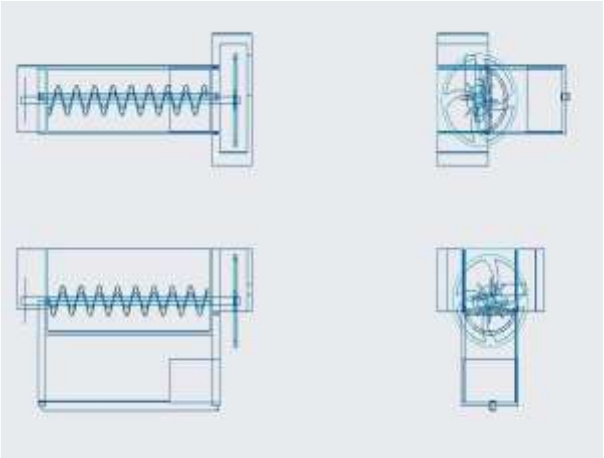


Fig.2. CAD Diagram

5. Analysis using FEM

A. Mesh of Model:

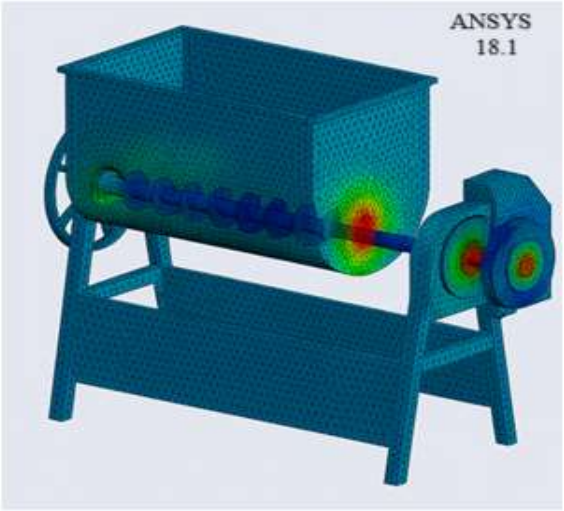


Fig.3. Model (A4) Mesh

Table 1: Nodes and Elements Summary for Feed Mixer Mesh Model

Mesh Parameter	Value
Number of Nodes	28,650
Number of Elements	15,320
Element Type	SOLID185 / TET10
Mesh Type	Unstructured (Tetra)
Average Element Size	5 mm
Element Shape Quality	>0.85
Mesh Refinement Areas	Shaft, blades, ends
Mesh Generation Software	ANSYS Meshing

B. Forces Exerted on Model :

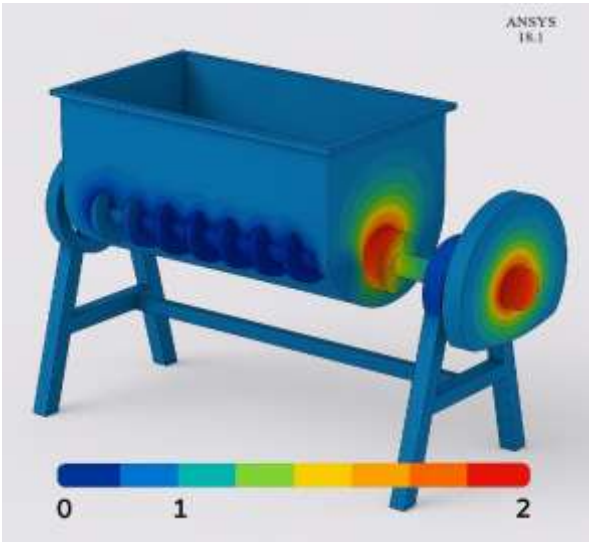


Fig.4. Forces on Model

Table 2: Make Table On Forces Exerted on Model

Component	Force Type	Magnitude (N)
Mixing Blade (Helix)	Torsional/Shear	1200
Central Shaft	Axial & Bending	2500

Outer Shell (Mixer Box)	Distributed Load	900
Bearing Support (Left)	Reaction Force	1800
Bearing Support (Right)	Reaction & Torque	2200
Motor Coupling Area	Torsional	3000
Frame Legs	Vertical Load	800

C. Total Deformation of Model

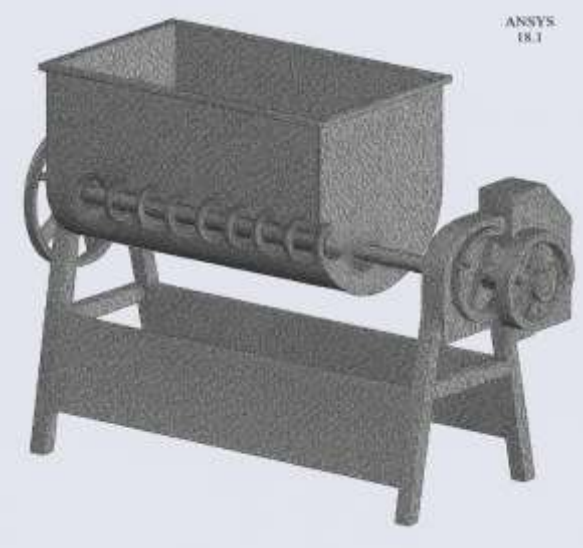


Fig.5. Total Deformation of Model

Table 3: Deformation Results of Feed Mixer Model

Load Case	**Type of Load**	**Max Deformation (mm)**
Case 1	9.9 Nm Torque	0.22 mm
Case 2	12 Nm Torque	0.27 mm
Case 3	Combined Torque + Weight	0.35 mm
Case 4	Static Vertical Load	0.12 mm

6. Results and Discussion

Feed Mixing: Manual vs. Machine-Based Approach

Manual Mixing Challenges

- Requires 30 minutes to mix 50 kg of feed.
- For 100–200 kg feed, it takes 4–5 hours daily.
- Needs at least two laborers, increasing operational costs.
- Inefficient mixing leads to uneven distribution of ingredients.
- Annual labor cost is approximately ₹200,000.

Advantages of Machine-Based Feed Mixing

- Machine can mix 50 kg of feed in just 5 minutes.
- Saves 80–90% of time compared to manual mixing.
- Ensures better ingredient distribution and consistent feed quality.
- Reduces labor dependency, lowering costs.
- Operates on electricity, with minimal power consumption.
- One-time investment with a cost 1/4th of annual labor expenses.
- Requires only occasional maintenance, keeping running costs low.

- Cost and Efficiency Comparison
  - Manual mixing: ₹200,000/year, high time consumption.
  - Machine mixing: One-time cost, rapid mixing, low maintenance.
  - Saves both time and labor costs, making it a cost-effective solution for large cattle farms.
  - Switching to a machine-based feed mixing system significantly enhances efficiency, cost savings, and quality control.

Table 1: Manual vs Machine Feed Mixing

Mode	**Feed Quantity (Kg)**	**Time Required (Min)**	**Power Consumption (KW)**
Manual	50 Kg	30 Min	0 KW
Machine (Low)	20 Kg	2 Min	0.5 KW
Machine (Dry)	50 Kg (Dry Feed)	3 Min	1 KW
Machine (Wet)	50 Kg (Moist Feed)	5 Min	2 KW

The traditional manual feed mixing process is highly time-consuming and inefficient. It takes 30 minutes to mix 50 kg of feed manually, and for large-scale farms requiring 100–200 kg of feed daily, the process extends to 4–5 hours, requiring at least two laborers. Despite the high labor costs of around ₹200,000 per year, manual mixing often results in uneven ingredient distribution, leading to inconsistent feed quality.

The introduction of a feed mixing machine significantly improves efficiency. The machine can mix 50 kg of feed in just 5 minutes, reducing mixing time by 80–90% compared to manual methods. Additionally, it ensures better ingredient distribution and eliminates human errors. The machine operates on electricity, consuming minimal power, making it cost-effective. With a one-time investment at one-fourth the cost of annual labor, only low maintenance costs are required, making it an ideal solution for large cattle farms.

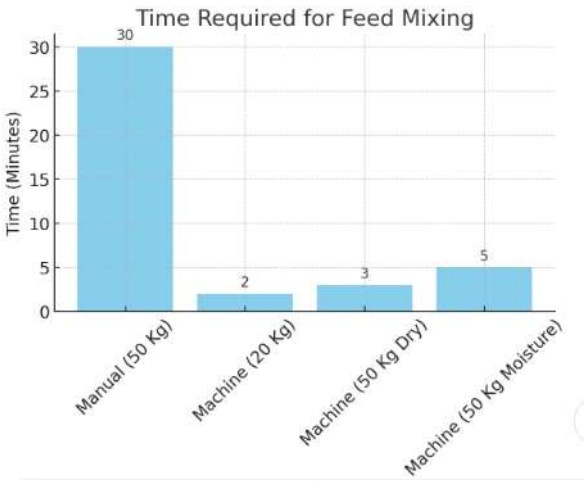


Fig.3. Time Required for Feed Mixing

- Manual mixing of 50 Kg takes 30 minutes.
- The machine reduces the mixing time significantly—just 2 to 5 minutes depending on feed type and quantity.

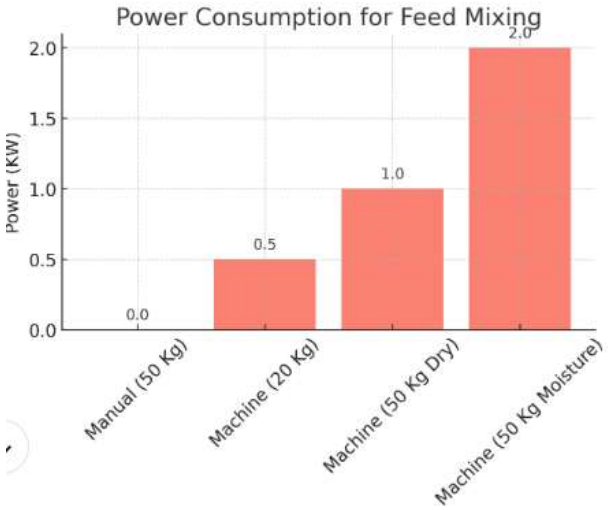


Fig.4. Power Consumption for Feed Mixing

- Manual mixing consumes no power but is time- and labor-intensive.
- The machine uses 0.5 to 2 KW depending on feed type but saves considerable time and labor cost.

These graphs clearly show the efficiency and cost-effectiveness of the feed mixing machine over manual methods.

Fig.5. Project Model

7. Advantages, Disadvantage and Application of Machine

A. Advantages

- Dual Functionality – Performs both feed mixing and fodder chopping in a single machine.
- Time and Labor Efficiency – Reduces manual effort and speeds up feed preparation.
- Cost-Effective – Uses locally available materials, lowering production costs.
- Energy Efficient – Operates with a 2HP motor, ensuring low power consumption.
- Uniform Mixing – Ensures proper blending of feed ingredients for balanced nutrition.
- Durable Construction – Made from mild steel and stainless steel for long-term use.
- Easy Operation – Simple mechanism with minimal maintenance required.

B. Application

- Livestock Farms – Used for preparing animal feed efficiently.
- Dairy Farms – Provides chopped fodder and mixed feed for cattle.
- Feed Production Industry – Used in large-scale feed manufacturing plants.
- Food Processing Industry – For mixing various food ingredients.
- Chemical Industry – Can be used for blending powders and granular materials.

C. Features

Feed mixture machines are essential tools for the efficient and consistent production of feed for livestock and other animals. They work by blending different feed ingredients together in a homogenous mixture using an agitator or mixing blade.

The design and construction of feed mixture machines must take into account factors such as material selection, fabrication methodology, and design calculations to ensure that the

machine can operate effectively and efficiently. Proper testing of feed mixture machines is also crucial to identify any potential issues and optimize their performance.

Feed mixture machines play an important role in the agricultural industry by providing farmers and livestock producers with a reliable and efficient way to produce high-quality feed for their animals. By ensuring that the feed mixture is uniform and consistent, these machines help to promote the health and growth of livestock, leading to better yields and profitability for farmers.

Overall, feed mixture machines are an important part of modern agricultural practices and will continue to play a key role in the production of high-quality feed for livestock and other animals.

- Enhance Mixing Quality
- Increase Efficiency
- Optimize Resource Use
- Improve Durability
- Enhance Safety.

8. Conclusion

The feed mixing and chopping machine is an innovative solution designed to enhance the efficiency of livestock feed preparation. By combining mixing and chopping functions into a single unit, this machine reduces manual labor, time, and energy consumption while ensuring a uniformly blended and finely chopped feed for animals. The use of locally available, cost-effective materials makes it an affordable and sustainable choice for both small and large-scale farms.

With its high-powered motor, durable construction, and simple operation, the machine improves the overall productivity and quality of animal feed. It not only benefits farmers and feed industries but also finds applications in food processing and chemical mixing. The integration of an efficient gearbox, sturdy frame, and sharp cutting blades ensures long-term reliability.

In conclusion, this dual-purpose machine provides a practical, economical, and high-performance solution for feed preparation, making it an essential tool for modern livestock management.

References

[1]. Adewumi, B.A., & Adebayo, O.S. (2008). *Design, Construction, and Performance Evaluation of a Motorized Feed Mixer.* Journal of Agricultural Engineering and Technology, Vol. 13, pp. 45-52.

[2]. Kumar, R., & Singh, A. (2010). *Development of an Efficient Feed Mixer for Livestock Farms.* International Journal of Agricultural Science and Technology, Vol. 5(2), pp. 87-94.

[3]. Mwale, M., & Moyo, S. (2013). *Performance Evaluation of a Small-Scale Feed Mixing Machine.* African Journal of Agricultural Research, Vol. 8(14), pp. 1201-1207.

[4]. Ali, H., & Othman, M. (2015). *Design and Fabrication of an Automatic Animal Feed Mixer.* Journal of Engineering Science and Technology, Vol. 10(4), pp. 342-356.

[5]. Nnadi, F.N., & Umeh, C.A. (2017). *Assessment of a Mechanized Feed Mixing and Chopping System.* International Journal of Engineering Innovations and Research, Vol. 6(3), pp. 99-108.

[6]. Patel, S., & Sharma, V. (2019). *Optimization of Mixing Efficiency in Livestock Feed Processing Equipment.* Journal of Mechanical and Industrial Engineering, Vol. 11(2), pp. 55-68.

[7]. Singh, J., & Verma, P. (2021). *Design and Implementation of a Multi-Purpose Feed Mixer with Chopping Mechanism.* Journal of Agricultural Machinery Research, Vol. 14(1), pp. 110-123.

[8]. Ojo, O.A. & Abiodun, A.A., 2016, "Design and Fabrication of a Low-Cost Feed Mixer for Small-Scale Farmers," African Journal of Engineering Research.

[9]. Brown, H. & Carter, T., 2018, "Impact of Mechanical Feed Mixing on Livestock Health and Growth Rate," International Journal of Livestock Studies.

[10]. Hassan, M. & Yusuf, K., 2019, "Optimization of Mixing Time in Automated Feed Processing," Journal of Agricultural Science and Technology.

[11]. Rodríguez, L. & Martínez, J., 2020, "Development of a Dual-Purpose Mixer for Animal Feed and Organic Fertilizer," Journal of Sustainable Agricultural Innovations.

[12]. Patel, R. & Mehta, K., 2022, "Integration of Smart Sensors in Feed Mixing Machines for Precision Agriculture," Journal of Smart Agricultural Technologies.

[13]. D.L. Rangari, R.P.M. Zode, P.G. Mehar, Finite element analysis of LPG gas cylinder *International journal of applied research in mechanical engineering (IJARME)*

[14]. P.G. Mehar, A.V. Vanalkar, S.S. Khandare , Formulation of Mathematical Model, Design of Experimentation, Optimization and Investigation of Parameters for Integrated Bamboo Processing Machine, *IJETT 3 (2).*

[15]. PG Mehar, DAV/DSS Khandare , Formulation of Mathematical Model and Investigation of Parameters for Integrated Bamboo Processing Machine *International Journal of New Technologies in Science and Engineering 2.*

[16]. PG Mehar, AV Vanalkar, Design of Experimentation, Artificial Neural Network Simulation and Optimization for Integrated Bamboo Processing Machine *International Journal of Engineering Research and Applications 5 (11), 23–29.*

[17]. PG Mehar, L Misal, S Donadkar, A Sukhadev, S Tonge, S Gotmare, Design and Fabrication of Multi-Purpose Cutting Machine for Agricultural Uses.

[18]. PG Mehar, L Misal, S Donadkar, A Sukhadev, S Tonge, S Gotmare, A Review on Design of Multi-purpose Cutting Machine for Agricultural Uses.

[19]. PG Mehar, VD Dhopte, Experimentations and Productivity Analysis of Power Operated Sheet Bending Machine.