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Design and Analysis of a Multifunctional Cutting Machine for Agricultural Uses

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Abstract: The persistent shortage of agricultural labor underscores the urgent need for efficient mechanized solutions tailored for small and marginal farmers. This study presents the design and finite element analysis (FEA) of a multifunctional cutting machine capable of performing three critical agricultural operations: sugarcane seed cutting, groundnut stripping, and straw cutting. The machine's design integrates a single-phase motor system that converts rotary motion into precise reciprocating cutting action, ensuring consistent and accurate operation. A high-speed cutter with a motor is incorporated to handle crop stems efficiently. Emphasis is placed on simplicity, affordability, and ease of maintenance to make the machine suitable for rural farming communities. The mechanical components are modeled and analyzed using FEA techniques to ensure structural integrity, reliability, and durability under varying operational loads. This design-focused approach reduces dependency on manual labor, lowers operational costs, and minimizes material wastage, thereby enhancing overall agricultural productivity. By combining essential cutting processes into one robust system, the proposed machine offers a cost-effective and technically sound solution that addresses the pressing challenges of modern Indian agriculture

Keywords: Multifunctional Cutting Machine, Finite Element Analysis (FEA), Agricultural Mechanization, Rural Farming Solutions etc.

I. INTRODUCTION

Agriculture remains the backbone of the Indian economy, providing employment and livelihood to nearly two-thirds of the country's population and contributing approximately 16.1% to the national GDP. Despite its critical socio-economic role, the sector faces persistent challenges, including an acute shortage of manual labor, rising operational costs, and low productivity due to dependence on traditional farming practices. One of the primary reasons for the labor shortage is the migration of rural workers to urban areas in search of better employment opportunities, coupled with the diminishing appeal of strenuous agricultural work. This shortage becomes even more pronounced during peak seasons such as sowing and harvesting, directly impacting crop yield and farmers' income.

Mechanization in agriculture has emerged as an effective and sustainable solution to address these challenges by improving efficiency, reducing drudgery, and ensuring timely operations. However, small and marginal farmers, who form the majority in India, often lack access to advanced machinery due to high costs, complex maintenance, and unsuitability for small landholdings. To bridge this gap, there is a growing demand for affordable, user-friendly, and multifunctional machines that can perform multiple tasks with minimal human intervention. Among various agricultural operations, sugarcane seed cutting, groundnut stripping, and straw cutting are particularly labor-intensive and time-consuming. India is one of the world's largest producers of sugarcane, with an annual production of about 300 million tons. The conventional practice involves cutting harvested sugarcane into 5–6 parts, each containing 2–3 buds for planting. This manual process requires substantial labor, contributing to increased costs and operational delays. Similarly, groundnut cultivation involves separating pods from harvested plants, which demands 20–30 workers per acre—a significant expenditure of time and labor. Moreover, cutting straw from maize and jowar for use as livestock feed is another repetitive task that adds to the burden on farmers, especially during the busy post-harvest period.

To address these critical issues, the proposed project focuses solely on the design and finite element analysis (FEA) of a multifunctional cutting machine capable of integrating these three operations into a single, compact unit. The machine's primary design consideration is to convert the rotary motion from a single-phase motor into precise reciprocating motion, ensuring consistent cutting and stripping performance. Additionally, a high-speed cutter operating at 10,000 RPM is incorporated to handle the stems of various crops with ease and accuracy.

Finite element analysis plays a pivotal role in modern machine design, enabling engineers to simulate and evaluate structural behavior under diverse loading conditions. By employing FEA tools, the proposed machine's frame, cutting blades, transmission components, and moving parts can be rigorously analyzed for stress distribution, deformation, and factor of safety. This reduces reliance on costly physical prototypes and extensive trial-and-error testing. The insights gained through simulation help optimize the design for durability, cost-effectiveness, and ease of fabrication while ensuring reliability in real-world agricultural environments.

This project addresses the pressing need for mechanization among small and marginal farmers by focusing on the systematic design and analysis of an integrated cutting machine. Through its multifunctionality and robust structural design verified by FEA, the proposed solution aims to enhance productivity, reduce manual dependency, and promote sustainable agricultural practices in India's rural heartland

Agriculture is a cornerstone of the Indian economy, providing a livelihood for nearly two-thirds of the population and occupying approximately 43% of the country's land area. Contributing 16.1% to India's GDP, the sector is vital but faces numerous challenges, particularly labor shortages during peak seasons. Factors such as the migration of workers to cities, the appeal of non-farm jobs with higher wages, and the declining social perception of agricultural labor have worsened this issue. Additionally, rapid urbanization has reduced available farmland, making agricultural mechanization essential to improving efficiency and productivity. The integration of modern farming techniques and machinery offers a viable solution to address these concerns.

India is a major producer of key agricultural commodities such as sugarcane, straw, and groundnuts. With an annual production of approximately 300 million tons, sugarcane plays a significant role in India's agricultural economy. Traditionally, sugarcane planting requires manual cutting into smaller segments, each containing 2-3 seeds, before sowing in moist soil. This process is labor-intensive, involving nearly 4 million farmers and a substantial portion of the rural workforce. Similarly, straw cutting, particularly for maize and jowar, is essential for producing livestock fodder. After harvesting, maize straw, which typically measures 150-200 cm in length, must be cut into smaller pieces for animal feed. Manual cutting is slow and tedious, necessitating mechanization to increase efficiency. Groundnut cultivation also relies heavily on manual labor, with 20-30 workers per acre needed to separate groundnuts from plants, making the process both time-consuming and labor-intensive.

To address these challenges, this project aims to develop a multi-purpose cutting machine that integrates three key agricultural processes: sugarcane seed cutting, groundnut stripping, and straw cutting into a single, cost-effective system. This innovation will significantly enhance agricultural efficiency while reducing labor dependency, making farming more sustainable for small-scale farmers.

To ensure the reliability and durability of the machine, Finite Element Analysis (FEA) is employed in the design phase. The Finite Element Method (FEM) is a computational technique used to model mechanical stress in agricultural machinery. It is particularly effective in simulating the structural behavior of complex components, accounting for varying material properties, intricate geometries, and dynamic forces. FEM analysis involves creating a mesh of nodes, with higher density in areas expected to experience greater stress, such as joints, corners, and potential fracture points. By applying FEM to agricultural equipment, engineers can predict stress distribution, deformation, and failure risks before production, reducing the likelihood of mechanical failure in the field. The use of FEM in mechanized farming equipment enhances performance, durability, and efficiency, contributing to the advancement of modern agricultural practices.

II. PROBLEM STATEMENTS

1) Labor Shortage – Agriculture faces a severe labor shortage, especially during peak seasons, due to increased migration to cities and better-paying non-farm jobs.
2) Time-Consuming Traditional Methods – Manual planting, harvesting, and processing of crops like sugarcane and groundnuts require excessive time and labor, reducing overall productivity.
3) High Cost of Mechanization – Advanced agricultural machinery is often expensive, making it unaffordable for small and marginal farmers.
4) Limited Awareness and Implementation – Despite technological advancements, many rural farmers lack awareness and access to modern agricultural equipment.
5) Land Scarcity Due to Urbanization – The rapid expansion of urban areas reduces arable land, increasing the need for efficient farming methods.
6) Mechanical Failure Risks – Agricultural machinery must be optimized to prevent failures that could lead to financial losses and downtime.
7) Need for Optimization and Simulation – There is a necessity to develop and test agricultural equipment using Finite Element Analysis (FEA) to improve durability and performance before field deployment.

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III. METHODOLOGY

A. Design Calculations

1) Sugarcane Seed Cutting

Force required to cut the bud of sugarcane F= 400N Bud cutting frequency = 23/min

Leather Belt specification:

ρ= 0.95 g/cm³

μ=0.35

t=5 mm

Permissible stress:

σ= 2.45 N/mm²

Centre distance of pulley = 25 cm

width of belt= 13 mm

thickness=5 mm

Worm gear specification:

Speed ratio:- N2/N1= 30:1

So N2=N1 x30

So N2-23 x30

So N2-690

Pully:-D2=10 cm

V=TD2N2/1000*60

V=(π×10×100x690)/1000*60

V= 3.611m/s

Length of belt :-

L=2C+ ((D1+D2))/2+ (D2-D1)2/4C

L=2×250+ (π(64.28+100))/2+ (100-64.28)2/(4×250)

L=759.1955mm

a 180-2 sin-¹(D2-D1)/2C

a 180-2 sin ¹(100-64.28)/(2×250)

a=171.806⁰

a=171.806/180×T

a=2.997 rad

Volume of belt:

V=LXBXT

V=100×13/10×5/10

V-65 cm3/m

Mass of belt:

m=0.95×65 gm

m=0.95×65/1000 kg

m=0.06175kg

mv²=0.06175 × 3.6112

mv²=0.80522

e(μxa)= e(0.35×2.997)=2.854

(T1-mv2)/(T2-mv²)= e(uxa)-2.854

(T1-0.80522)/(T2-0.80522)= e(uxa)=2.854

Max permissible stress in the belt:

0= T1/A

T1= o XA

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T1= 2.45 ×5×13
T1= 159.25N
So, T2= 55.798N
P=(T1-T2)XV
P=373.5 W

Torque Calculation
Torque formula:
P= (2*3.14*N*T)/60
where, P stands for Power, N stands for Speed, T stands for Torque. Torque in the motor before speed reduction,
P= (2*3.14*N3*T3)/60
373 = (2*3.14*1400* T1)/60
Hence, T3 = 2.54 (Nm)
We know that,
T3x N3 = T2x N2
Hence, T2 = (T3 x N3)/N2
thus, T2 = (2.54 x 30) T2 =5.08 (Nm)
Assuming the transmission efficiency is 82% hence, T2=5.08x 0.82
Hence, T2 = 4.16 (Nm)

For gear box :
T2x N2= T1x N1
4.16x 700 Tlx 23
T1= 126.6 (Nm)
Design of shaft:
Total vertical load acting on the pulley:
Wt = T1+T2 +W
= 159.25 + 55.798 +2
= 217.048 N

Bending moment acting on the shaft:
M = Wt x L
= 217.048 × 50
= 10852.4 N-mm

Twisting moment acting on the shaft:
T = 4160N – mm
Equivalent twisting moment:
T_{e} = root(2, (M ^ 2 + T ^ 2))
overline 2) 4^ 2 +4160^ 2) = sqrt[2] (10852.4^ 2 +
=11622.40 N-mm
t = 250N / m * m * 2
sigma yt
fos = 4
tau yt =0.5* sigma yt =125 N/mm^ 2
tau_{w} = 125/4
=31.25 N/mm^ 2
tau_{w} = 16T_{e} / pi * d ^ 3
d = (16 x 11622.40)/π x 31.25
=12.37 mm

=13 mm
As we are using 25mm dia. Shaft. So our design is safe.

Cutter Design:
Tyt = 125 N/mm² F= the average force for punching from the literature and the experiment is 400 N.
Tyt = F/A
= 400/2 x (D^2/4)
= 400/2 × (25^2/4)
= 0.4076 N/mm²
Since, t<<ty
Hence design is safe under shear.

2) Straw Cutting

This part of machine will cut straw, grass, maize plant and paddy plants etc., among these all the maize plant having more strength. So the machine requires more power to cut this maize plant. The force required to cut maize plant is 243 N. Now the calculation for power required for straw cutting operation is given below,
Torque = force × distance
Force = Force required to cut maize plant in N
Distance = 47.5/2 (47.5 is radius of pulley on which blade will be placed)
= 23.75 cm
Torque = 243 × 23.75= 5771.25 × 10-2 Nm
Power (P) = (2 × π × N × T)/60= (2 × π × 150 × 5771.25× 10-2)/60
P = 906.54 W
By considering loss,
Efficiency of belt = 85%
P = 906.54/0.85
= 1066.52Watts
P = 1 HP

3) Groundnut Stripper

Cutting energy = 147 mJ/mm2
Power (P) = 147 × Area
P = 147 × (π × d2)/4
P = 147 × 9.62
(By considering diameter of groundnut rubber blades is 3.5 mm)
P = 1414.30mJ
P = 1.414 J
This power is for only one groundnut plant, so by considering nearly a bunch of
30 groundnut plants the power is given below, also by taking belt efficiency as 85%l .
P = 1.414 × 30
P = 42.42 J
But, 1J/s = 1 W
P (J) = 42.42 J
P (W) = (42.42 × 480) / (60 × 0.85)
P = 399.24 Watts
P = 0.54 HP
According to power calculation maximum power required is 1 hp. So, the motor is purchased of 1.50hp, because the standard available motor is of that value.

4) Grass stem cutter (DC)
- Voltage V=12 V DC
- Current I=2 Amps (max)
- Speed N=10,000

1. Power Calculation (Electrical Input Power):
We calculate input power using the formula:
Pin=V×I
Pin=12×2=24 Watts
So the input power is 24 Watts.

2. Torque Calculation:
To find the torque, we use the relation between power, torque, and angular speed:
P=τ·ωP
Where:
- P is power in watts (24 W)
- ω is angular velocity in radians per second
- τ is torque in Nm

First convert RPM to rad/s:

$$\omega = \frac{2\pi \cdot \mathrm{RPM}}{60} = \frac{2\pi \cdot 10000}{60} \approx 1047.2 \text{ rad/s}$$

Now calculate torque:

$$\tau = \frac{P}{\omega} = \frac{24}{1047.2} \approx 0.0229 \text{ Nm}$$

So, the output torque is approximately 0.023 Nm.

3. Mechanical Work Done (on Grass Stems):
The motor operates at full power for 10 seconds while cutting a bundle of grass stems:
Energy used=P×t=24×10=240 Joules
That is the energy available to perform mechanical work i.e., to cut the stems.

IV. SCHEMATIC DIAGRAM

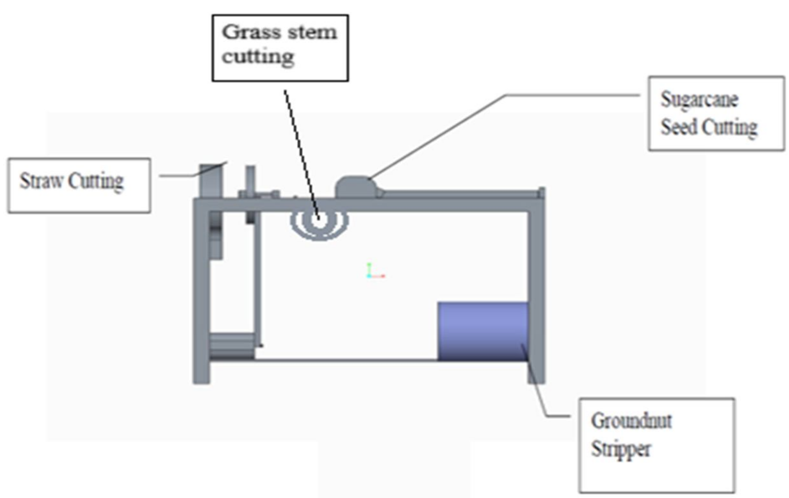

Fig.1. Schematic Diagram

B. Proposed System

Designed and built a machine, where it is possible to perform the following operations,

Sugarcane seeds cutting; Groundnut stripping; Straw cutting.

The different parts of this machine will be mounted on a sturdy frame. The wheels will be attached to this frame, so that it can move around the farm and it is a multipurpose cutter, to work in different conditions.

1) Sugarcane Seed Cutting

When the single-phase motor is activated, it operates at 1400 rpm, which is reduced to 700 rpm via a belt and pulley drive.

This speed is further reduced to 23 rpm by a gearbox with a 1:30 worm and worm wheel ratio. The gearbox is connected to a cam that converts rotary motion into reciprocating motion for the cutter.

As the cutter advances, it cuts the sugarcane, which is manually fed. During the return stroke, the cutter releases sugarcane sprouts, which are collected in a collector. This system efficiently converts rotational motion into reciprocating motion for the cutting process

2) Groundnut Stripper

It consists of hollow cylinder with the rod welded on the its periphery. The electric motor which is connected to the external power supply transmitted to the shaft.

The rotating shaft is mounted on the roller cylinder. Groundnuts are supplied in a rotating blades will be separating the groundnut from the plants and shelling.

3) Straw Cutting

It consists of two blades which is mounted in a circular ring that connected to the motor through the belt drive. Rotating blades will be cut the straw into small pieces.

4) Grass stem Cutter

A grass stem cutter with a high-speed DC motor and self-sharpening blades offers efficient, precise cutting. Adjustable height, safety guard, and lightweight design enhance usability. DC power boosts mobility, making it ideal for trimming grass, weeds, branches, and residues.

A hopper with a high-speed cutter, driven by a 10,000 RPM motor, will be incorporated into the machine. This addition will efficiently cut the stems of various agricultural crops, enhancing the machine's capability to handle different types of crops with ease and improving operational efficiency.

C. Working Principle

Working Principle: Designed and built a machine, where it is possible to perform the following operations,

Sugarcane seeds cutting; Groundnut stripping; Straw cutting.

The different parts of this machine will be mounted on a sturdy frame. The wheels will be attached to this frame, so that it can move around the farm and it is a multipurpose cutter, to work in different conditions.

D. Formulation of Research Problem for FEA

Problem formulation for Finite Element Analysis (FEA) in a multi-purpose cutting machine for agriculture involve several steps:

Problem Formulation: -

1)Define the Objective: Start by clearly defining the objective. In this case, it could be improving the cutting performance, reducing wear and tear, enhancing safety, or any other specific goal.

2) Identify Key Components: Identify the key components of the cutting machine that are critical to its performance, such as blades, gears, motors, and structural elements.

3) Material Properties: Collect material properties data for the components. This includes information on the tensile strength, modulus of elasticity, density of the materials used.

4) Load and Boundary Conditions: Determine the loads and boundary conditions the machine experiences during operation. For an agriculture cutting machine, this may include the forces exerted by the cutting process, vibrations, and external loads during transportation.

5) Geometry and CAD Modeling: Create a detailed CAD model of the cutting machine and its components. This model should accurately represent the machine's geometry.
6) Mesh Generation: Generate a finite element mesh for the model. The mesh divides the geometry into smaller elements, which are necessary for FEA calculations.
7) Define Analysis Type: Choose the type of FEA analysis to perform. This could be static analysis, depending on the specific problem you are addressing.
8) Material Assignment: Assign material properties to the elements in the mesh based on the components' materials.
9) Apply Loads and Constraints: Apply the loads and boundary condition identified to FEA model.
10) Solve the Model: Use FEA software to solve the model and obtain results. These results may include stress distributions, deformation patterns, and other relevant data.
11) Evaluate Results: Analyze the results to determine if the machine meets the desired performance criteria or if any areas of concern are identified.
12) Documentation: Document the entire FEA process, including assumptions, inputs, and results, for future reference and potential regulatory compliance.
By following these steps, you can effectively identify and formulate FEA for a multi-purpose cutting machine in agriculture, helping to improve its performance, durability, and safety.
Basic steps & Phases Involved in FEA:
Steps:
- Discretization
- Selection of approximation of functions
- Formation of elemental stiffness matrix
- Formation of total stiffness matrix
- Formation of element loading matrix
- Formation of total loading matrix
- Formation of overall equilibrium equation
- Implementation of boundary condition
- Calculation of unknown nodal displacements
- Calculation of stresses and strains.

Phases
Pre-Processing: Here a finite element mesh is developed to divide the given geometry into subdomains for mathematical analysis and the material properties are applied and the boundary Conditions.
Solution: In this phase governing matrix equation are derived and the solution for the primary quantities is generated.
Post-Processing: In the last phase, checking of the validity of the solution generated, examinations of the values of primary quantities such as a displacements and stresses, errors involved is carried out.

V. MODELING & ANALYSIS

A. *Software Modelling*
The 3D isometric view of multi-purpose cutting machine, including different operation by Solid Works CAD software.

Fig. 2: 3-D View of multi-purposed cutting machine

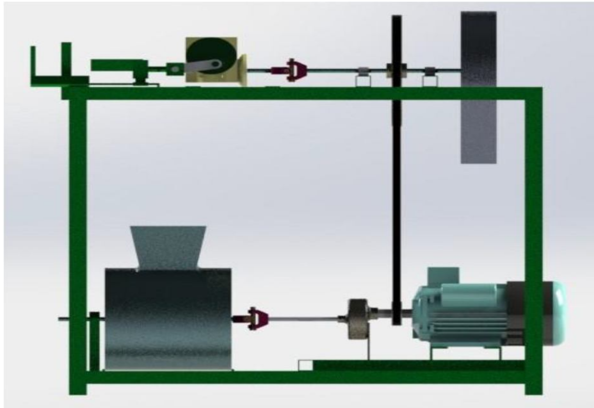

Fig. 4: Front View of multi-purposed cutting machine

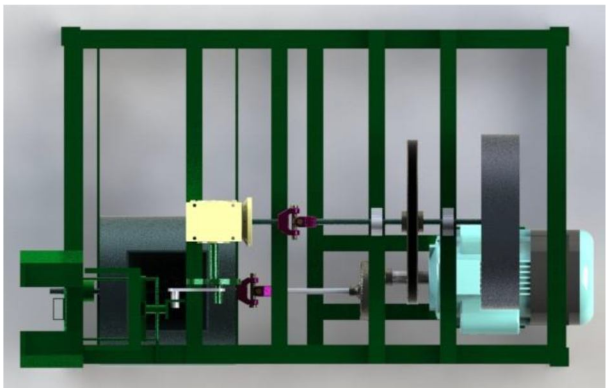

Fig. 5: Top View of multi-purposed cutting machine

B. Analysis using FEM

1) Mesh of Model

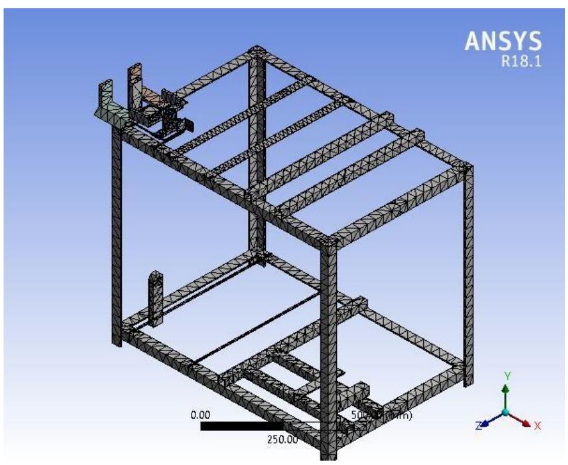

Fig. 6: Model (A4) Mesh

Table 1. Nodes and Elements of Model

Statistics	
Nodes	22590
Elements	9882

2) Forces Exerted on Model

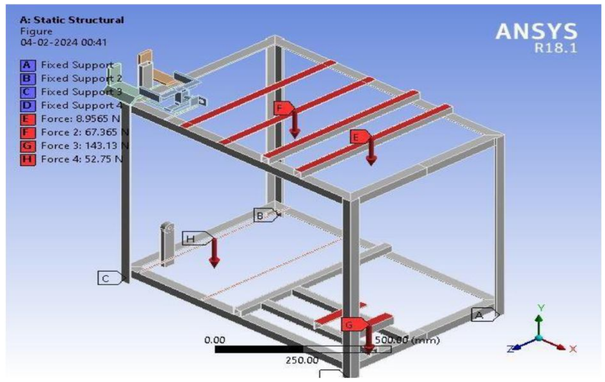

Fig. 7: Forces on Model

Table 2. Forces on Model

Object Name	Fixed Support	Fixed Support	Fixed Support	Fixed Support	Force 1	Force 2	Force 3	Force 4
Magnitude	A	B	C	D	E=8.9565N (ramped)	F=67.365N (ramped)	G=143.13N (ramped)	H=52.75 N (ramped)

3) Total Deformation of Model

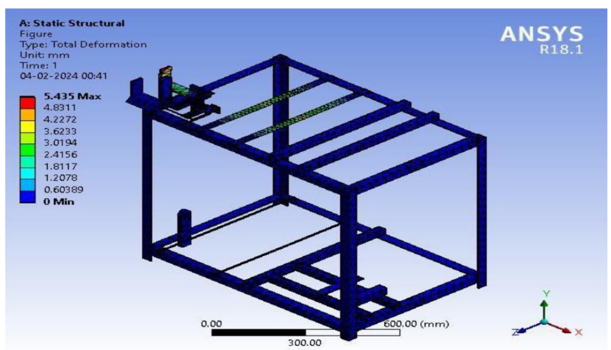

Fig. 8: Total Deformation of Model

Table 3. Deformation of Model

Time [s]	Minimum [mm]	Maximum [mm]
1.	0.	5.435

4) Equivalent Stress of Model

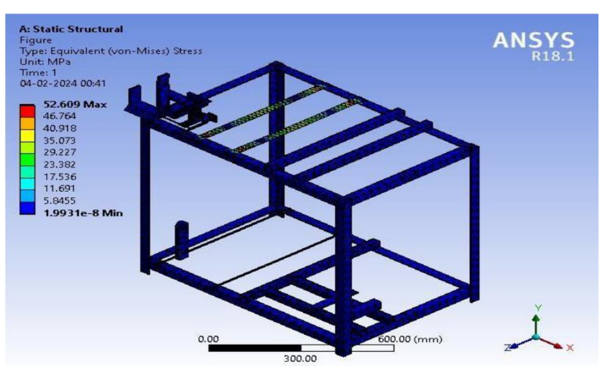

Fig 9: Equivalent Stress of Model

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Table 4. Stress of Model

Time [s]	Minimum [MPa]	Maximum [MPa]
1.	1.9931e-008	52.609

5) Equivalent Elastic Strain of Model:

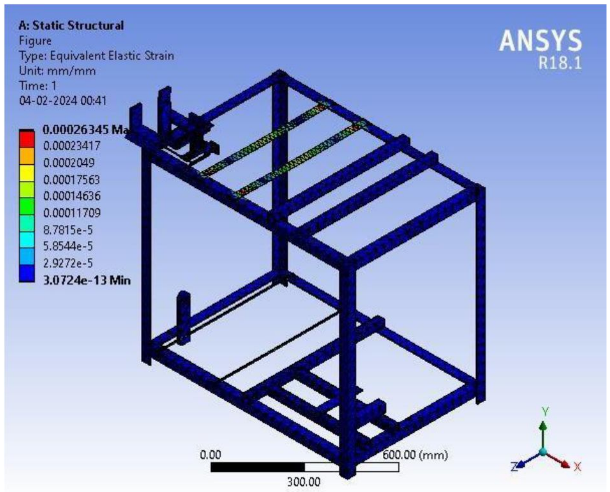

Fig.10: Equivalent Elastic Strain of Model

Table 5. Elastic Strain of Model

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]
1.	3.0724e-013	2.6345e-004

6) Safety Factor

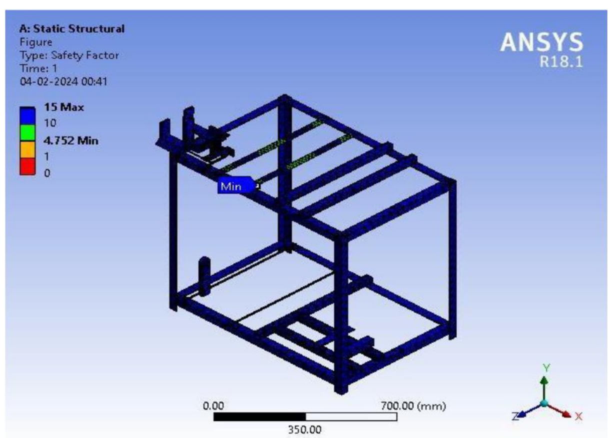

Fig. 11: Safety Factor of Model

Table 6. Safety Factor value of Model

Time [s]	Minimum	Maximum
1.	4.752	15.

Finite Element Simulation (FEM) was conducted on various components of the implement using ANSYS R18.1 software to perform static structural analysis. A three-dimensional model was developed and uploaded into the software, where standard material properties such as Young's Modulus, ultimate tensile strength, yield strength, Poisson's Ratio, and density were assigned.

Proper connections between different components were established, and an appropriate meshing method and size were selected to create the mesh structure. Theoretical calculations, considering shock and fatigue factors, were carried out to determine applied forces, moments, and boundary constraints. The resulting Von Mises stress and total deformation were analyzed, leading to design modifications for optimal part dimensions. The FE analysis results were represented using colored contour plots, showing stress levels and deformation variations.

For the main frame, applied forces and boundary conditions were established, and the results showed a total deformation of 5.435 mm with a maximum equivalent stress of 52.609 N/mm². The maximum equivalent elastic strain of the model was calculated as 2.6345e-004 mm/mm. To ensure structural safety, a maximum safety factor of 15 was considered for the main frame. These analyses helped optimize the design, ensuring durability, efficiency, and reliability in real-world applications.

VI. RESULTS AND DISCUSSION

The results obtained from the Finite Element Analysis (FEA) provide critical insights into the structural behavior of the implement. The total deformation observed in the main frame was 5.435 mm, which is within acceptable limits for safe operation. The maximum equivalent stress induced in the model was 52.609 N/mm², which is well below the yield strength of the material, ensuring structural integrity under applied loads. Additionally, the maximum equivalent elastic strain recorded was 2.6345e-004 mm/mm, indicating that the deformation is minimal and within the elastic range of the material.

The analysis of different components showed stress concentration areas that required optimization. Design modifications were implemented to reduce stress accumulation and improve overall durability. The results were presented in the form of colored contour plots, highlighting the variation in stress levels and deformation across different regions of the structure.

A safety factor of 15 was selected for the main frame, ensuring that the implement can withstand unexpected loading conditions without failure. The simulation results confirm that the designed model is structurally stable, efficient, and capable of performing under real-world agricultural conditions. These findings will contribute to the development of a more reliable and optimized agricultural implement.

Table 7: Summary of FEA Results

Parameter	Value	Permissible Limit
Total Deformation	5.435 mm	<10 mm
Max. Equivalent Stress	52.609 N/mm^2	Below Yield Strength
Max. Equivalent Strain	2.6345e-004 mm/mm	Elastic Range
Safety Factor	15	Standard Value

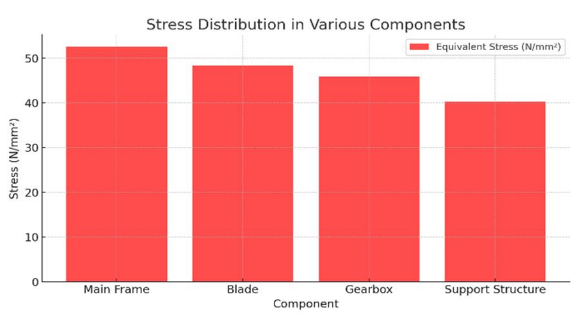

Fig. 12: The graphs represent the stress distribution in various components

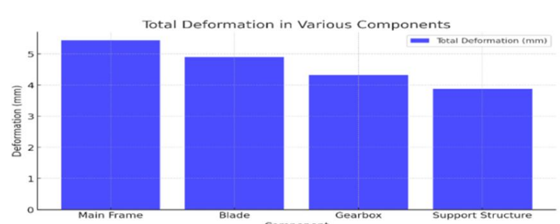

Fig. 13: The graphs represent the total deformation in various components

The obtained FEA results validate that the designed multipurpose cutting machine is structurally efficient and reliable. The observed deformations and stresses remain well within the acceptable limits, preventing premature failure or excessive wear. By optimizing stress concentration areas, the implement's durability was improved. Additionally, the safety factor ensures robustness against unforeseen loads.

The use of FEA in agricultural machinery design allows for predictive performance assessment before field deployment, ultimately improving machine efficiency and longevity. Future work can focus on further material optimization to enhance cost-effectiveness without compromising strength

The FEA analysis confirms the multipurpose agricultural cutting machine's stability and efficiency. With deformation and stress values within acceptable limits, the machine is safe for operation. Implementing design modifications based on stress analysis further improves performance, ensuring durability and reliability in agricultural application.

VII. ADVANTAGES, DISADVANTAGE AND APPLICATION OF MACHINE

A. Advantages

1) Labour cost is reduced.
2) Wastage of sugarcane is reduced
3) Easy in construction.
4) Easy to maintain.
5) It reduces time.
6) It does not create air pollutant.

B. Disadvantage

1) Machine is heavy weight.
2) Machine creates more noise.

C. Application

It is used in agriculture sector.

It helps institutions such as the agricultural university, the agricultural university and, in School children to learn about the agricultural operation of farmers.

VIII. CONCLUSION

In the robust multi-purpose cutting machine, three individual operations are combined. Using this machine it is possible to reduce the problem of labor crises as it makes the process faster and the manpower required to operate the machine is also less. It performs more than one operation, so you can save processing time. In the sugarcane seed cutting operation, the sugarcane waste can be controlled and the cut seeds are easy to sow. In the peanut shelling operation, instead of 10-20 jobs per acre, only two jobs can separate the peanuts from the plant using this machine. In the rice husking operation, while separating the rice from the grinding waste, more traditional methods will be used. Using this machine, the waste will be less and instead of 5-6 jobs, only 2 jobs can perform the same operations in a minimum time. If this machine is used by the maximum number of farmers, surely the farmer can overcome the problem of job crises, thus reducing the number of jobs. cost and process become faster and easier.

Based on the results obtained in this study, the following specific conclusions can be drawn:

1) The three-dimensional model of multi-purposed cutting machine for agriculture was successfully created in SolidWorks 2021, and optimum part dimensions were achieved by doing FE analysis in ANSYS R18.1 workbench software. The simulation was very helpful to understand the effect of different forces on the model.
2) The stress induced and the deformation of each component were found to be less than the allowable stress and maximum deformation of the material selected which signifies the safe design of implement.
3) FEM enables to optimize and simulate the complex agricultural machinery and to investigate the stresses, deformations and safety factor induced in the parts well before product development to avoid failure in the later phase of field evaluation.

REFERENCES

[1] Prof. Dipak U Adhapure, Kolekar, Navnath, Gadhaye (2019),"Design Development & Fabrication of Sugarcane Bud Cutting Machine", IJSRD, Volume 6, Issue 12.

[2] Krishna Prasad,Harish Kumar H,Harsha B Harshith, Kishan Kumar(July 2017)."Design and Fabrication of Sugarcane Bud Cutting Machine",IJESC,Volume 7,Issue 7.

[3] Suraj S Magdum, Shubham Pawar, Pankaj B Gavali (Oct. 2016), "Sugarcane bud cutting machine", IJIRSE, Volume 2, Issue 10.

[4] Sanjay Patil Sir. Nikhil Nangare. Aditya Waghmare. MayurZope. Meet Thakker."Design and Modification of Sugarcane Bud Scooping Machine" IRJET: International Research Journal of Engineering and Technology e-ISSN: 2395 -0056 Volume: 03 Issue:04 | April-2016 www.i Raghtate.

[5] Ashish S. and Dr. C.C. Handa "Design and fabrication of groundnut sheller machine." IJIRST-International Journal for Innovative Research in Science & Technology 1.7 (2014). rjet.netp ISSN: 2395-0072.

[6] Javeed Basha, Mr. G Maruthi Prasad Yadav, "Fabrication and performance test of an Ultraportable Crop cutter" LJRSET Volume 2, Issue 2 Pages: 13-253.

[7] Adarsh J Jain, Shashank Karne. Srinivas Ratod, Vinay NI Toted and Karan "Design and fabrication of smallscale Sugarcane Harvesting Machine" ISSN 2278 - 0149 jjmerr Vol. 2, No. 3, July 2013© 2013 IJMERR.

[8] Abel Roy J, Gat Vaibhav D, Patel Harshavardhan, Upadhye Dhiraj D. Students Under the guidance of Kiran P.Asst. Professor, "Design and Fabrication of Semi-automated Sugarcane Bud Chipper" FIESTA-16 A National Level Conference and Technical Fest on 30th April 2016.Rudolf.

[9] Marco Bentini, Roberta Martelli (2013) 'Prototype for the harvesting of cultivated herbaceous energy crops, an economic and technical.

[10] Gol, A. K. and S. K. Nada: Performance of power operated groundnut stripper. AMA, 22(3): 25-28.on ventional

[11] H. Kibar and T. Öztürk, Physical and mechanical properties of soybean, Int. Agrophysics, 2008, 22, 239-244

[12] Reza Tabatae Color and Ghaffair Kiani, Soyabean stem cutting energy and effect of blade parametes on it Journal of Biological science 10(9), 1532-1535 2007, ISSN 1028-8880.l

[13] Sunil K. Mathanker a, Tony E. Grift a, Alan C. Hansen a,b , Effect of blade oblique angle and cutting speed on cutting energy for energy cane stems, biosystems engineering 133 (2015) 64 e70.

[14] 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)

[15] 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).

[16] PG Mehar, DAV/DSS Khandare , Formulation of Mathematical Model and Investigation of Parameters for Integrated Bamboo Processing Machine

[17] International Journal of New Technologies in Science and Engineering 2.

[18] 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.

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

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

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