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Multipurpose Cutting Machine for Agricultural Uses: A Review

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Abstract-

Farming operations dependent on manual labor face two key problems: delayed timelines and seasonal workforce shortages because of traditional farming practices. The development of a multifunctional agricultural cutting machine seeks to improve farm efficiency and reduce agricultural complexity. The high costs and limited access to automated machinery constitute main obstacles which primarily affect farmers working in rural locations. The project features three fundamental agricultural automation devices with the Sugarcane Seed Cutter using a motorized gearbox to turn rotary motion into precise reciprocating motion for better cutting results as well as the Groundnut Stripper which separates groundnuts from plants using a spinning shaft and cylinder system and the Straw Cutter utilizes circular rotating blades driven by a belt-driven motor to process straw material. Small-scale farmers receive benefits from the system which was created with three main design elements focused on simplicity and affordability alongside user-friendly features. The machine reduces waste while boosting operational flexibility and productivity which provides farmers with a contemporary solution to important agricultural problems.

Keywords: *Sugarcane Seed Cutting, Groundnut Stripper, Solid Works, ANSYS, Finite Element Analysis, Static Structural Analysis etc.*

1. Introduction

The Indian economy depends heavily on agricultural activities since they provide earnings for approximately two-thirds of the population. The agricultural sector extends across 43% of India's total territories and contributes 16.1% to national economic output. Labor shortages present a significant problem to the agricultural sector because high-demand seasons need qualified workers. Better non- agricultural job opportunities along with urban migration and decreased social interest in farm work create these problems. The ongoing reduction of arable land during urban development requires modern machinery for enhancing both operational efficiency and output results. Advanced farming technology provides a practical solution that simultaneously enhances agricultural production rates while handling existing problems in the field [1][2].

Sugarcane along with straw and groundnut constitute among India's essential crops which the nation cultivates for agriculture production. Sugarcane agriculture makes substantial economic contributions to Indian farming which places the country among major world producers since farmers yield around 300 million tons each year. Sugarcane planting requires cuttings to be divided into small segments with two to three buds before burying them into wet soil. The implementation demands significant human labor input. Sugarcane cultivation includes a workforce of 4 million people including farmers and laborers who represent approximately 7.5% of the rural personnel. The farming task of straw cutting

plays a crucial role in acquiring maize and jowar crops. Straw after harvesting gets transformed into pieces between 150-200 cm which provide animal feed for cattle, buffaloes, goats, and oxen. Manual performance of this work shows how important mechanization has become because it delivers inefficient results. The groundnut farming process demands intensive labor to divide nuts from plants since each acre requires between twenty and thirty workers which slows down the entire operation. Implemented mechanized systems would help decrease manpower requirements while improving operational productivity.[3][4].

- **Sugarcane Seed Cutting**

The nation of India stands among the top worldwide in sugarcane production because it consistently produces approximately 300 million tons annually. When planting occurs the stalks get cut into 5 to 6 sections which include 2 to 3 buds. A substantial group of workers needs to carry out this operation. The rural labor population consists of approximately 7.5% due to the 4 million people who work in sugarcane cultivation and associated labor efforts.

- **Groundnut Stripper**

The labor-intensive process of removing groundnut pods from the plants remains the main agricultural practice in Indian cultivation. Every acre requires 20–30 employees to complete the manual pod removal task that uses substantial time resources and labor. The proposed project develops an agricultural cutting machine which serves multiple purposes for resolving these existing challenges. The integrated machine unites groundnut stripping with straw cutting and sugarcane seed cutting features which prioritizes low operating expenses and simplified operation for farmers working with limited resources.

- **Straw Cutting**

Field workers cut straw leftovers from maize and jowar harvesting into short pieces for livestock feeding purposes including cows, buffaloes, oxen and goats. Manual workers decrease remaining stalks to sizes ranging from 150 to 200 centimeters. The reduction process takes both high physical effort and prolonged time duration.

2. Problem Statements

- **Labor Shortage** – The agricultural industry currently faces a severe labor deficit that occurs mainly during crucial crop care periods because rural workers moved to cities for better-paying jobs.
- **Time-Intensive Traditional Practices** – Traditional farming methods for sugarcane and groundnut require large commitments of time together with substantial labor which reduces both productivity and operational efficiency.
- **High Cost of Modern Machinery** – The high costs of modern farming equipment block small and marginal farmers from buying mechanization tools because of their limited financial capabilities.
- **Lack of Awareness and Accessibility** – Rural farmers face poor awareness alongside limited access to contemporary farm equipment and tools because of the low level of technological progress reached thus far.
- **Decline in Farmland Due to Urban Growth** – Agricultural land availability decreases because of urban growth which demands the use of efficient farming technology.
- **Risk of Mechanical Failures** – Farming equipment needs design features that decrease the probability of

mechanical breakdowns because equipment failures mean expensive maintenance along with production pauses.

- **Requirement for Equipment Optimization** – Finite Element Analysis (FEA) techniques should be used to validate and optimize farming equipment design because manufacturers need assurance for reliable performance under real field conditions.

3. Literature Review

- **Prof. Dipak U. Adhapure et al. [1]** The study explores an innovative method to enhance seed quality and reduce bulk by using excised axillary nodes of sugarcane, referred to as node chips. These are compact, easily transportable, and cost-effective. Node chip technology shows potential in accelerating the multiplication of new sugarcane varieties. The use of suitable plant growth regulators and nutrients can support initial growth. The authors proposed a pedal-operated sugarcane node cutter that allows efficient slicing of internodes, making better use of the sugarcane stalk, which is often wasted using traditional methods.
- **Krishna Prasad et al. [2]**
  This paper introduces a semi-automated machine designed for cutting sugarcane nodes. The developed device makes it possible to utilize approximately 1.8 tons of sugarcane stalk that would otherwise go unused in traditional practices. The machine reduces labor efforts and boosts productivity. Built on a mild steel frame, the setup helps separate buds efficiently. Traditionally, around 3 tons of sugarcane are used per acre for planting, out of which nearly half goes to waste. This machine reduces such wastage by enabling more efficient bud separation.
- **Suraj S. Magdum et al. [3]**
  The proposed design includes a platform with a pair of hemisphere chipping knives made from GI pipe, driven by a belt mechanism for speed control. Unlike conventional flat cutters that completely detach nodes, this design ensures a smoother and less wasteful node separation. GI blades with sliding tips increase cutting precision and blade lifespan. A cam and roller follower system transforms rotary motion into a reciprocating cutting action, powered by an electric motor. The setup is capable of cutting around
  30 buds per minute and can accommodate various sizes and diameters of sugarcane stalks.
- **Sanjay Patil et al. [4]**
  The study highlights the inefficiencies of traditional sugarcane planting methods, which are labor-intensive and require a large volume of stalks per hectare. The authors propose the integration of machine vision and image processing technologies to identify and isolate nodes for mechanical planting. This approach aims to streamline the planting process and reduce dependency on manual labor while improving the precision of bud placement in the field.
- **Ashish S. Raghtate et al. [5]**
  The authors developed a cost-effective groundnut sheller machine, targeted at small-scale farmers and local entrepreneurs. Five experimental trials demonstrated that the device is significantly faster and more economical compared to manual methods or alternative techniques. This innovation notably cuts down time, labor, and energy input, offering a substantial reduction in overall project

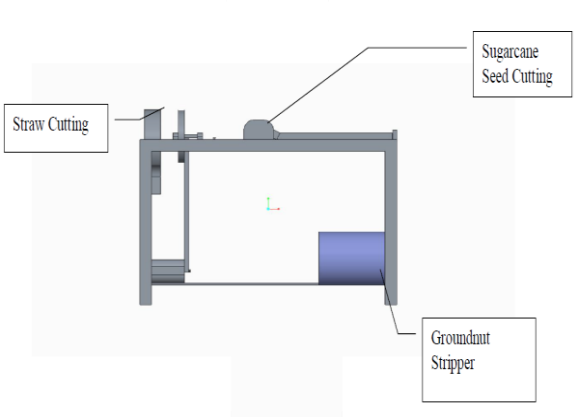
costs—an important advantage in today's cost-conscious economy.

- **Javeed Basha et al. [6]**
  This study presents the fabrication and evaluation of an ultra-portable crop cutting machine. The goal was to enhance operational efficiency and profitability by reducing the expenses associated with manual cutting processes. The equipment is designed to handle different crop types during the harvesting period, providing a solution to labor shortages and related fieldwork issues.
- **Adarsh J. Jain et al. [7]**
  A compact, user-friendly groundnut decorticator machine was developed, operating on a 1 H.P. electric motor. The device is aimed at beginner farmers or entrepreneurs with limited investment capacity. The decorticator is equipped with essential components such as a feed hopper with flow control, a shelling unit, separation system, and power supply. The machine offers increased productivity with low initial cost
- **Abel Roy J. et al. [8]**
  This research investigated the energy and force requirements for cutting pigeon pea stalks. A commercially available blade was mounted on a pendulum-type dynamic tester to simulate cutting at a 90° angle to the stalk axis, with knife speeds ranging from 2.28 m/s to 7.23 m/s. Tests conducted at 42.6% moisture content revealed that cutting force is directly related to the cross-sectional area of the stem. A specialized stem cutter was designed based on this data.

Research Gap –

The analysis of agricultural machinery structure and safety continues to experience missing data about factors affecting sugarcane seed cutters as well as straw cutters and groundnut stripping machines. Indian economy depends fundamentally on agriculture as a base industry which will continue to be essential for the coming years. Research into operator safety with improved machine reliability requires comprehensive evaluation of equipment stress levels together with strain and deflection throughout its operational phase. The evaluation depends on CAD modeling and ANSYS simulations to study stress distribution, deformation and safety factor and static structural integrity. The early application of simulation methods helps identify future breakdowns that could affect the product during its field use which leads to decreased risks and performance improvements.

4. Research Methodology



A multifunctional agricultural machine was conceptualized and fabricated to carry out three primary operations:

- Sugarcane seed cutting
- Groundnut stripping
- Straw cutting

The machine components are mounted on a durable frame, fitted with wheels to allow easy movement across the farm. This design enables the machine to function under various field conditions.

A. Sugarcane Seed Cutting

A single-phase motor starts the system with 1400 RPM then transforms into a speed of 700 RPM through a belt and pulley mechanism before the gearbox uses its 1:30 worm and worm wheel ratio to lower it to 23 RPM. The speed lowers first to 700 RPM with a belt-pulley system before dropping to 23 RPM through an apparatus featuring a 1:30 ratio of worm and worm wheel gears. A cam attached to the gearbox converts its rotational movement into reciprocating motion to drive the cutter.

Similar to other crops sugar cane requires manual feeding followed by processing with the reciprocating cutter. The return stroke of the mechanism allows for collection of the released sprouts after which the cutting process continues without interruption.

B. Groundnut Stripper

A single-phase motor starts the system with 1400 RPM then transforms into a speed of 700 RPM through a belt and pulley mechanism before the gearbox uses its 1:30 worm and worm wheel ratio to lower it to 23 RPM. The speed lowers first to 700 RPM with a belt-pulley system before dropping to 23 RPM through an apparatus featuring a 1:30 ratio of worm and worm wheel gears. A cam attached to the gearbox converts its rotational movement into reciprocating motion to drive the cutter.

Similar to other crops sugar cane requires manual feeding followed by processing with the reciprocating cutter. The return stroke of the mechanism allows for collection of the released sprouts after which the cutting process continues without interruption.

C. **Straw Cutting**

The machine possesses a dual blade design which connects to motorized power through driving belts in a circular arrangement. The machine operates at quick speeds by rotating blades that produce fine segments from straw material. The machine contains a hopper which features an integrated fast cutting unit driven by a motor with rotary speed of 10,000 RPM. Quick and efficient cutting of diverse crop stalks becomes achievable through this system which improves the machine's performance for agricultural use.

5. Components Required

A. **Power Source (Motor):**

The electrical power conversion into mechanical work through motors operates best in situations where the activity demands light- duty operations. In this machine, a 1 HP motor operating at 1400 RPM serves as the main power source. The majority of fixed-speed applications employ these motors yet they can operate under variable speeds when connected to variable frequency drives.

A. Gearbox:

The gearbox employs two functions to decrease motor speed along with torque growth. Better control requires the gearbox to modify shaft rotational speed. The system implements a worm gear arrangement having shafts at a right angle position. One roundworm rotation produces one tooth advancement in the gear thus creating a system that is small and effective for torque strength increase.

B. Shaft:

A solid mild steel shaft performs power transmission at 1440 RPM. The shaft works as an interconnecting link which provides efficient torque-controlled rotation between the power supply and active machine elements.

C. V-Belt Pulley:

The transmitting system uses V-belt pulleys to connect the motor to the cutter blade shaft which distributes power efficiently. Power transfer performs better with multiple V-belts than with the single belt configuration due to their flexibility capabilities.

D. Universal Joint:

The joint enables rotary motion transmission between shafts that have misalignment issues. The cross shaft links two perpendicular hinges to facilitate precise motion transmission between off-angle shafts.

E. Pedestal Bearing:

Long rotating shafts obtain intermediate support from pedestal bearings. The smooth rotation of the system depends on these bearings that also preserve critical shaft alignment.

F. Clutch:

The machine features a manually control clutch used to turn power on and off for the groundnut stripping equipment. The manual clutch system helps the equipment start without shock to the motor and safeguards it from sudden heavy power usage.

6. Advantages, Disadvantages, and Applications of the Machine

A. Advantages

1. The system decreases the requirement for human employees therefore decreasing operational expenses.

2. Minimizes wastage during sugarcane processing.

3. The straightforward construction design provides builders with simplicity in their tasks.

4. Maintenance requirements are minimal.

5. Operation efficiency raises through time savings.

6. The system operates without creating any harmful air pollutants which leads to an environmentally friendly operation.

B. Disadvantages

1. The weight of the machine hinders mobility to some extent.

2. Operation of the machine creates loud noise at high volume levels.

C. Applications

1. The principal application of this machine occurs in agricultural fields during crop-based processing.
2. Educational organizations such as agricultural colleges and schools should use this technology to show modern farming methods and equipment to their students.
3. The device serves as an educational tool for enhancing student comprehension of modern farming techniques during mechanized operations.

7. Conclusion

The developed multi-purpose agricultural machine integrates three agricultural operations including sugarcane seed cutting and groundnut shelling together with straw cutting into one equipment. The machine reduces operator demand at work while performing tasks at higher efficiency. This single unit machine gives three benefits of time savings with less waste in each process. This machine provides three essential functions: it produces clean sowable seeds from sugarcane and performs groundnut shelling with one operator and it completes straw processing while minimizing waste in all three operations. When widely used this machine will reduce farm costs while improving processing efficiency and boosting agricultural productiveness for farmers.

8. Reference

[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." IJIRSTInternational 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 International Journal of New Technologies in Science and Engineering 2.

[17] 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.

[18] PG Mehar, L Misal, S Donadkar, A Sukhadev, S Tonge, S Gotmare, Design and Fabrication of MultiPurpose Cutting Machine for Agricultural Uses.

[19] PG Mehar, L Misal, S Donadkar, A Sukhadev, S Tonge, S Gotmare, A Review on Design of Multipurpose Cutting Machine for Agricultural Uses.

[20] PG Mehar, VD Dhopte, Experimentations and Productivity Analysis of Power Operated Sheet Bending Machine. 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
International Journal of New Technologies in Science and Engineering 2.

[17] 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.*

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

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

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