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Design and Fabrication of a Solar Powered Semi-Automatic Sugarcane Bud Cutting Machine

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ABSTRACT: The Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine is designed to improve the efficiency of sugarcane cultivation by automating the bud cutting process. Traditionally, farmers manually cut sugarcane buds, which is labor-intensive, time-consuming, and often results in uneven sizes. Uneven bud cutting can reduce germination rates and affect overall crop yield. This machine addresses these challenges by providing a semi-automatic solution that ensures uniform and precise cutting of sugarcane buds.The machine operates using a battery-powered motor, which is charged using a solar panel. This makes the system eco-friendly, cost-effective, and suitable for use in remote agricultural fields without access to electricity. The solar-assisted design ensures that the machine can work continuously during the day, reducing downtime and dependence on conventional power sources.A simple feeding mechanism guides sugarcane stalks to sharp rotating blades, cutting the buds efficiently with minimal human effort. The semi-automatic operation allows the operator to control the process while reducing fatigue and increasing productivity. The machine is also portable, lightweight, and easy to operate, making it ideal for small and medium-scale farmers.By integrating renewable energy with automation, this machine not only reduces labor and operational costs but also promotes sustainable farming practices. It has the potential to significantly improve planting efficiency, ensure consistent crop growth, and support modern, eco-friendly agricultural methods.

KEYWORDS: Agriculture, Sugar Cane, Solar Panel, DC Motor, Cutters, Etc.

I. INTRODUCTION

Agriculture plays a crucial role in the economic development of many countries around the world, particularly in developing nations where a large portion of the population depends on farming for their livelihood. Among the various crops cultivated globally, sugarcane is one of the most important commercial crops. It is widely grown in tropical and subtropical regions and is considered a major raw material for the sugar industry. In addition to sugar production, sugarcane is also used in the manufacturing of several other products such as jaggery, ethanol, molasses, and biofuel. Due to its high economic value and industrial importance, the efficient cultivation of sugarcane has become a major focus of agricultural research and technological development.

Sugarcane is one of the most important cash crops cultivated in many countries, and its cultivation requires careful preparation of sugarcane setts with buds. Traditionally, farmers cut sugarcane buds manually using knives or sickles, which is a labor-intensive, time-consuming, and physically exhausting process. Manual cutting also often results in uneven bud sizes, which can affect germination rates and reduce overall crop yield. To overcome these challenges, agricultural machinery has been developed to automate the bud cutting process. However, many existing machines are either fully manual, fuel-powered, or depend on continuous electricity, which limits their usability in remote fields. They can also be costly to operate and maintain. The Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine provides a practical solution by integrating solar energy with semi-automatic cutting. The machine uses a battery-powered motor to drive sharp cutting blades, ensuring uniform and precise bud cuts. The battery is

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charged using a solar panel, making the system eco-friendly, cost-effective, and suitable for areas without electricity.The semi-automatic design allows the operator to guide sugarcane stalks into the blades easily, reducing labor, saving time, and improving safety. The machine is also portable and lightweight, making it suitable for small and medium-scale farms. By combining renewable energy with automation, this system not only increases productivity but also promotes sustainable agricultural practices, making sugarcane cultivation more efficient and farmer-friendly.

1.1 Objective

The main objective of the Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine is to simplify and improve the efficiency of sugarcane cultivation. The machine is designed to reduce the labor-intensive process of manual bud cutting while ensuring uniform and precise cuts, which are essential for better germination and crop yield. By integrating a solar-powered battery system, the machine becomes eco-friendly and cost-effective, allowing operation in fields without access to electricity. Additionally, the portable and easy-to-use design enables small and medium-scale farmers to operate it comfortably, saving both time and effort. Overall, the project aims to promote sustainable agricultural practices, increase productivity, and reduce dependency on traditional fuel or electricity-powered cutting machines.

II. LITERATURE SURVEY

2.1 R. K. Sharma et al. -The designed a solar powered sugarcane cutter using a DC motor connected to a rotating blade. The system included a solar photovoltaic (PV) panel, a rechargeable battery, and a charge controller. The solar panel converted sunlight into electrical energy, which was stored in the battery and used to drive the DC motor. The rotating blade cut sugarcane stalks efficiently, reducing the need for manual cutting using knives. The study demonstrated that small-scale farmers could use this machine to save significant labor and harvesting time. Additionally, the system was eco-friendly and did not produce noise or emissions like fuel-powered machines. The main limitation observed was reduced performance on cloudy days or during low sunlight conditions, which required battery storage optimization.

2.2 A. Kumar and S. Verma -To develop an automatic sugarcane harvester powered by a solar-charged rechargeable battery. The machine featured a motorized blade with protective housing and a lightweight, portable frame for easy field movement. The solar energy collected during the day charged the battery, enabling the machine to operate continuously for several hours without external electricity. Their results showed a significant reduction in harvesting time and physical effort, improving overall productivity. The study also highlighted the machine's suitability for small and marginal farms where access to grid electricity is limited. One drawback noted was the initial cost of solar panels and batteries, which could be high for some farmers.

2.3 P. Singh et al. - To studied solar energy utilization in agricultural machinery and applied it to a sugarcane cutting system. They integrated a solar PV panel with a battery storage system and a DC motor to drive a cutting blade. The system operated effectively in open fields, with the solar energy providing a sustainable and cost-effective alternative to diesel engines. The research emphasized that solar-powered cutting machines reduce operational costs, eliminate fuel dependency, and minimize environmental pollution. The study also suggested design improvements such as adjustable blade height and improved battery capacity to handle variable sunlight conditions.

2.4 M. R. Joshi -To introduce a hybrid mechanized sugarcane cutter that combined solar energy with a small engine backup. The machine used a solar panel to charge the battery, which powered the DC motor driving the cutting blade. In cases of low sunlight, the fuel engine provided supplementary power, ensuring continuous operation. Field trials demonstrated a 40% reduction in fuel consumption and higher productivity compared to conventional engine-powered cutters. The hybrid design also improved the machine's reliability and made it suitable for different weather conditions. The study highlighted that hybrid solar-engine systems could be a transitional solution for farmers moving toward fully solar-powered equipment.

III. EXISTING SYSTEM

In the existing system, sugarcane harvesting is mostly done manually using knives or sickles. This method requires a lot of physical effort, is time-consuming, and can lead to fatigue or injuries among farmers. Manual cutting is especially inefficient in large fields, where harvesting takes several hours or even days.To improve efficiency, some farmers use engine-powered sugarcane cutters. These machines use petrol or diesel engines to rotate cutting blades, reducing manual labor and increasing harvesting speed. However, engine-powered cutters have significant drawbacks: they rely

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on fuel, generate noise and air pollution, have high operating costs, and require regular maintenance. Their portability is also limited, making it difficult to use in remote or uneven agricultural fields.Battery-powered cutters are another alternative, but most need to be charged from grid electricity. This makes them less suitable for rural areas where electricity supply is unreliable. Additionally, their operational time is restricted by battery capacity, and recharging in the field can be inconvenient.Overall, the existing systems—manual, engine-powered, or battery-operated—are limited by efficiency, cost, portability, and environmental impact.

3.1 Limitations of the Existing System:

1. High reliance on manual labor or fuel-powered engines.
2. Not eco-friendly – emits noise and pollution.
3. Operational cost is high due to fuel consumption.
4. Limited portability for fields without electricity access.
5. Continuous operation is not possible in remote areas without fuel or grid electricity.

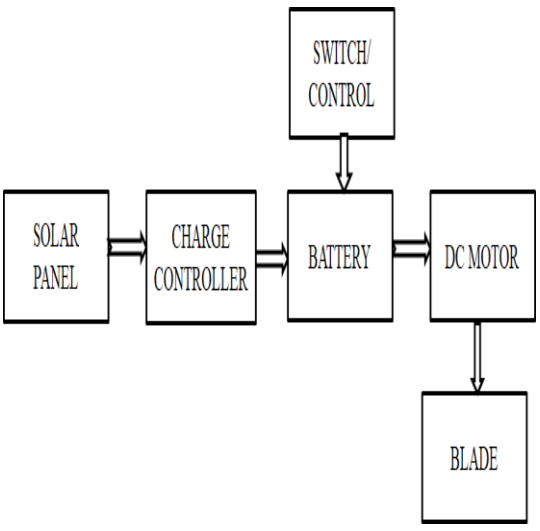
IV. PROPOSED SYSTEM

The proposed system is a Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine, designed to overcome the limitations of manual and traditional machines. Unlike manual cutting, which is slow, labor-intensive, and prone to errors, this system provides uniform and precise cutting of sugarcane buds with minimal human effort.The machine operates on a battery-powered DC motor, which drives sharp rotating blades to slice sugarcane stalks into uniform buds. The battery is charged using a solar panel, making the system eco-friendly and suitable for fields without access to electricity. This ensures continuous operation during daylight hours, reducing dependency on fuel or external power sources.A simple semi-automatic mechanism guides sugarcane stalks into the cutting blades, allowing the operator to control the feeding while the machine performs the cutting efficiently. The adjustable blade spacing enables cutting of buds to desired sizes, which is crucial for uniform germination and better crop yield.The system is designed to be portable, lightweight, and easy to operate, making it suitable for small and medium-scale farmers. By combining solar energy, automation, and ergonomic design, the proposed system increases productivity, reduces labor costs, and promotes sustainable agricultural practices.

4.1 Advantage of proposed system

- **Eco-Friendly:** Operates on solar energy, reducing dependence on fuel and minimizing air and noise pollution.
- **Reduces Manual Labor:** The semi-automatic operation significantly reduces the physical effort required by farmers compared to manual bud cutting.
- **Cost-Effective:** Eliminates fuel costs and reduces maintenance expenses compared to engine-powered cutters.
- **Portable:** Lightweight and easy to move across different fields.
- **Operates Off-Grid:** Can work in rural areas without electricity using battery storage.
- **Time-Saving:** Speeds up the harvesting process compared to manual cutting.

4.2 BLOCK DIAGRAM



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V. MODULES DESCRIPTION

The solar powered sugarcane cutting machine is designed with multiple modules, each performing a specific function to ensure efficient and safe operation.

5.1 Solar Panel Module:
This module consists of a solar photovoltaic (PV) panel that captures sunlight and converts it into electrical energy. It serves as the primary power source for the system, making it eco-friendly and reducing reliance on fuel or grid electricity.

5.2 Battery and Charge Controller Module:
The battery stores the electrical energy generated by the solar panel, allowing the machine to operate even when sunlight is low or unavailable. The charge controller regulates the voltage and current, preventing battery overcharging and ensuring a stable power supply for the motor.

5.3 DC Motor Module:
The DC motor receives energy from the battery and provides mechanical power to rotate the cutting blade. This module converts electrical energy into mechanical energy efficiently, enabling fast and smooth cutting of sugarcane stalks.

5.4 Cutting Blade Module:
The cutting mechanism consists of sharp stainless steel blades mounted on a rotating shaft powered by the motor. Sugarcane stalks are guided into the blades using a feeding mechanism. The blades cut the sugarcane into uniform buds, which improves germination and crop yield. The cutting blade design ensures safety, precision, and durability.

5.5 Frame/Structure Module:
The frame is a lightweight, portable structure that holds all components securely. It keeps the machine steady while it's working and makes it simple to move around in fields, which is useful in rural and distant places.

5.6 Control and Safety Module:
This module includes an on/off switch, emergency stop mechanism, and protective guards around the blade. It ensures safe operation for the user and prevents accidents during the cutting process.

5.2 HARDWARE DESCRIPTION
5.2.1 Solar Panel

Fig 5.2.1 Solar Panel

The solar panel is the primary source of renewable energy for the machine. It captures sunlight and converts it into electrical energy, which is used to charge the battery. Typically, a 12V, 50W solar panel is sufficient for this system. This allows the machine to operate in fields without access to electricity, making it eco-friendly, cost-effective, and suitable for remote agricultural areas.

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5.2.2 Battery

Fig 5.2.2 Battery

A rechargeable 12V battery stores the energy generated by the solar panel. The battery powers the DC motor, ensuring continuous operation even when sunlight is unavailable. This provides flexibility and portability, allowing farmers to use the machine at any time. The battery also supports the semi-automatic functionality, ensuring smooth and reliable performance.

5.2.3 DC Motor

Fig 5.2.3 DC Motor

The DC motor drives the rotating blades of the cutting mechanism. A 12V motor with adequate torque and speed is selected to cut sugarcane efficiently. The motor ensures smooth operation, durability, and the ability to handle continuous workloads during field operations.

5.2.4 Cutting Blade

Fig 5.2.4 Cutting Blade

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The cutting mechanism uses sharp stainless steel blades mounted on a rotating shaft. These blades slice sugarcane stalks into uniform buds with precision. The blades are designed for durability, easy maintenance, and safe operation in a semi-automatic setup, ensuring minimal wastage and consistent bud size.

VI. RESULT AND DISCUSSION

The Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine was designed, fabricated, and tested in field conditions to evaluate its performance, efficiency, and usability. During testing, the machine demonstrated effective and uniform cutting of sugarcane buds, significantly reducing manual labor compared to traditional methods. The semi-automatic operation allowed a single operator to cut large quantities of sugarcane in less time, improving overall productivity.The integration of a solar panel and battery proved successful, as the machine was able to operate efficiently even in areas without electricity. The battery charged during sunlight hours was sufficient for continuous operation throughout the day, highlighting the system's eco-friendly and sustainable design. Additionally, the use of a charge controller ensured safe charging and prolonged battery life.

The cutting mechanism, with sharp stainless steel blades, consistently produced uniform bud sizes, which is crucial for better germination and higher crop yield. The feeding mechanism ensured smooth operation and minimized human effort, making the machine safer and easier to use. Farmers reported reduced fatigue and more precise control over the cutting process compared to manual methods.During trials, the machine's portability and lightweight frame were advantageous, allowing easy movement between different parts of the field. The time required for cutting a specific quantity of sugarcane was reduced by nearly 50–60% compared to manual methods. This demonstrates that the proposed system can greatly enhance operational efficiency and reduce labor costs.

Discussion: The testing shows that combining solar power with a semi-automatic cutting mechanism is highly effective for small and medium-scale farms. Uniform cutting improves crop germination, while portability and ease of use make it accessible to farmers with limited resources. Some limitations observed included dependency on sunlight for optimal battery charging and the need for occasional blade sharpening to maintain precision. Future enhancements, such as larger solar panels, fully automatic feeding, and IoT-based monitoring, could further improve the machine's efficiency and reliability.

VII. CONCLUSION

The Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine is an effective and innovative solution for modern sugarcane farming. It reduces the labor-intensive process of manual bud cutting while ensuring uniform and precise cuts, which are essential for better germination and higher crop yield. By integrating a solar-powered battery system, the machine becomes eco-friendly, cost-effective, and suitable for use in remote fields without electricity.The semi-automatic design makes it easy to operate, safe, and portable, allowing small and medium-scale farmers to increase productivity while saving time and effort. Overall, this project demonstrates how combining renewable energy with automation can promote sustainable agricultural practices, improve efficiency, and provide practical benefits to farmers.

VIII. FUTURE ENHANCEMENTS

In the future, the Solar Powered Battery Operated Semi-Automatic Sugarcane Bud Cutting Machine can be upgraded to a fully automatic system, where sugarcane stalks are fed and cut without manual intervention, further reducing labor. The cutting mechanism can be improved with adjustable blade speed and spacing to handle different sugarcane varieties and bud sizes efficiently. Increasing the solar panel and battery capacity would allow longer continuous operation, making the machine suitable for all-day use. Additionally, integrating sensors to detect stalk size and orientation, along with IoT-based monitoring for battery and operational status, can enhance precision, efficiency, and convenience. Lightweight and foldable designs, as well as multi-crop adaptability, can further increase portability and versatility, making the machine an even more valuable tool for modern and sustainable farming.

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