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Need, Scope And Development Of Battery-Operated Sensor Based Sugarcane Cutting System For Planter

Ashutosh Mishra[1], Ramesh Pal[2], Swati Singh[3], N.C. Shahi[4], Shivani Baliyan[5] and Gargi Shekhar[6]

[1&2] School of Agricultural Sciences and Engineering, IFTM, University, Moradabad Uttar Pradesh, India
[3]Applied Science, SCRIET, CCSU, Meerut, Uttar Pradesh, India
[4] MCAET Ambedkar Nagar,Uttar Pradesh, India
[5]School of Agriculture, Dev Bhoomi Uttarakhand University, Dehradun. India
[1]Corresponding Author- ashutoshiisr@gmail.com

ABSTRACT

Sugarcane planting is traditionally a labour-intensive process that involves significant physical effort. However, mechanized planting methods offer a more cost-effective alternative to traditional practices, reducing both the labor requirements and the physical strain associated with planting. India plays a crucial role in global sugarcane production, contributing 1325% to the world's total and 41.11% of Asia's output. The country cultivates sugarcane on approximately 4.10 million hectares, producing 300.25 million tonnes of cane and 18.90 million tonnes of sugar annually. This study focuses on evaluating various performance parameters of a Ground wheel and PTO-operated sugarcane cutting mechanism planter. Key aspects under examination include the length of cane sets, the number of sets planted, the occurrence of damaged buds, the spacing between sets, and field efficiency. The planter is tested at three different PTO speeds-1250, 1350, and 1450 RPM to assess how these variations impact planting performance and efficiency. In both the above methods, power is given from the ground wheel of the tractor or the PTO, due to which sometimes the PTO keeps running and cutting continues. The tractor remains stopped or the tractor keeps running and due to some reason, the ground wheel is not able to run and the cutting remains stopped due to which there is a possibility of gapping, not cutting the sett properly and getting damn. Given the above problems, a new system is being developed.

Keywords: *Sugarcane, Semiautomatic Planter, Power take-off unit, sensor, wholesale Planter, Set Cutting Blade tractor operated, India.*

1. INTRODUCTION

The agricultural sector has seen tremendous improvement with the introduction of novel technologies to boost productivity, efficiency, and sustainability. The adoption of sensor-based battery-operated systems for some specific tasks in agriculture like sugarcane cutting can be huge. Sugarcane planting is very labor intensive and time consuming for planters. It causes a shortage of labor, ineffectiveness, and a rise in operational costs. This modern solution presents an automated harvesting process through a sensor-based battery-operated sugarcane cutting system.

It has highly advanced sensors that recognize the sugarcane stalk and cuts them with minimal wastage and maximal efficiency in terms of quality yield. This design battery also cuts off the fossil fuels to use in its operations and thus makes the whole process more environmentally friendly with low carbon emissions compared to other mechanical harvesters. Lastly, the portability and the ease of use have made it easily accessible to small farmers who cannot afford the usage of heavy machinery.

While operational efficiency is the scope that brings this technology forward, it makes agriculture more sustainable by increasing resources and bringing down manual input into it. In addition, with the IoT aspect being brought in, this would make it better for its functionalities because this will allow it to have real-time monitoring, data collection, and analysis, which will consequently help in the decision-making process; the farmer would be able to check up on performance, predict maintenance, and prolong the life of equipment.

It is a giant leap towards increasing the emphasis on precision agriculture and sustainable farming. As such, this sensor-based, battery-operated sugarcane cutting system will revolutionize the sugarcane industry, allowing planters to break free from traditions and join the bandwagon of modern agricultural trends-it not only addresses current issues but also lays down an excellent foundation for a better, more resilient, and efficient future in farming.

2. REVIEW OF LITERATURE

Guerra et al. (2018) researched to analyze the application of handheld EDXRF for in situ determination of potassium (K), calcium (Ca), sulfur (S), and silicon (Si) in fresh sugarcane leaves. The result from my research showed that this method gave a quick and non-destructive analysis of the concentrations of nutrients in sugarcane crops. Thus, it is deduced that EDXRF will be a good technique to monitor real-time nutrition conditions in crop cultivation. With EDXRF, this practice in sugarcane will increase its effective management in sugarcane cultivation.

Kituu (2001) focused on designing, fabricating, and testing a sugarcane farm furrower. The study's objective was the development of a mechanized furrowing solution in sugarcane farming. The development process of the equipment is captured in technical specifications, as well as its performance during field tests. The outcome of the experiment showed that the furrower actually improved planting efficiency and decreased the amount of labor required. This is the most pressing issue of sugarcane farming practice.

Meniketti (2015) investigated the historical and environmental consequences of sugarcane plantation during colonial Nevis in West Indies through an archaeological approach. The current study exhaustively researched the manner in which this mode of capitalism affected both changes in the environment as well as the structures in society during the period of colonization. Focusing the approach on archaeological data along with the historical record brought forward complex relationships between agriculture practice and environmental degradation inside the colonial economic system. This work underlined long-term impacts of sugarcane farming on both landscapes and human communities.

Mohanaselvan et al. (2024) examined mechanization levels and occupational health hazards with regard to sugarcane farming in India. In the present study, they noted that although some phases of sugarcane cultivation were increasingly mechanized; however, various operations remained chiefly manpower-intensive. This even posed considerable risks with respect to occupational health for the large number of those manpower resources involved, which include musculoskeletal disorders along with unfavourable climatic conditions. Further research stated that there was a need to mechanize sugarcane production and implement various preventive health measures to reduce risks towards health and improve conditions about working.

Mulope (2023) conducted a historical analysis on labor migration of Nakambala sugarcane cutters at Mazabuka District from the time starting in 1964 till 2017. Such a paper was to identify the socio-economic determinants of labor migration, including the working conditions of cutters, and long-term community impacts.The study identified that labor migration is a cyclical process and its implications for migrant workers' livelihoods underscore the need for policy interventions that consider labor rights and socio-economic disparities.

Nihei et al. (2015)looked into how sugarcane is grown in São Paulo, Brazil. It showed the different ways sugarcane is grown according to how land is used, the system applied and the yield. Challenges in the industry dealing with both environment and the economy were studied. It was found that sugar cane in São Paulo was mostly planted using technical tools, yet its contribution to Brazil's output raised environmental and resource issues.

3. SUGARCANE PLANTING

Setts are stem cuttings from sugarcane plants used in the process of planting after growing a new bud or two. Frederick Douglas rye is placed in furrows, either level or slightly sloping and is 8–10 cm deep, with plants spaced about 75–90 cm apart. Generally, planting should be done in spring or autumn, depending on your area's weather and the amount of water available. Before any planting begins, the land has to be deeply ploughed, harrowed and levelled so that water and air can drain through properly. Rich organic matter is important in the soil and fertilizers and compost are often added to increase how fertile the soil becomes. You should make sure the buds are planted in the proper moisture for quick and healthy germination.

The sugarcane plant needs to be watered frequently during times of little or no rain. Usually, after a week, germination starts and one set can bring out numerous shoots. At the start, you have to pay special attention to weeds, because they could compete with the baby plants for food, light and water. Common methods for controlling weeds used by farmers include hand weeding, covering soil with mulch or applying herbicides. It is essential for growth to practice earthing up as well as to apply fertilizers at strategic times. Good management methods help sugarcane produce a tall main stalk which is ready for harvesting after 10 to 16 months depending on the type and weather.

3.1. Types of sugarcane planting

3.1.1. Sugarcane manual planting

Sugarcane planting is made efficient through the traditional act of cutting sugarcane manually. It is widely practiced whenever there are no machines for large-scale farming and local farmer's hand-collect sugarcane to be used as seed. Because sugarcane comes from cuttings, the right ways to cut it make it easier for the buds to grow.

Figure 1: Sugarcane manual planting

- **Tools and Techniques**

It is common for farmers to use machetes or sickles to gather sugarcane when it's ready to harvest. Cut the celery stalks low to the soil and cut away both the tops and roots to maximize the amount you can eat. After that, each stalk is separated into smaller sections, called setts which are usually about 30–45 cm long. There should be 2–3 healthy buds on your setts for proper germination. If cutting is done with care, buds are safer and healthier for your crop.

- **Advantages and Challenges**

In landscapes with unusual features or on small areas, using hand tools works better than using machines. The process doesn't require much money, making it a great option for small farmers. Yet, the process requires a lot of effort, takes a lot of time and can be exhausting. Correct guidance and updated tools help decrease these issues, make work easier to do and maintain safety.

- **Best Practices**

Picking strong and healthy parent plants that are free from pests helps you achieve more yields. Farmers should remove and replant sugarcane quickly in hot areas to avoid drying. Staking my stalks and keeping them in a shaded spot before planting helps them remain viable.

Figure 2: Traditional sugarcane tools

3.1.2. Sugarcane Sett Cutting Machine for Planting

The sugarcane sett cutting machine helps to automate the way sugarcane stalks are prepared for planting. By the machine doing the cutting, growers can save time and improve the accuracy of cutting sets meant for propagation. Since sucrose-cane is propagated with plant parts known as setts, each set should be cut carefully to help all the sugarcane grow uniformly and produce good yields.

- **Working Principle**

Most sugarcane sett cutting machines come with feed rollers, sharp blades and a way to adjust the size of the sett. The machine feeds the sugarcane stalks and cuts them all to an average of 30–45 centimetres so they have the required buds. Some machines have ways to take leaves off and remove bad portions, providing neat and healthy setts for planting.

- **Advantages**

- **Efficiency**: The machine significantly reduces the time and labor required to prepare planting material, making it ideal for large-scale operations.
- **Precision**: Uniform cutting ensures all sets are of consistent size and quality, improving germination rates.
- **Cost-Effectiveness**: While the initial investment in a machine may be high, it reduces long-termlabor costs and enhances planting efficiency.
- **Reduced Wastage**: By minimizing damage to the buds and cutting precise lengths, the machine reduces material wastage compared to manual methods.

- **Applications and Suitability**

Sett cutting machines are valuable in large sugarcane plantations since manual workers can be easily overworked or too slow. These robots prove useful in places where highly skilled workers are hard to find or labor is expensive.

- **Challenges**

Even with all its advantages, the machine needs to be maintained regularly so its blades stay sharp and all its parts function smoothest. Buying this type of machinery is often difficult for people who farm on a small scale. Still, sharing the work with other farms or getting government support can help more people use these technologies.

3.1.3. Sugarcane cutter planter with disc type (DTSCP)

The DTSCP has two disks of 65 centimeter diameter, each placed beside the other to form V-shaped furrows suitable for planting sugarcane. The discs are designed to stand on the land at a 20° angle and a 15° inclination, supporting good soil penetration and furrow making.

The system lets users change the spacing between the discs to a range of 750 mm – 900 mm to suit the fields they are using. Both blades move in opposite directions and are sharpened at the bottom to prevent laborers from feeling an upward force on the canes. As a result, the cutting action is exact and disturbance-

free. It is constructed for use by two operators, with two seats so that laborers can provide a continuous supply of sugarcane to be planted.

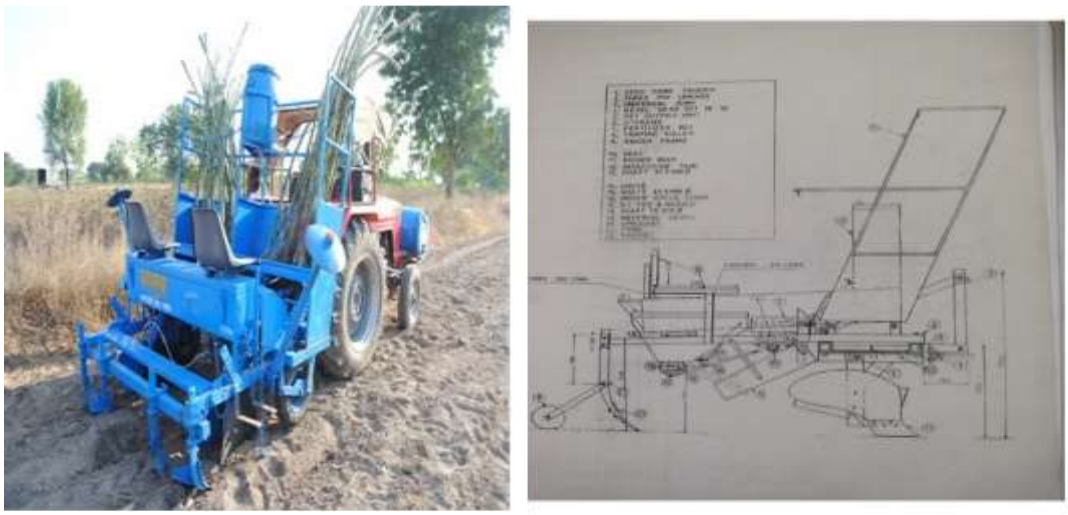

Figure 3: Ground Wheel Operated Sugar Cane Planter

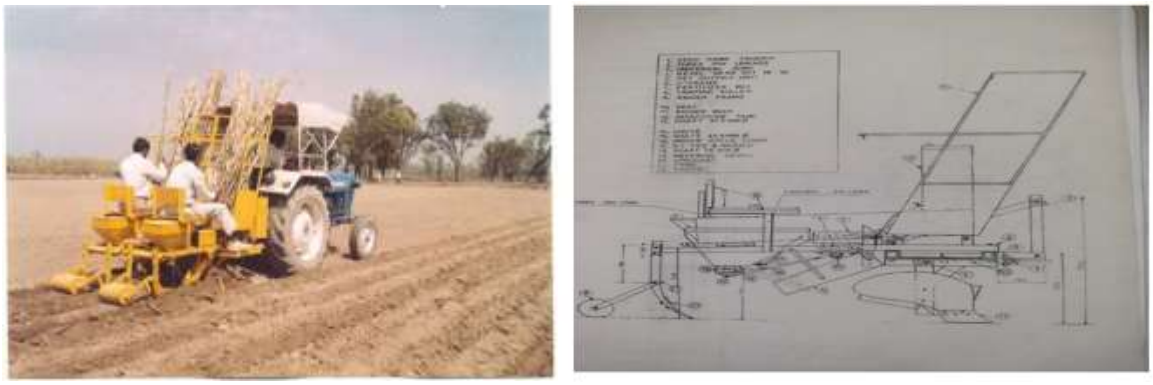

Figure 4: Power take off operated (PTO) Sugar Cane Planter.

These figures 3 and 4 demonstrate the two operational types of DTSCP used in mechanized sugarcane planting.

4. NEW SYSTEM–BATTERY OPERATED SUGARCANE CUTTING MECHANISM FOR PLANTER

The battery-operated sugarcane cutting machine developed for planters improves the planting of sugarcane by making it more efficient and accurate. The new system switches from manual or diesel cutters to an electric device that uses rotating blades or shears to evenly cut the sugarcane setts used for planting. Most gardeners put the device on a portable frame or attach it to a planter machine, so it can move easily across broad areas. Environmentally and financially, using a rechargeable battery system helps because it brings down the use of fossil fuels and cuts both air and noise pollution. Besides, safety features are included, for example blade guards and devices that turn the machine off automatically if it becomes unsafe while it runs.

The new approach increases the speed and accuracy of settle preparation; guaranteeing cuttings are the same length with the edges clean, both leading to improved germination and plant success. Because the system automates the cutting stage, workers need less effort and fewer people, making sugarcane farming

easier for smaller farmers. Besides, it makes it possible to cut and drop stones into planting furrows together which can be matched with other planter parts for smooth planting. On a single charge, the battery lasts for many hours and lithium-ion updates have increased both its durability and how well it performs. On the whole, the battery-operated method is a major advance toward making sugarcane farming more mechanized and more sustainable.

4.1. Working Principle of new developed system

A sugarcane cutting and dispensing machine is operated automatically and efficiently for the best possible results. To begin, the operator puts a sugarcane stem into a tube two inches in diameter and seven feet long. The sensors have been positioned to notice when sugarcane is present in the pipe. Following detection, an actuator is turned on to balance the stem so it stays still when the cut is made. With the press of the button, a motor drives a spinning blade to slice your material at the required length. This ensures that all cut sections are uniform and suitable for sowing purposes. Following the cut, the bottom opening of the pipe, which is initially closed to hold the sugarcane segment in place, is controlled by a motor-driven sliding mechanism. This mechanism opens the gate, allowing the cut section to slide outeither by gravity or assisted ejectioninto a collection area. Once the segment is dispensed, the bottom gate automatically closes, resetting the machine for the next operation. The machine then returns to its initial state, awaiting the insertion of the next sugarcane stem, and the cycle continues seamlessly until all the sugarcane stems are processed.

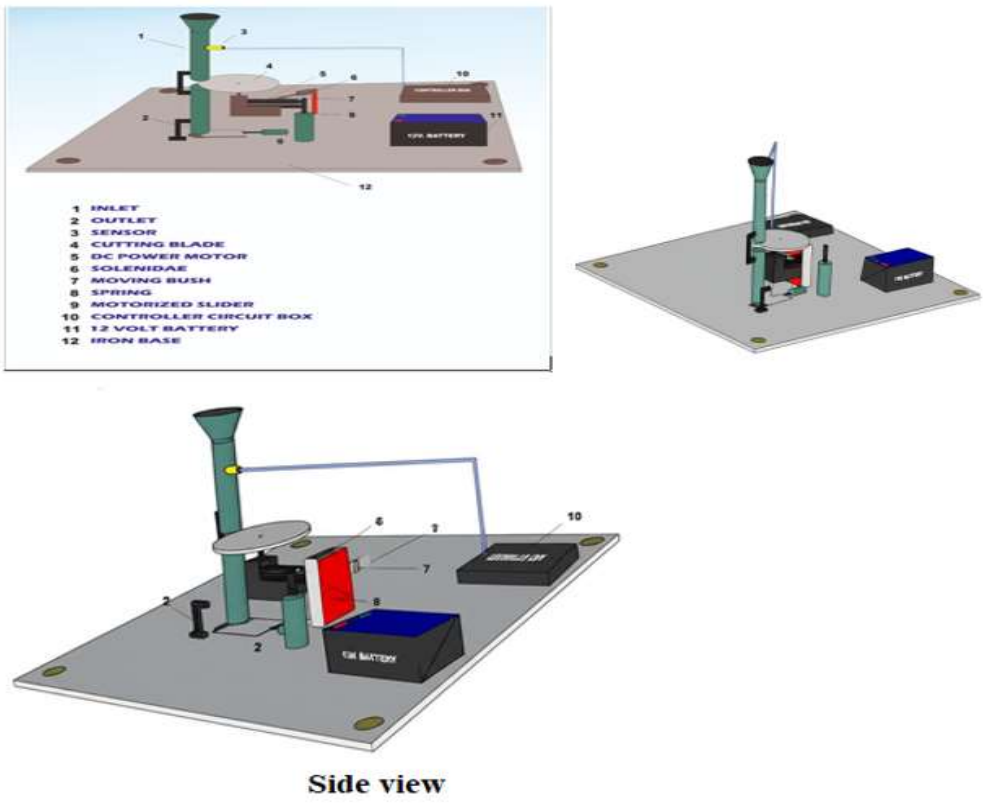

Figure 5: Sensor based battery operated cutting mechanism for plantar

Control Panel Sensor Battery Sugar Cane Stand Blade Motor Development of Sugarcane cutting system for planter Tank Control Panel Sensor Battery Sugar Cane Stand Tank Sensor Blade Motor Development of Sugarcane cutting system for planter

4.2. System Components and Innovations

The battery-operated sugarcane cutting mechanism integrates a series of intelligently coordinated components to automate the cutting and dispensing process efficiently. The system begins with the insertion of a sugarcane stem into a hollow pipe structure, where a proximity or infrared sensor detects its presence. Once detected, a solenoid actuator engages to stabilize the stem, ensuring it remains stationary during the cut. A motor-driven rotating blade then activates, making a clean, uniform cut at a pre-set length suitable for planting. This automated precision improves consistency and reduces manual errors.

Following the cutting operation, the system uses a motorized slider to handle the dispensing of the cut sheet of fabric. The bottom opening of the pipe is first closed to make sure the cut piece stays put in the pipe. With the gate triggered by the motor, gravity or a little aid helps the sett slip out onto the conveyor belt. Following this, the gate automatically shuts, making the device set for another run. Sensing, actuation, cutting and dispensing are directed by a microcontroller which is itself powered by a specialized battery system. The unit is fixed to a stable frame that allows it to be easily used on different farms.

❖ **Process Flow**

1. Insertion & Detection
- The operator inserts a sugarcane stem into a hollow pipe structure.
- A proximity or infrared sensor detects the presence of the sugarcane.

2. Cutting Mechanism
- Upon detection, a solenoid actuator engages to stabilize the sugarcane.
- A rotating blade mechanism, driven by a motor, activates and performs a clean cut at the desired length.
- The cutting process is precise, ensuring uniform sizes suitable for sowing.

3. Dispensing Mechanism
- After cutting, the bottom opening of the pipe remains initially closed to hold the cut section.
- A motor-driven sliding mechanism then opens the bottom gate.
- The cut sugarcane section slides out of the pipe through gravity or assisted ejection.
- Once dispensed, the bottom opening closes automatically, readying the machine for the next cycle.

4. Repeat Cycle
- The machine resets and waits for the next sugarcane insertion.
- The cycle repeats until all stems are processed.

Table 1: Functional Description of System Components

Component	Function
Proximity/IR Sensor	Detects sugarcane presence in the pipe
Solenoid Actuator	Holds sugarcane firmly during cutting
Motor with Rotating Blade	Performs the cutting operation
Motor-Slider Mechanism	Opens and closes the bottom gate for dispensing
Control Unit (Microcontroller)	Coordinates sensing, cutting, and dispensing operations
Power Supply	Provides required voltage and current to components

Frame and Support Structure	Physical body for holding all components

5. CONCLUSION

The development of a battery-powered sensor-based device for cutting sugarcane plants is an important advance in mechanizing agriculture that helps solve the main problems of traditional planting methods. Advanced sensors, actuators and a motorized blade help ensure accurate sett cutting, less bud damage and minimize the chance of planting gaps sensed in PTO and ground-wheel systems. Besides, not using fossil fuels to power vehicles raises awareness about taking care of our planet. Automating cutting and discharging sugarcane setts by the machine saves time, reduces the need for manual labor and increases field efficiency. Because both big and small sugarcane farmers stand to gain, this method supports the spread of precision farming and helps make farming more sustainable which benefits rural areas in India.

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