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RESEARCH ARTICLE

DESIGN AND FABRICATION OF SUGARCANE BUD CHIPPER MACHINE TO IMPROVE THE FARM PRODUCTIVITY

Hasham Mukhtar, Muhamad Owais, Muhammad Mohsin Waqas*, Yasir Niaz, Kamran Ikram, Muhammad Ashraf

Department of Agricultural Engineering, Khwaja Fareed University of Engineering and Information Technology, Rahim Yar Khan, Pakistan
Corresponding Author Email: mohsin.waqas@kfueit.edu.pk

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ABSTRACT

Sugarcane holds immense significance, particularly in a nation like Pakistan, where it is a staple for millions of people. Sugarcane farming in Pakistan spans from small individual farms to corporate enterprises. While modern machinery with advanced technology has been developed to simplify sugarcane cultivation, it's primarily accessible to corporate farmers due to its high cost. Consequently, there is a pressing need for a cost-effective, user-friendly machine that can deliver excellent results, enhance profits, and be more accessible. In the traditional method of planting sugarcane, the sugarcane is typically cut into pieces and buried. However, only a single bud-chip is required for sugarcane growth, leading to wastage of the remaining sugarcane. The machine is designed to precisely extract single bud-chips from sugarcane, saving time compared to manual and other cutting methods. The primary objective of this project is to streamline the bud-chip extraction process through the aforementioned machine, which demands less human labor, reduces investment costs, and saves time, making it a profitable investment for all farmers. The core purpose of this development is to enhance sugarcane germination while using a smaller quantity of sugarcane. In this method, only bud-chips are utilized to cultivate the sugarcane nursery. The initial weight of the sugarcane ranged from 0.92 kg to 1.21 Kg, and the length of the sugarcane from these selected stalks varied between 53 and 84 inches. The combined weight of the three sugarcane stalks was 3.28 kg, but after removing the buds, it reduced to 2.45 kg, with the bud-chips themselves accounting for a weight of approximately 0.74 kg. This approach to sugarcane production will bolster farm productivity and sustainability.

KEYWORDS

Sugarcane Production, Bud-Chip Cutting Machine, Precision Farming, Sustainability

1. INTRODUCTION

Sugarcane holds significant economic importance in Pakistan and numerous other regions globally. In Pakistan, the average sugarcane yield per hectare is relatively low, ranging from 450 to 500 kg, in contrast to other countries. Various agronomic factors, including crop and bed preparation, planting techniques, timing, water availability, fertilizer application, ratoon crop management, harvest timing, crop variety, and protective measures, have a considerable impact on production. These factors also directly influence production costs.

It's worth noting that sugarcane cultivation primarily serves the purpose of producing sugar-based products, such as alcohol for the pharmaceutical industry, ethanol for fuel, and bagasse for paper and chipboard production. Pakistan holds a significant position in the global sugarcane-producing nations, ranking fifth in sugarcane production and approximately fifteenth in sugar production. By 2020, Pakistan had produced a remarkable 81 million tons of sugarcane, representing a substantial increase from 23.2 million tons in 1971, growing at an annual rate of 3.58%.

Sugarcane is cultivated across approximately 1.2 million hectares in Pakistan. In a conventional sugarcane planting system, 6-8 tons per hectare are used as planting material, consisting of around 36,000 stalk pieces with 2-3 branches. These stalk pieces, known as "sets," can have one, two, or three shoots and are used as seeds. Managing and transporting such a large quantity of planting material presents logistical challenges, and the viability of the sugarcane deteriorates quickly, impacting germination.

An alternative approach to both reduce costs and improve seed quality is to use axillary cuttings from sugarcane stalks, known as bud chips. Bud-Chips are small, easy to transport, and cost-effective. Bud-Chips technology holds promise for expediting the development of new sugarcane varieties. The remaining sugarcane can be utilized to produce juice, sugar, or jaggery. This approach significantly reduces seed demand to less than one ton per hectare.

The research work done on the design of the bud cutter and bud chipper machines are presented here. Parthasarathy et. al., (2022) worked on the design and development of multi-purpose brush cutter for agricultural operations. Madhur et. al., (2022) design and development of sugarcane bud chipping machine. Magdum et. al., (2016) sugarcane bud cutting machine. Design and fabrication of semiautomatic sugarcane bud cutting machine.

In Pakistan, three methods for sprouting sugarcane cultivation sets are popular, requiring a total of 8-10 tons per hectare of seed material. The primary goals of designing a bud-chip cutting machine for small-scale farmers are to decrease seed requirements and enhance profitability.

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2. METHODOLOGY

2.1 Design of Bud Chip Cutting Machine

A bud chip cutting machine was developed to efficiently extract seeds from sugarcane bud chips while optimizing the use of the remaining sugarcane stalk. Initially, the machine's design was created in AUTOCAD, as depicted in Figure 1. This bud chip cutter machine operates in a hybrid mode, with one method being pedal-based, utilizing the force applied by the person sitting on the machine's seat to cut the sugarcane bud chip. The other method employs an attached electric motor. The pedal-based bud chip cutter machine offers enhanced comfort compared to manual operation, significantly improving cutting efficiency and user performance.

The cutting blade moves downward when the pedal is pushed, and it automatically returns to the upward position due to the spring connection. After placing the sugarcane in the cutting area, the operator can comfortably push the pedal while seated in a chair. High-quality materials were chosen for each component of the machine. The machine precisely cuts bud chips of uniform size from the nodes of sugarcane stalks, ensuring that undamaged bud chips are used as seeds. Figure 2 represents the manually operated machine.

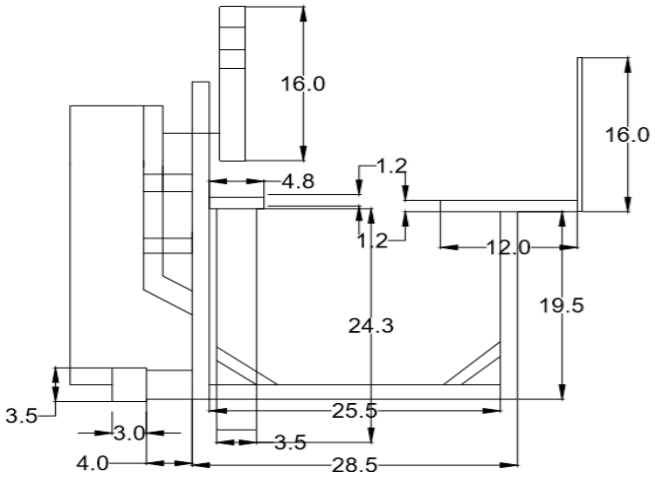

Figure 1: Layout of sugarcane bud chipper machine

Figure 2: Manual Operated Sugarcane Bud Chip Cutting Machine

2.2 Working Principle of Machine

2.2.1 Manually Pedal Operated

For the purpose of bud chip extraction, healthy sugarcane aged between 6 to 8 months and free from pests and diseases is utilized. The sugarcane, from which the buds are to be obtained, is positioned beneath the cutting blade. The cutting blade is set into motion by a foot-operated pedal connected through a series of linkage mechanisms. To facilitate the cutter's placement, a circular hole matching the cutter's diameter is drilled into the plate, allowing the cutter to move through it. The necessary cutting force is generated by the pressure applied to the pedal. As the metal blade moves, it removes the sugarcane bud chip during the downward motion, and with one full rotation, a bud is separated from the cane. To assess the bud chip condition before cutting, the sugarcane needs to be rotated to have the bud facing the operator.

2.2.2 Motor Operated

The single-phase AC motor is securely positioned within a channel affixed to the base using bolts. This motor is linked to a circular disc. To ease the installation of the cutter, a circular hole matching the cutter's diameter is drilled into the plate, allowing the cutter to pass through. The vertical movement of the blade is facilitated by a rod connected to the motor's output circular disc via a bush. A gearbox is employed to achieve the optimal motor speed reduction.

Figure 3: Motor and manual operated sugarcane bud chipper machine

3. RESULTS AND DISCUSSION

The experiment involved performing bud chip cuttings using three sugarcane stalks of varying sizes, as indicated in Table 3.1. The initial weight of the sugarcane ranged from 0.92 kg to 1.21 Kg, and the length of the sugarcane from these selected stalks varied between 53 and 84 inches. The combined weight of the three sugarcane stalks was 3.28 kg, but after removing the buds, it reduced to 2.45 kg, with the buds chips themselves accounting for a weight of approximately 0.74 kg.

Table 1: Observation and Calculation

Sr. No	Weight of complete sugarcane (Kg)	Length of complete sugarcane (Inch)	Weight of sugarcane without bud chips (Kg)	Weight of bud chips removed (Kg)	Number of bud chips removed with motor	Number of bud chips removed manually
1	1.21	84	0.91	0.30	20	8
2	1.15	72	0.86	0.29	18	8
3	0.92	53	0.68	0.24	17	7

To calculate the benefit using this approach, we determined the average weights of sugarcane and buds based on the aforementioned three stalks. The average weight of the sugarcane was set at 1.1 kg, and the average bud weight was established at 0.25 kg. Since the desired plant population in one acre is 60,000 plants in Pakistan, the average seed application required to meet this goal is approximately 4,000 kg per acre. By using the average bud weight (0.25 kg) as a benchmark, the seed requirement can be reduced from 4,000 kg to 1,000 kg, resulting in a substantial saving of approximately 3,000 kg per acre of sugarcane.

4. CONCLUSION

The designed machine offers a range of advantages, making it user-friendly, cost-effective in terms of labor, efficient in cutting speed, and economically viable with low capital and operational expenses. Moreover, it is environmentally friendly and minimizes seed damage by exclusively

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removing the sugarcane buds. This innovation is particularly valuable in rural areas where there is a shortage of available labor and worker fatigue is a common issue. By introducing both motor and pedal-operated sugarcane bud cutter machines, these challenges are effectively addressed, resulting in increased sugarcane productivity. This project not only provides a high return on small investments but also simplifies the sugarcane bud cutting process, creating entrepreneurial opportunities for engineering students.

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