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Grass Ninja 220 Chopper Machine

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Abstract

The Grass Ninja 220 Chopper Machine was developed as a practical solution to real-world challenges faced by small-scale farmers and rural livestock owners, especially in the preparation of animal feed. Traditional grass cutting methods using machetes or sickles are time-consuming, physically exhausting, and produce uneven cuts that affect animal digestion and lead to feed waste. On the other hand, commercial grass chopper machines are often too expensive, heavy, and unsuitable for home-based or small-scale use. To address these challenges, this study proposes a low-cost, compact, and energy-efficient chopper machine made from recycled components, including a 220 W washing machine motor and an 18 l plastic bucket as the chopping chamber. The system features a dual-blade configuration with an additional booster blade to enhance internal circulation and cutting efficiency. Several performance tests were conducted, including cutting comparison between wet and dry grass, blade configuration analysis, and one-cycle chopping time. Results showed that the machine consistently produced grass lengths between 2 cm to 5 cm which ideal for goat digestion, with the most efficient and uniform results achieved using the dual-blade and booster blade combination. The machine operated on household electricity, showed minimal vibration, and did not overheat during testing. In conclusion, the Grass Ninja 220 Chopper Machine successfully addresses the issues of manual labor and feed waste, while promoting low-cost, sustainable engineering. Its use of recycled parts, low power consumption, and suitability for local fabrication align with green engineering principles and highlight its potential for community-based agricultural improvement.

1. Introduction

The preparation of animal feed plays a vital role in livestock productivity, particularly for small-scale farmers who rely on fibrous plants such as Napier grass or paddy straw. Traditionally, grass is cut using hand tools such as machetes or sickles. This method is time-consuming and physically demanding, especially when preparing large quantities daily. Furthermore, manual cutting produces uneven results, which can hinder digestion and reduce feed intake among animals [1].

Commercial grass chopper machines are available in the market but are often costly, heavy, and powered by high-capacity fuel or electric motors. These machines are primarily intended for large-scale operations and are inaccessible to smallholder farmers, especially in rural or lower-income areas [2].

This project aims to develop a plug-in powered grass chopper machine that is compact, affordable, and made using recycled and accessible materials. The machine uses a 220 W washing machine motor, a reused 18-liter paint bucket as the chopping chamber, and custom stainless-steel blades, including a booster blade that mimics a blender mechanism to lift and re-circulate grass during operation. The machine is designed to be safe, simple to operate, and energy-efficient for use in small-scale or home-based agricultural environments [3]. To ensure optimal performance, the motor's torque characteristics were selected based on the expected load from the grass being cut. The torque output of the 220 W motor is sufficient to overcome the resistance of both wet and dry grass, which typically requires a torque range of 0.75 Nm. This ensures that the blades can effectively cut through varying densities of grass without stalling or excessive strain on the motor.

2. Literature Review

Chopper machines have long played a vital role in agriculture and industry by improving the efficiency of processing organic materials. Their origins trace back to early farming practices where manual tools like sickles and scythes were used, though these required considerable effort and delivered inconsistent results [4]. In the 19th century, manually operated fodder choppers with rotating blades began to reduce labor needs, though they still had limited output. The early 20th century introduced motorized choppers powered by steam and fuel, significantly boosting capacity and reducing physical strain. Electric chopper machines emerged mid-century, offering reliable, low-maintenance alternatives and leading to the development of specialized models for silage and recycling. Recently, battery-powered choppers have grown in popularity, offering portability and efficiency through advanced lithium-ion technology [5]. Modern choppers now feature smart automation, variable blade speeds, and automatic feeding systems, making them more energy-efficient and cost-effective across agricultural and industrial settings.

2.1 Concept of Chopper Machine

Chopper machines use high-speed rotating blades powered by an electric motor to cut large or fibrous materials into smaller, uniform pieces, making them ideal for processing grass, stalks, and food waste in agriculture. The motor transfers rotational force to the blades within a cylindrical chamber, where the materials are manually or automatically fed in. The blades operate at speeds between 1,000 RPM and 3,000 RPM, utilizing both impact and shear cutting methods for efficient chopping. After cutting, the material is discharged through a chute, often filtered by a mesh to ensure uniformity [6]. The machine’s effectiveness depends on factors such as motor power, blade sharpness, chamber design, and ventilation. Designed to be safe, simple, and reliable, chopper machines offer an efficient solution for feed preparation and organic waste processing in small-scale agricultural settings.

2.2 Available Algricultural Chopper Machine

Several chopper machines are available on the market; each designed for specific applications. Agricultural choppers are commonly used for processing grass, fodder, and crop residues to prepare animal feed and manage farm waste efficiently. Chopper machines can be categorized based on their power source and intended application: electric and fuel powered. Electric chopper machines as shown in Fig. 1(a) use a direct power supply to drive a motorized blade system, offering consistent and high-speed chopping for medium to large-scale applications, though they require access to electricity and are less portable. Fig. 1(b) is a fuel-powered choppers, powered by gasoline or diesel engines, are designed for heavy-duty agricultural work, capable of processing tough materials in high volumes, but they involve higher operational costs, require frequent maintenance, and contribute to environmental pollution.

(a) (b)

Fig. 1 *Algricultural chopper machine (a) electric chopper machine; (b) fuel-powered chopper machines*

2.3 Study on Wet and Dry Grass Characteristics

The condition, texture, and length of grass significantly influence chopper machine performance and output quality, particularly in feed preparation. Wet grass, being heavier and more pliable due to high moisture content, tends to stick to blades and clog the chute, increasing motor load and producing fewer uniform cuts, but is suitable for immediate feeding. Dry grass, in contrast, is lighter, more brittle, and chops more cleanly, allowing for smoother operation, reduced friction, and consistent output ideal for storage or dry feed. Additionally, grass texture affects cutting ease: soft-textured grass like young Napier or lawn clippings is easy to chop and yields finer output, while coarse or fibrous grass such as mature Napier or sugarcane leaves requires sharper blades and stronger motors. Grass that exceeds 20 cm in length may wrap around the shaft and cause jamming, highlighting the need for pre-trimming. The ideal chopped length ranges from 2 cm to 5 cm, improving digestibility and minimizing feed wastage. These factors guide the selection of blade type, chamber design, and feeding method for optimal chopping efficiency.

2.4 Grass Texture and Length in Chopping Applications

The texture and length of grass are important factors affecting the performance of chopper machines and the quality of animal feed as stated in Table 1. Grass characteristics vary by species, moisture content, and growth stage, influencing chopping efficiency and feed suitability. Texture refers to how fibrous or soft the grass is. Soft grasses, like young Napier grass and lawn clippings, chop easily and produce uniform output. In contrast, coarse grasses, such as mature Napier grass and paddy straw, require sharper blades and more power to chop efficiently. Tough textures can increase motor resistance and lead to uneven chopping. Grass length is crucial both before and after chopping. Grass longer than 20 cm may wrap around the blades, causing jams. Ideally, chopped grass for animal feed should be between 2 cm to 5 cm long, improving digestibility and reducing feed waste.

Table 1 *Comparison of grass texture and length on chopper performance*

Grass Type	Texture	Chopping Difficulty	Recommended Output Length	Remarks
Young Napier Grass	Soft, smooth	Low	2 cm to 4 cm	Easy to cut, ideal for consistent feeding
Mature Napier Grass	Coarse, fibrous	High	3 cm to 5 cm	May require pre-cutting or stronger motor
Paddy Straw	Dry, brittle	Moderate	2 cm to 5 cm	Cuts cleanly but may generate more dust
Lawn Grass Clippings	Soft, short	Very Low	1 cm to 3 cm	Easily processed, minimal load on motor

2.5 Optimal Grass Length for Goat Digestion

Maintaining an optimal grass length of 2 to 6 centimeters is crucial for goat digestion, as it enhances chewing efficiency, digestion rate, and nutrient absorption. Forage that is too long can be rejected by goats or chewed inefficiently, leading to reduced intake and gastrointestinal issues, while excessively short particles (below 1 cm) may pass through the digestive system too quickly, hindering proper fermentation in the rumen. Properly chopped grass promotes effective mastication and saliva production, which regulates rumen pH and supports microbial activity essential for breaking down fibrous feed. For small-scale farmers, using a chopper machine to achieve this recommended length can improve livestock health and productivity, reduce labor and feed loss, and contribute to sustainable feeding practices.

3. Grass Ninja 220 Chopper Machine Design

The design phase encompasses critical components, including blades, motors, mesh filters, and the chopping chamber. These components are fabricated and assembled into a functional prototype utilizing a 220 W washing machine motor and an 18 l plastic bucket as the chopping chamber. Fig. 2 illustrates the complete assembly drawing of the plug in powered grass chopper machine, highlighting all essential components involved in the cutting process.

Fig. 2(a) depicts the chopping chamber, which serves as the primary body where raw grass is fed through an inlet opening located at the top. This chamber is built from a recycled 18 l plastic paint bucket, making it lightweight, cost-effective, and easy to maintain. Its cylindrical design facilitates smooth internal circulation and enhances blade efficiency. It functions as the containment area for grass during the chopping process, preventing debris from escaping. The chopping action occurs within this chamber.

The blade system, mounted vertically to the motor shaft inside the chamber (though not visible externally) as shown Fig. 2(b). The blade configuration consists of two straight blades and a booster blade, positioned opposite each other on a central disc that is directly affixed to the vertical shaft. The straight blades are oriented horizontally for effective cutting, while the booster blade is slightly angled above to elevate the grass and prevent clogging, ensuring continuous chopping. The primary cutting blades are crafted from stainless steel for durability and long-lasting sharpness, while the booster blade (agitator) is made from mild steel sheet, designed to lift grass upward and prevent it from accumulating at the bottom without being cut.

The output chute, which is attached to the side of the chopping chamber as illustrate in Fig. 2(c). This chute serves as the outlet for the chopped grass. As the grass is reduced to a suitable size (between 2 cm to 5 cm), it is discharged through this chute. A fixed mesh filter is installed at the entrance of the chute to block larger particles, redirecting them back into the chamber for further cutting and ensuring size consistency in the output. The mesh filter is incorporated to regulate the output size, allowing only finely chopped pieces to pass through. The motor as shown in Fig. 2(d), positioned beneath the chamber. This 220 W recycled washing machine motor has been repurposed for this project due to its low power consumption, reliable speed, and compact design. The motor drives the blades through a direct shaft connection, providing stable rotation for efficient chopping. Fig. 2(e) shows the switch panel, which is mounted on the side of the base frame. This panel features a straightforward ON/OFF switch connected to a 240 V plug for household electricity. Internal wiring is securely routed through the frame to mitigate any risk of contact or electrical hazards. The wiring system includes a 3 pin AC plug, an ON/OFF switch, a safety fuse, and connectors, ensuring safe and reliable operation of the motor.

Fig. 2(f) illustrates the base frame, constructed from 20 mm thick plywood. It supports all primary components—chamber, motor, and wiring—while providing a stable foundation. The base design incorporates a compartment for motor mounting and optional ventilation space. Its simple square shape facilitates easy assembly and transport. Additionally, it offers a solid platform for mounting the motor and chamber while absorbing vibrations during operation. Fig. 2(g) shows the wheels attached beneath the base. These swivel casters are designed for easy mobility of the machine between work areas. Each wheel is equipped with a locking mechanism to ensure the machine remains stable and secure during operation. Overall, the system is designed to be efficient and user-friendly for small-scale agricultural applications, featuring an inlet at the top for loading grass and an outlet chute on the side for discharging the chopped material.

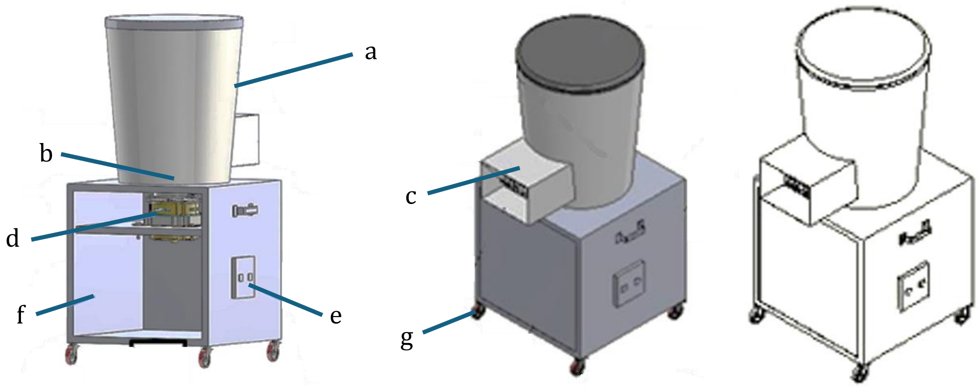


Fig. 2 *Technical drawing of Grass Ninja 220 Chopper Machine*

4. Experimental Setup

After the prototype of the plug-in powered grass chopper machine was fabricated, several tests were carried out to evaluate its performance, cutting effectiveness, safety, and overall reliability. The first test evaluated the effect of grass condition wet versus dry on the machine's chopping performance. This test aimed to determine which type of grass produced more consistent, clean chopping results. For this experiment, 500 g of freshly cut Napier grass was collected using a lawn cutter and placed into a collection basin. The fresh sample (Sample A) was immediately inserted into the chopping chamber with the standard blade setup. After chopping, the output was examined for size consistency. The same procedure was repeated for Sample B, which was also Napier grass but dried under the sun for 1 hour in a separate container before chopping. Both samples were compared based on cut quality, smoothness of discharge, and motor performance.

The second test assessed the performance of different blade configurations on output quality and processing time using 1 kg of dry Napier grass. The purpose was to determine which setup gave the most efficient chopping. The machine was first equipped with one straight blade and one booster blade (Blade Setup A), and the grass was chopped with the processing time recorded. The chopped material was then collected and measured for length uniformity and ease of flow. Next, the same steps were repeated using two straight blades with one booster blade (Blade Setup B). The comparison focused on the uniformity of the output grass. This experiment will evaluate time taken to chop 1 kg grasses into 2 cm to 6 cm length with different number of blades with availability of rotation.

The third test simulated a full chopping cycle using 1 kg of grass under both blade configurations. The objective was to identify the most efficient setup in terms of total cycle time, stability, and ease of use. For each configuration, the total time from loading to complete discharge of chopped grass was measured. Observations were also made on machine vibration, possible jamming inside the chamber, and whether the outlet chute allowed smooth flow without blockage. The cut grass in both tests was collected in the same basin for measurement and evaluation.

For safety precautions during all tests, the chopping chamber lid was closed securely before operation to prevent debris from escaping. Additionally, the outlet chute was also closed during chopping to maintain internal pressure and prevent premature ejection of uncut material. These precautions ensured safe and efficient operation throughout the testing process.

5. Results and Discussion

Each test was carried out to determine the machine's performance, reliability, and functionality under different conditions and configurations.

5.1 Grass Ninja 220 Chopper Machine Working Principle

The plug-in powered grass chopper machine as shown in Fig. 3 operates based on the principle of high-speed rotational cutting. At the core of the system is a vertical shaft connected directly to a 220 W brushless AC motor, which is recycled from a household washing machine. This motor, powered by standard 240 V AC supply, provides the mechanical torque required to spin the blades mounted at the lower part of the chopping chamber. The chopping chamber, made from an 18 l plastic paint bucket, acts as a cylindrical enclosure where grass is inserted and processed. Users manually feed freshly cut grass through the top inlet. Once inside the chamber, the main blades, which consist of two horizontally aligned straight stainless-steel blades, rotate at high speed to chop the grass into smaller pieces. These blades deliver cutting force through a combination of impact and shearing action, depending on the blade edge and the grass texture.

To improve internal circulation and ensure uniform chopping, a booster blade is mounted above the main blades. The booster blade is slightly inclined and functions by lifting and recirculating the grass, preventing material from settling at the bottom or sticking to the sides. This helps direct any uncut grass back into the blade's path for additional processing, which results in consistent output size ranging from 2 cm to 5 cm. As the grass is chopped, centrifugal force pushes the material outward toward the side outlet chute. This chute is connected near the lower side of the chamber and includes a fixed mesh filter that allows only uniformly sized particles to exit, while larger or uncut pieces remain inside for reprocessing. The chute also guides the chopped grass into a collection basin or container for easy handling.

The entire system is controlled using a manual switch panel mounted on the base frame. This switch allows the user to turn the motor on or off safely. The base is constructed using sturdy plywood and equipped with caster wheels for mobility, making the machine easy to transport to different work areas. For user safety and operational efficiency, the chopping chamber is fitted with a secure top lid that must be closed during operation. This prevents grass from flying out and reduces the risk of contact with the blades. Similarly, the outlet chute should remain closed during active chopping to avoid unwanted discharge or clogging. Overall, this machine combines simple mechanics with effective design elements like blade positioning, chamber shape, and booster circulation to deliver a compact, affordable, and energy-efficient solution for small-scale grass chopping, especially for rural and home-based agricultural use.

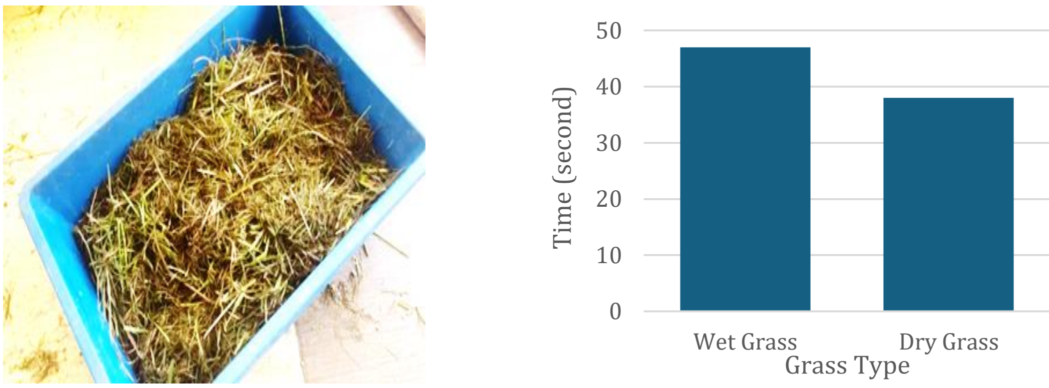
(a) **(b)**

Fig. 3 *Grass Ninja 220 Chopper Machine*

5.2 Evaluation on Grass Ninja 220 Chopper Machine

The first test aimed to evaluate the machine's chopping performance based on the condition of the grass, comparing freshly cut (wet) grass to grass that had been dried for 1 hour. Observations indicated that dry grass facilitated smoother cutting with lower blade resistance, resulting in a more uniform output size ranging from 2 cm to 5 cm. It flowed efficiently through the chamber without sticking or clogging, which ensured consistent operation and minimized strain on the motor. In contrast, wet grass exhibited moderate blade resistance and tended to adhere to the chamber walls and around the shaft, leading to potential clogging near the mesh filter and producing less consistent output sizes. Although the machine capable to chopped both types of grass, dry grass demonstrated superior performance in terms of cutting quality and mechanical efficiency.

Fig. 4(a) illustrates that dry grass exhibited enhanced performance, characterized by smoother blade rotation, reduced clogging, and more consistent chopped output 2 cm to 5 cm compared to wet grass, which resulted in higher resistance and occasional blockages. This observation suggests that freshly cut grass is optimal for chopping, provided it is neither overly wet nor too dry. The results of this test confirm that grass condition significantly influences chopping performance. When using wet grass, a tendency to stick to the chamber walls and blades was noted, causing resistance during operation, which slowed the cutting process and resulted in irregular output sizes. Additionally, occasional clogging occurred near the mesh filter due to moisture content increasing friction and clumping. However, wet grass retains more nutritional value for animal feed, making it beneficial in certain contexts. Conversely, dry grass passed smoothly through the blades with minimal motor strain and no signs of clogging. The output was more uniform, and the cutting process was both faster and more efficient. This indicates that while dry grass offers better mechanical performance, wet grass may still be preferred in feeding situations requiring high nutritional content. To balance these benefits, utilizing semi-dry grass may present an optimal solution. Fig. 4(b) presents a graph comparing the time taken (in seconds) for processing two different types of grass: wet grass and dry grass. The data shows that wet grass requires significantly more time, around 47 seconds, compared to dry grass which takes approximately 38 seconds. This difference suggests that the physical properties or composition of wet grass make it more challenging to process compared to dry grass. The graph illustrates the importance of considering the grass type and its associated processing time when managing livestock feed or related agricultural activities.



(a) **(b)**

Fig. 4 *(a) Freshly cut grass after chopping; (b) time taken to fully chopped 500 g grass*

The second test involved comparing two blade configurations: one blade with a booster blade (Blade Setup A) and two blades with a booster blade (Blade Setup B). This comparison assessed their effects on output consistency and processing time. Blade Setup A produced moderate chopping results, with output sizes ranging from 3 cm to 6 cm and requiring approximately 42 seconds to process 1 kg of grass. Some longer strands were observed, indicating less uniformity. In contrast, Blade Setup B demonstrated improved efficiency, reducing processing time to 32 seconds while generating a more consistent output within the 2 cm to 4 cm range. This enhanced performance was attributed to better circulation and additional cutting edges, which helped redistribute uncut material within the chamber, ensuring a thorough and even chop. Fig. 5 highlights the significant impact of blade configuration on both output quality and chopping time. Using freshly cut Napier grass, the configuration with one blade and a booster produced moderate results, with an output length of 3 cm to 8 cm and a chopping time of 42 seconds. In contrast, the configuration with two blades plus a booster improved output consistency to 2 cm to 6 cm and reduced processing time to just 32 seconds. This underscores the advantage of having more cutting surfaces and improved internal circulation, which facilitates faster and more uniform chopping performance during operation. The results of this test confirm that blade configuration directly affects chopping efficiency and output size. The use of only one blade along with a booster blade resulted in slower chopping with moderately consistent output; some grass remained longer than the target range, indicating that a single blade was insufficient for uniform chopping, particularly in areas with low blade contact. In contrast, the combination of two blades with the booster blade enabled faster and more consistent cutting. The second blade increased the frequency of cutting actions, while the booster helped to re-lift and circulate uncut grass, ensuring it passed through the cutting zone multiple times. This configuration allowed for better contact with the material, producing finer and more uniform lengths in a shorter time, making it ideal for preparing goat feed within the 2 cm to 6 cm range.

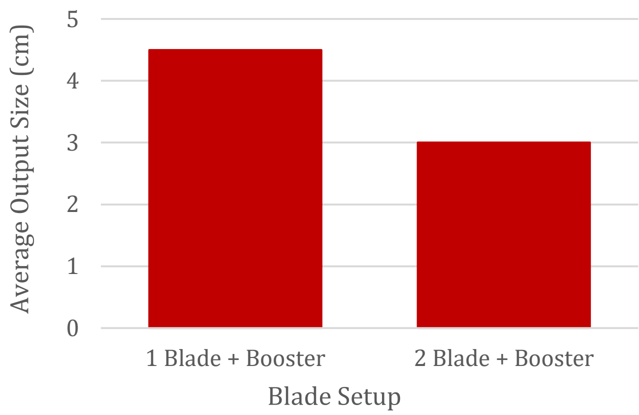


Fig. 5 *Blade configuration versus grass output size*

The third test aimed to evaluate the total time required to complete one full chopping cycle using 1 kg of grass for each blade setup. With Blade Setup A, the machine completed the cycle in 46 seconds with low vibration and stable operation. Conversely, Blade Setup B completed the cycle more quickly, taking just 38 seconds, although it introduced a moderate level of vibration and slight movement when used on lightweight surfaces. Despite this, the output was cleanly and completely discharged without jamming or refeeding, confirming that the two blades plus booster configuration provided the best operational flow. These results reinforce the importance of blade design and grass condition in maximizing chopping speed, output quality, and machine stability in small scale agricultural applications. Fig. 6 presents the findings from the full-cycle chopping test, showing that the two blades setup completed the process in 180 seconds with high stability, while the two blades plus booster blade configuration reduced the time to 132 seconds but introduced slight vibration. Despite this, the enhanced blade arrangement provided faster and cleaner discharge, establishing it as the most effective setup overall. During the full-cycle chopping test, it was observed that the dual-blade setup with a booster blade completed the cycle more quickly than the single-blade configuration. The reduced chopping time (by 48 seconds) demonstrates a more efficient cutting process, which is particularly important for daily feed preparation. However, the increased number of blades also introduced more vibration during operation, likely due to higher cutting force and rotational momentum. Despite the increased vibration, the machine remained relatively stable, with only slight movement observed on flat surfaces. This suggests that future improvements could include anti-slip pads or rubber feet to enhance stability during operation. Meanwhile, the single-blade configuration offered better stability but required significantly longer to complete the cycle, illustrating a trade-off between speed and operational smoothness.

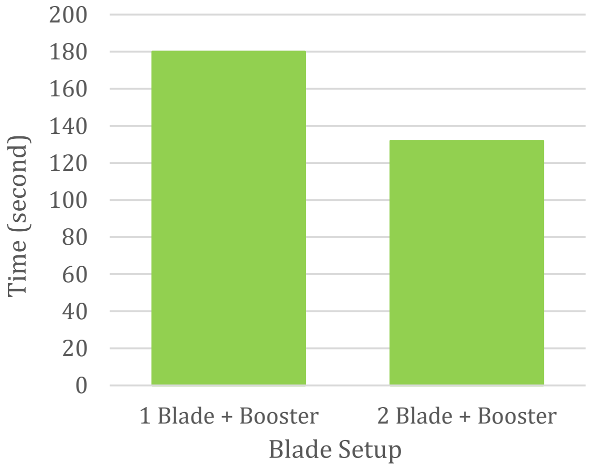


Fig. 6 *Chopping time by blade setup*

6. Conclusion

In conclusion, the plug-in powered grass chopper machine successfully achieved its goal of providing an affordable, user-friendly, and effective solution for small-scale agricultural feed processing. During testing, the machine demonstrated reliable performance across different grass conditions and blade configurations, with freshly cut Napier grass proving preferable due to its optimal moisture content that facilitated easier circulation and clean cuts without excessive clogging, aligning with previous findings on the benefits of semi-moist feed for processing. The configuration with two blades and a booster blade produced the most consistent chopped length of 2 cm to 6 cm, which is ideal for livestock digestion, as the increased cutting contact area and enhanced internal blade circulation allowed the grass to be lifted, repositioned, and evenly processed within a single cycle, outperforming the single-blade setup by reducing the risk of long, uncut strands. The machine's energy-efficient design using a recycled washing machine motor and durable plastic chamber also demonstrated its potential for rural and home-based applications, though further improvements such as a pedal-operated lid system and a shaft-clearing mechanism would enhance its safety, usability, and lifespan, making it more suitable for a wide range of smallholder farmers, training institutions, and community-based agricultural operations.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Fahmi Izzudin Johari, Hariz Syahmi Faisol, Irfan Haziq Zahir Anuar, Hafsa Mohammad Noor;* ***data collection:*** *Fahmi Izzudin Johari, Hariz Syahmi Faisol, Irfan Haziq Zahir Anuar;* ***analysis and interpretation of results:*** *Fahmi Izzudin Johari, Hariz Syahmi Faisol, Irfan Haziq Zahir Anuar, Hafsa Mohammad Noor;* ***draft manuscript preparation:*** *Hafsa Mohammad Noor, Fahmi Izzudin Johari, Hariz Syahmi Faisol, Irfan Haziq Zahir Anuar, Mohd Najib Janon, Tuan Mohd Hafeez Tuan Ibrahim. All authors reviewed the results and approved the final version of the manuscript.*

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