World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

Development of a Coconut (*Cocos nucifera*) Cutting Machine for Village-Level Coco-Juice Production in Samar, Philippines

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World Journal of Advanced Engineering Technology and Sciences, 2025, 17(01), 429-435

Publication history: Received on 22 September 2025; revised on 27 October 2025; accepted on 30 October 2025

Article DOI: https://doi.org/10.30574/wjaets.2025.17.1.1450

Abstract

This study presents the design and fabrication of a low-cost motorized Cutting machine intended to support village-level young-coconut juice production in Samar, Philippines. The prototype aims to provide a safer, faster, and more consistent alternative to manual cutting practices commonly used in local coconut-based microenterprises. The machine features a 14-inch carbon-steel cutting blade mounted on a 1-inch rotating shaft supported by pillow block bearings, powered by a 1.0-horsepower electric motor through a V-belt and pulley transmission system with an integrated gear reduction mechanism. A stainless-steel coconut catcher with ergonomic gripping elements and an optional juice-punch attachment enhances stability and improves pre-extraction capability. Locally sourced materials and conventional workshop processes were utilized to ensure manufacturability and accessibility for rural users, with a total fabrication cost estimated at approximately PHP 15,500.

This paper presents the development stages including conceptual design, material selection, construction procedures, and power transmission calculations to validate operational feasibility. Performance evaluation parameters, such as throughput, cut uniformity, juice recovery, vibration, user safety, and operator effort, are identified for future testing. The prototype demonstrates the potential of appropriate-technology solutions to strengthen grassroots mechanization and contribute to livelihood improvement in coconut-producing communities.

Keywords: Young coconut Cutting machine; Grassroots mechanization; Rural enterprise development; Sustainable village technology; Samar Philippines

1. Introduction

Coconut (*Cocos nucifera* L.) is a cornerstone of agricultural productivity in the Philippines, recognized not only for its economic contribution but also for its socio-cultural significance across rural communities. Young coconut water has emerged as one of the key growth products within the industry, supporting local markets and export development (Philippine Coconut Authority [PCA], 2022). Despite its importance, value-addition processes in the coconut supply chain remain under-researched and under-developed, limiting opportunities for diversification and enterprise growth (Zainol et al., 2023).

Among its many derivatives, fresh coconut water, or “buko juice,” has gained widespread popularity due to its natural electrolyte content and associated health benefits. However, postharvest processing of young coconuts is largely manual

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in many regions of the country. A geospatial assessment of agricultural mechanization in the Philippines found that post-production activities for key crops, including coconut, remain at low mechanization levels—especially in rural provinces (Malicdem, 2023). Manual coconut cutting using hand tools such as bolos or machetes is labor-intensive, often hazardous, and can result in inconsistent product quality. These constraints are particularly evident in Samar, where limited access to technology and financial resources restricts scaling-up efforts among small vendors and micro-entrepreneurs.

Efforts to address these challenges have emphasized the development of affordable and locally manufacturable technologies to improve productivity and worker safety in coconut processing (Philippine Center for Postharvest Development and Mechanization [PHilMech], 2023). Appropriate mechanization has the potential to enhance output, reduce physical strain, and minimize risks associated with traditional cutting tools. In this context, the present study aims to design and fabricate a motorized coconut-Cutting machine suited for village-level coco-juice production. The prototype emphasizes simplicity, safety, and affordability through the use of readily available materials and localized fabrication methods. Ultimately, this initiative seeks to strengthen grassroots mechanization and contribute to sustainable agro-industrial development in coconut-producing communities.

2. Methodology

2.1. Research Design

This study employed an engineering design and fabrication approach to develop a safe, efficient, and low-cost coconut Cutting machine for village-level coco-juice production in Samar, Philippines. The process involved four major phases:

- Needs assessment and functional specification,
- Design and materials selection,
- Prototype construction, and
- Operational verification using qualitative observational evaluation.

2.2. Needs Assessment and Operational Requirements

Consultations were conducted among local coconut vendors and micro-processors in Catbalogan City to determine key operational concerns including safety, cutting speed, coconut stability, and manufacturability. From these consultations, the essential functions of the machine were established, namely:

- High-carbon steel cutting blade assembly,
- Coconut catcher and holding mechanism,
- Torque transmission system,
- Juice punch and collection feature, and
- Foot-switch-based activation control.

The study did not involve human or animal subjects; therefore, ethical approval was not required.

2.3. Design Specifications and Component Selection

2.3.1. Cutting Blade Design

A 14-inch × 2-inch × 6 mm high-carbon steel blade was selected for sharpness, food contact compatibility, and impact resistance. Heat treatment was applied to improve wear resistance, and a radial runout of ≤0.5 mm was maintained to ensure smooth rotation.

2.3.2. Power Transmission System

A 1.0-hp (746 W), 220 V, single-phase electric motor rated at 1725 rpm served as the prime mover. Power transfer was achieved using a V-belt (RECMF-6500) connecting a 10-inch motor pulley to a 1.5-inch driven pulley, yielding a 6.67:1 speed ratio. A 1:20 worm-gear reducer further decreased blade shaft speed to ≈13 rpm while increasing torque output by more than fivefold (≈28–30 N·m), exceeding cutting force requirements (~1.75 N·m).

2.3.3. Coconut Catcher and Safety Mechanism

The catcher was constructed from 304 stainless steel with gripping teeth and a polyurethane strap to prevent fruit displacement. A foot switch (JINYEDO LT3, AC-15, 380V, IP44) was integrated to provide deliberate and hands-free activation, minimizing accidental contact with the cutting blade.

2.3.4. Frame and Structural Configuration

The machine frame was made from 1½ × 1½ × 3 mm mild steel angle bars, selected for high stiffness and workability. A safety factor of ≥2.0 was applied in structural computations to withstand repetitive cutting loads.

2.4. Materials and Measurement Equipment

All components were sourced from local suppliers in Samar to ensure affordability and replicability. Standard workshop measuring tools were employed for dimensional precision, including a vernier caliper (Mitutoyo 500-196-30), torque wrench, micrometer, and digital tachometer for rotational speed validation.

2.5. Construction Procedure

The fabrication was performed at the Samar State University Mechanical Technology Laboratory using conventional machining and welding equipment.

2.5.1. Frame Fabrication

A 900 mm × 600 mm × 850 mm rectangular frame was fabricated using shielded metal arc welding with cross-bracing added to minimize vibration.

2.5.2. Drive Assembly Installation

The motor was installed on an adjustable mounting plate for proper belt tensioning, followed by alignment of the pulley-belt system and gear reducer to ensure efficient power transfer.

2.5.3. Blade and Catcher Mechanism Setup

The blade was fixed to the rotating shaft supported by pillow block bearings (UC205). The catcher was positioned vertically beneath the blade to ensure accurate cutting alignment.

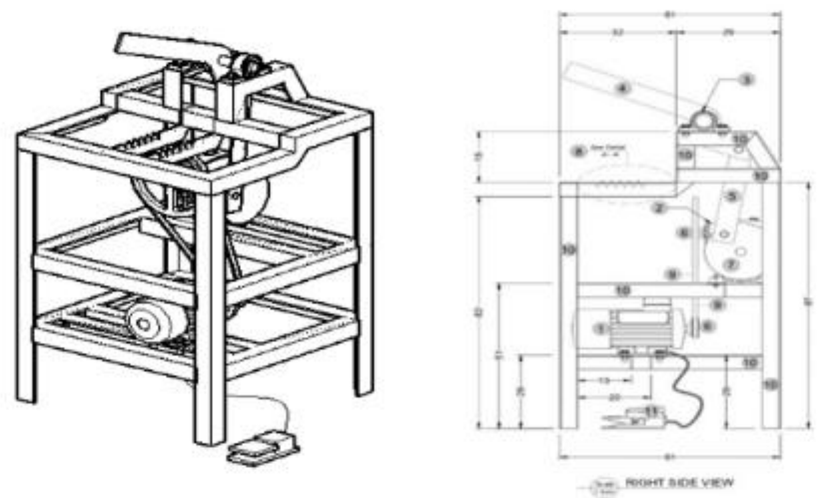
2.5.4. Juice Punch Feature Installation

A punch rod was mounted on the platform to pre-extract coconut water and reduce juice spillage during cutting.

2.5.5. Foot Switch Integration

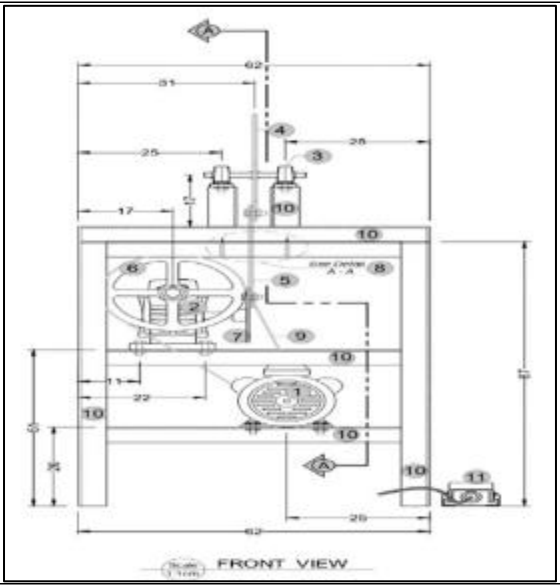
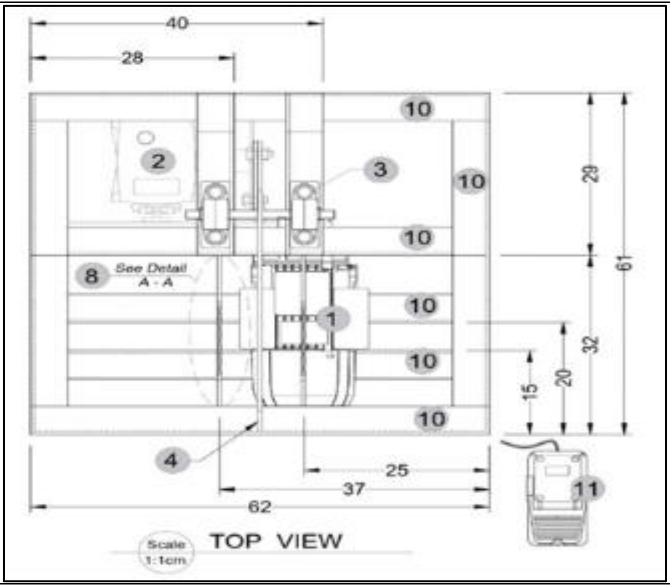
A waterproof industrial-grade foot switch was wired into the circuit to serve as the primary activation mechanism, ensuring safe engagement and preventing accidental start-up.

Figure 1 The Fabricated Young Coconut (*Cocos nucifera*) Cutting Machine



1	ELECTRIC MOTOR 1.0 HP
2	1:20 GEAR REDUCER
3	1" Dia. PILLOW BLOCK
4	6mm thick CARBON STEEL CUTTING BLADE 14" L x 2" W Sharpened one sided
5	2" x 7mm thick Connecting Rod
6	10" and 1 1/2 Diameter Pulleys
7	7" Dia. Flanged / 6mm Thickness
8	Catcher sharp metal teeth (Stainless Steel 6mm x 2")
9	V-Belt RECMF-6500
10	Square frame fabricated from Angled Iron supports all components
11	Foot Switch (JINYEDO LT3) AC-15, 380V, IP44 GB/T14048.5-2017

Isometric view of the machine showing the frame, motor, and cutting blade	Side view highlighting the gear reducer, pulley system, and connecting rod

	
Front view of the coconut holding catcher with stainless steel teeth	Top view of the frame layout with all components in mounted positions

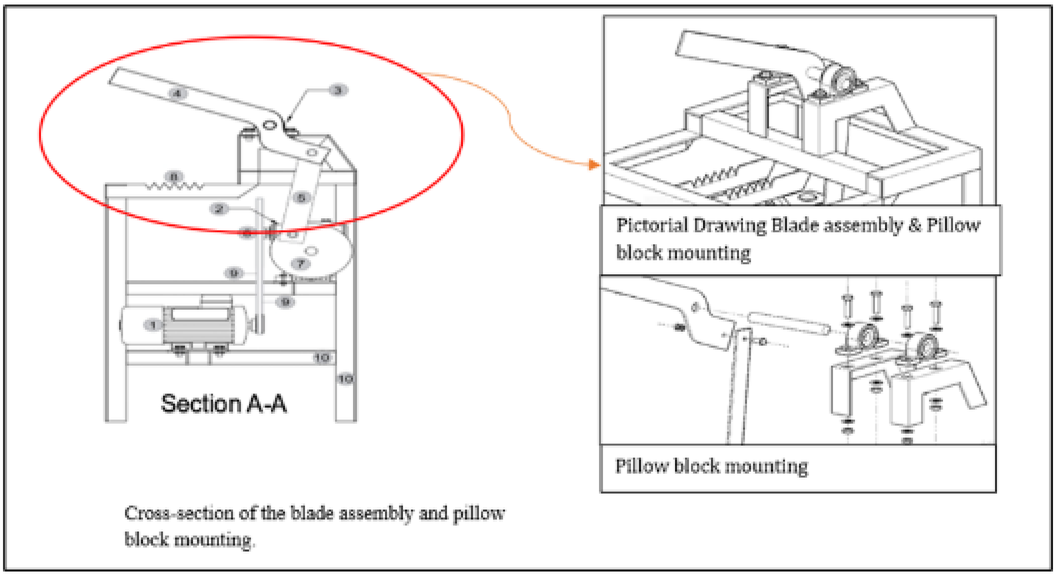


Figure 2 Schematic Diagram of the Young Coconut (*Cocos nucifera*) Cutting Machine

3. Results and Discussion

3.1. Prototype Outcome

The completed prototype successfully met the dimensional, structural, and functional requirements established during the design phase. The machine components were properly aligned, ensuring reliable operation and improved safety compared to manual cutting practices. During initial functional checks, the blade rotated smoothly without noticeable vibration, aided by the flanged stabilizing disc that maintained dynamic balance during rotation. The stainless-steel coconut catcher demonstrated effective gripping performance and securely held the fruit in position, reducing the likelihood of slippage during Cutting. Additionally, the optional juice punch mechanism functioned as intended by allowing pre-extraction of coconut water from tender young coconuts, which minimized spillage and enhanced operational cleanliness. These qualitative observations confirm that the assembled prototype is capable of performing the basic tasks required for village-level coconut Cutting operations.

3.2. Cost Efficiency and Replicability

One of the major advantages of the machine lies in its cost-efficient fabrication using commonly available materials and standard mechanical components. Table 1 shows the bill of materials with an estimated total cost of PHP 15,500, which is considered affordable for rural microenterprises. The use of locally sourced angle bars, pillow block bearings, and V-belt drive elements ensures that replacement parts are accessible in regional hardware stores, enabling ease of maintenance and repair. Furthermore, the fabrication procedure—composed mainly of welding, basic machining, and assembly—can be replicated in local workshops without requiring advanced manufacturing technologies. This enhances the potential for community-level adoption, scaling, and technology transfer to other coconut-producing areas.

Table 1 Materials Used and Cost

Component	Estimated Cost (PHP)
Electric Motor (1.0 hp)	8,500
Carbon Steel Blade	1,000
Frame Materials	1,800
Pulleys & Belt	1,200
Gear Reducer	2,200
Miscellaneous (Bearings, Bolts, Paint)	800
Total Estimated Cost	15,500

3.3. Limitations and Implications for Future Work

This study was limited to the design and prototype development stage; therefore, quantitative performance evaluation was not yet conducted. Essential operational parameters—including cutting time per coconut, juice recovery rate, user ergonomics, vibration characteristics, and long-term durability—will be tested in future phases of this research. In addition, user safety enhancements such as blade shielding and ergonomically optimized handling features may be explored to further improve the prototype for commercial adoption. Despite these limitations, the successful fabrication outcome provides a strong foundation for subsequent improvement, field validation, and eventual deployment within rural coconut-processing enterprises.

4. Conclusion

The development of the young coconut cutter successfully demonstrated a practical engineering solution to the recurring safety, efficiency, and consistency issues associated with traditional manual cutting methods. The fabricated prototype met its intended dimensional and functional requirements, showing smooth blade rotation with minimal vibration, effective coconut holding through the catcher mechanism, and reduced spillage aided by the integrated juice punch. The use of locally available materials and standard workshop fabrication techniques further supports the machine's applicability within community-based processing environments.

Findings from the initial performance assessment indicate that the design is not only cost-efficient, but also replicable for small-scale production, making it suitable for rural livelihood applications and micro-enterprise adoption. The prototype's structure exhibited appropriate rigidity and stability, which contributes to operator safety and reliability during operation. While additional testing on throughput, long-term durability, and ergonomic performance is recommended, the machine demonstrates strong potential to improve value-adding practices in young coconut processing and can serve as a foundation for future design optimization and commercial deployment.

Compliance with ethical standards

Acknowledgments

Acknowledge supporting institutions, grants, and individuals who contributed to the work.

The authors express their gratitude to the Center for Engineering, Science, Technology and Innovation, Samar State University, and the College of Industrial Technology, Samar State University, for their technical and logistical support in this project.

Disclosure of conflict of interest

All authors declare that they have no conflict of interest related to this publication. *(If applicable, disclose competing interests for each author.)*

The authors declare no conflict of interest.

References

[1] Abelgas, R., Reyes, M., & Lim, S. (2022). Coconut processing safety issues in rural enterprises. Journal of Philippine Agricultural Technology, 12(3), 45-52.

[2] Aragon, C. (2000). Coconut Program Area Research Planning and Prioritization. PIDS Discussion Paper Series No. 2000-31.

[3] DA-PhilMech. (2023). Small-Scale Coconut Postharvest Technologies. Department of Agriculture – Philippine Center for Postharvest Development and Mechanization.

[4] Del Mundo, A. M., Dizon, E. I., & Saldivar, A. A. (2019). Nutritional and functional properties of coconut water. Philippine Journal of Science, 148(3), 423–432.

[5] Garcia, J. A., Tesorero, L. & Obispo, M. (2020). Designing Rural-Based Agricultural Equipment for MSMEs. Philippine Journal of Applied Engineering, 8(1), 23–30.

[6] Ghosh, P., Thomas, R. J., & Verma, S. (2021). Agricultural diversification through value addition in coconut farming systems. Agricultural Systems, 192, 103211. https://doi.org/10.1016/j.agsy.2021.103211

[7] Jarimopas, B., & Kuson, P. (2007). Development of a young coconut fruit opening machine. Biosystems Engineering, 98(2), 214–219. Elsevier – Biosystems Engineering. https://doi.org/10.1016/j.biosystemseng.2007.06.008

[8] Sabeena, F., Bhat, A. I., & Radhakrishnan, T. (2020). Functional properties of coconut water: A review. Food Research International, 137, 109754. https://doi.org/10.1016/j.foodres.2020.109754

[9] Malicdem, J. P. B. (2023). Geospatial assessment on the distribution and level of mechanization in Pamplona, Cagayan, Philippines. Journal of Social Sciences & Humanities, 2(2), 45–57.

[10] Philippine Coconut Authority. (2022). 2022 coconut trade performance and market trends. Philippine Coconut Authority.

[11] Philippine Center for Postharvest Development and Mechanization. (2023). Annual mechanization report 2023. PHilMech.

[12] Vitug, E. G. (2023). Developing the coconut value chain in Central Luzon, Philippines: A case study of coco-geonets in Aurora. Asian Journal of Agriculture and Rural Development, 13(3), 183–191. https://doi.org/10.18488/5005.v13i3.3693

[13] Zainol, F. A., et al. (2023). Coconut value chain analysis: A systematic review. Agriculture, 13(7), 1379. https://doi.org/10.3390/agriculture13071379

[14] International Labour Organization. (2021). Rapid assessment of value-chain potentials of the coconut sector in the Philippines. ILO Country Office for the Philippines.