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Advancements in Coconut Dehusking Technologies: A Comprehensive Review of Mechanization Trends, Performance Metrics, and Sustainability

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Abstract

This review thoroughly investigates the evolution, performance, and design variants of coconut dehusking machines, which range from manual to automatic systems. Through a focused Boolean search on Scopus, 25 pertinent papers published between 1990 and 2024 were chosen using a structured literature review process. The selected studies were examined to assess cost, dehusking capacity, ergonomics, and operational efficiency. The results indicate a clear mechanization trend. Despite being less expensive, manual systems only produce 60 to 100 coconuts per hour and inflict a physical strain on operators. Semi-automatic machines with hydraulic systems and spiked rollers have intermediate capacity (120–240 coconuts/hour) and efficiency (85–90%), but they need to be manually loaded and maintained regularly. Due to their high cost, complexity, and restricted accessibility in remote regions, automatic systems that use lead screws, motorized clamps, and sensors have the best performance, reaching up to 271 coconuts/hour with 98–100% efficiency. Despite this, these systems are still underutilized. The review concludes that widespread adoption requires scalable and affordable solutions made for smallholder farmers. Locally sourced materials, modular design techniques, and the integration of renewable energy sources are among the recommendations. Particularly in low-resource agricultural areas, the study backs mechanization as a feasible means of enhancing coconut processing productivity, safety, and sustainability.

Keywords: *Coconut, Coconut dehusking machine, Agricultural processing, Operational efficiency, Performance Metrics, Rural technology, Renewable energy integration, Ergonomic design.*

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Introduction

Coconut (Cocos nucifera) is one of the world's most useful and important perennial plants (Chopra & Peter, 2005; Ramadurai et al., 2019). Coconut plays an important role in the economic, social, and cultural activities of millions of people in our country (Ramadurai et al., 2019). Coconut provides food, edible oil, industrial oil, and health drinks to humanity (Ramadurai et al., 2019). All parts of the coconut tree are useful in one way or another, and the crop profoundly influences the socio-economic security of millions of farm families (Ramadurai et al., 2019). It is well known that the coconut fruit can be used for versatile purposes (Naliapara et al., 2022). Despite its extensive use, processing coconuts, especially dehusking (Anaemeje et al., 2022), is still a time-consuming and ineffective operation (Ikechukwu & Nduka, 2016) that frequently relies on manual techniques that reduce production and endanger worker safety.

Traditional coconut dehusking is a physically taxing and inconsistently high-quality procedure (Adedipe, 2024a) that includes experienced workers using handheld spikes or machetes to remove the fibrous husk from the hard shell. According to studies, dehusking a coconut by hand takes roughly 5-10 minutes, and there is a significant chance of damage from repetitive exertion or blade slippage (ANILBHAI, 2022). Additionally, inefficiencies in coconut supply chains have been made worse by the lack of skilled labour in rural economies, which has raised production costs and decreased small-scale farmers' profitability (Muralidharan et al., 2019). These difficulties highlight how urgently the coconut sector needs mechanised dehusking solutions that may increase output, lessen reliance on labour, and raise safety standards (Idogho et al., 2025; Chinedu, Chukwudi et al., 2021; Dikeogu et al., 2014).

Researchers and engineers have created a variety of coconut dehusking machines over the last few decades, ranging from basic lever-operated devices to fully automated hydraulic systems (Ekpechi et al., 2023; Ekpechi et al., 2025; Erebugha et al., 2024; Eze et al., 2021; Ezeaku et al., 2024; Ezechukwu et al., 2025). Early inventions that achieved dehusking speeds of 60–80 coconuts per hour, like the pedal-powered dehusker (VITTHALRAO, 2012) and spike-and-wedge mechanisms, showed notable advantages over manual approaches. However, these systems frequently needed a lot of human work and had trouble adapting to varying coconut sizes (Ikebudu et al., 2012; Ikebudu et al., 2015; Iweka et al., 2019; Iweka & Owuama, 2020; Iweka et al., 2021a; Jugu et al., 2025; Ikebudu et al., 2021). Recent developments that promise increased throughput and less kernel damage include sensor-based automation, hydraulic presses, and motorised rotary blades (O. D. K. et al., 2024; Nwankwo et al., 2012; Nwankwo et al., 2011; Vivian et al., 2025; Madukasi et al., 2025; Mulani et al., 2022). Despite these advancements, mechanised dehuskers have not been widely adopted because of a number of issues, including high costs, complicated maintenance, and a lack of understanding among farmers in underdeveloped nations (Adedipe, 2024b).

This paper provides a thorough review of coconut dehusking machines, looking at their working efficiency, design development, and processes (Owuama & Owuama, 2021; Swift et al., 2012; Onyenanu et al., 2015; Ubani & Onyenanu, 2024; Ukwu et al., 2024; Utu et al., 2024). The review's conclusions are especially pertinent to stakeholders in the agro-industry, agricultural engineers, and legislators looking for scalable ways to maximise coconut processing (Nnaji et al., 2024; Offodum et al., 2025; Okonkwo et al., 2012; Onyenanu & Nwigbo, 2021; Onyenanu et al., 2024). For example, low-cost, semi-automatic dehuskers might be advantageous for smallholder farmers in Southeast Asia and India (Senthilnathan et al., 2020), whereas large-scale growers might favour fully automated systems for increased productivity. This work adds to the continuing discussion on agricultural mechanisation and its role in attaining food security and economic resilience in areas that rely heavily on coconuts by bridging the gap between scholarly research and real-world applications.

Literature Review

Investigations on coconut dehusking mechanisms demonstrate an evolution from basic manual techniques to an advanced automated system. Manual devices, like blade assemblies and lever-based models, are simple and economical, but they have a poor throughput and place a lot of physical strain on operators (Kwangwaropas, 1991b; K & Naik, 2020). Improved ergonomics and operational efficiency are shown by semi-automatic systems, such as spiked rollers and hydraulic mechanisms, which may produce up to 240 coconuts per hour with dehusking periods of 3.34 minutes or less (Pascua et al., 2018; Anuar, 2022). These middle-range options strike a mix between cost and functionality, but they are limited by the maintenance requirements and fluctuations in coconut size. In contrast, dehusking times are reduced to 10–30 seconds and efficiencies of over 90% are achieved by automatic machines that are outfitted with motors, lead screws, and microcontrollers (Alcantara et al., 2010; Adebimpe et al., 2024). Cost, complexity, and low farmer knowledge continue to impede implementation despite their improved metrics. Although recent advancements incorporate user-friendly interfaces and cater to local coconut types, scalability and affordability issues still exist. The literature as a whole highlights a global trend towards mechanisation, with automatic and semi-automatic systems providing the optimum balance for different operational scales, especially in areas striving for sustainable agro-industrial transformation.

Methodology

A systematic literature review methodology was used in this work to compare manual, semi-automatic, and automatic systems to assess the mechanisms, design evolution, and operational efficiency of coconut dehusking machines (Kitchenham et al., 2009; Van Dinter et al., 2021). In order to find gaps and trends in agro-mechanization, the review methodology included design innovations, socioeconomic impacts, and performance indicators.

Data Collection Strategy

The Scopus database was chosen because of its thorough coverage of the literature on agricultural engineering and mechanisation and its strict adherence to peer-reviewed, high-impact publications (Aromataris & Riitano, 2014; Bramer et al., 2017). A Boolean search string combined key terms:

- *"coconut dehusking machine" OR "cocos nucifera dehusker"*
- AND (*"manual" OR "semi-automatic" OR "automatic"*)
- AND (*"design" OR "efficiency" OR "ergonomics" OR "cost-benefit"*).

The search spanned 1990–2024 to capture both foundational and cutting-edge studies, yielding 1,243 initial results. After screening for relevance and rigor, **25** papers met the criteria for final analysis.

Publication of Journals by Ranking

The publication trends illustrated in Figure 2 indicate a significant increase in research interest in coconut dehusking technologies during the previous decade, particularly between 2020 and 2024. The information shows a significant scholarly emphasis on cost-effectiveness, ergonomic design, and mechanization efficiency. The increasing demand for labor-saving alternatives in coconut-producing regions, where manual dehusking continues to be a supply chain bottleneck, is reflected in this rise. It is noteworthy that the agriculture sector is moving towards precision mechanization to close production gaps, as seen by the proliferation of studies on semi-automatic and automated devices, such as hydraulic presses and IoT-enabled dehuskers. This pattern is consistent with larger initiatives to conform to the Sustainable Development Goals (SDGs), especially in developing nations where occupational dangers and post-harvest losses are still prevalent. Another indication of the interdisciplinary convergence of engineering, ergonomics, and agro-technology in improving coconut processing is the increase in high-impact journal papers.

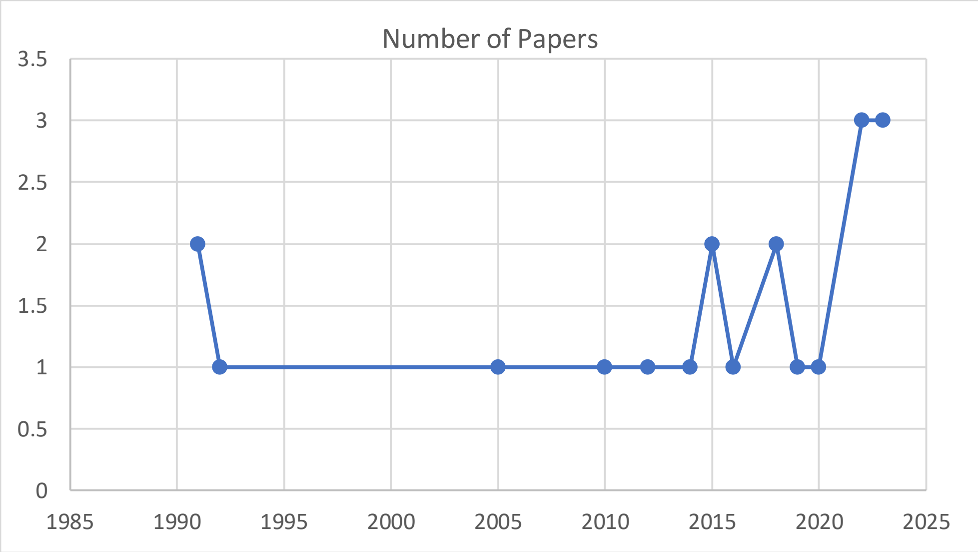

Figure 2: Graph of Journal Article by Year of Publication (Osobajo et al., 2017)

Results

A comparative overview was created to explain the operational variations and performance efficiency of several coconut dehusking methods. Table 1 compares manual, semi-automatic, and automatic dehuskers, focusing on key characteristics including dehusking time, capacity, efficiency, and mechanical setup. This table clearly illustrates the trade-offs between simplicity, throughput, and technological complexity across system types.

Table 1: Comparison of Manual, Semi-Automatic, and Automatic Coconut Dehusking Systems

System Type	Study Topic	Performance Metrics	Description	Citations
Manual	"Design, Manufacturing and Testing of the Manually Operated Coconut Dehusking Machine"	"Average dehusking speed is 30-35 seconds per coconut. Total dehusking cost is about 0.21 Baht per coconut."	"…consists of four main parts, ie, the frame, the lever mechanism, the dehusking mechanism, and the lifting mechanism in conjunction with the dehusking mechanism, while the other picks up, turning, and handling coconuts"	(Kwangwaropas, 1991b)
	"Manually Operated Coconut Dehusking Machine for Rural Agriculturist"	"From the results, it has been observed that a very small number of rejections, i.e., 97 percent good dehusked coconuts, were obtained. A common operator can dehusk approximately 100 coconuts per hour without any assistance."	The major parts of a manually operated coconut dehusker are blades, L-rod, disc lever, table, and spring. The L-rods pivoted to the disc plate at the bottom, when pushing the disc plate with the operator's leg that opens and penetrates the husk and pulls it away from the coconut."	(K & Naik, 2020)
	"Coconut Dehusking Machine"	"In this project, the model of the coconut dehusking machine is fabricated instead of the actual prototype."	"The piercing operation is when the ram is pushed, the top moving blade, top static blade, and bottom static blade pierce the coconut husk. In the peeling operation, the ram is depressed further until the top moving blade is pushed radially outwards. The bottom blade holder is then rotated using a bottom lever to apply shear force on the husk to remove it from the shell."	(Fahrurrazi et al., 2022)
Semi-Automatic	"Performance Characteristics of a Coconut Dehusking Machine"	"The superimposed contour plots of different factors generated an optimum region and yielded a dehusking performance with force requirement of 109.59 N, power consumption of 6.41 kW, dehusking time of 3.34 minutes,	"It is powered by a 7.5 hp gasoline engine and with an average output capacity of 240 coconuts per hour. Its salient features are as follows: a dehusking blade with cutting tooth and blade side face angle, movable coconut base assembly, ability to remove husks starting at the basal portion, which is	(Pascua et al., 2018)

		dehusking rate of 4 nuts per minute, and dehusking efficiency of 85.23 %."	the softest part of the coconut, and operable by a single person."	
	"Design and fabrication of an economical coconut dehusking machine"	"The output speed is reduced to 30 rpm by using a gear gearbox. When the coconut is placed between the spiked shafts rotating in opposite directions, the husk is peeled off from the coconut."	"The machine has two rotating shafts with spikes mounted on a frame. The shafts are rotated by a three-phase motor."	(R et al., 2018)
	"To Design a Semi-Auto Coconut Peeling Machine"	"It is estimated that the daily output rate is 220 coconuts, based on theoretical calculations."	"The machine weighs an overall total of 186.932 kg and consumes an overall total of 40.149 watts."	(Anuar, 2022)
	"Development and Improvement of the Hydraulic Coconut Dehusking Machine"	"The continuous dehusking speed was found to be 22.2 seconds per 2 coconuts."	"Each machine consists of the frame, a lifting mechanism, a dehusking mechanism, an ejecting mechanism, and a nuts pan. During operation, each operator put a coconut on the lifting mechanism to start the working cycle automatically."	(Kwangwaropas, 1992)
	"Conceptual Design of Coconut Dehusking Machine"	"The dehusking performed at a rate of 70-80 coconuts per hour."	"The machine will use a hydraulic system, including a ram, fed from a pump."	(Adzimah & Turkson, 2015)
	"Development of a Cost-Effective Coconut Dehusking Machine"	"Testing showed the machine achieving 90% dehusking efficiency at 120 nuts/hour."	"It consists of a rigid steel frame, two counter-rotating cylindrical drums fitted with spikes, an electric motor, a V-belt drive system, and a control panel."	(Onyenanu & Uwadibe, 2024)
	"Design and construction of a low-cost coconut husk removing machine"	"The unit can dehusk about 70 coconuts per hour compared with about 40 nuts per hour from a skilled worker using the spike method. Cost-benefit analysis indicates that it should be commercially viable."	"The machine with manual loading and unloading of coconuts will yield productivity higher than the existing process with less manpower. Also, the machine can accommodate different sizes of the coconut that are cultivated anywhere in Sri Lanka."	(Rizvi et al., 2023)
Automatic	"Automated coconut dehusking and cutting machine"	"A distinct advantage of the machine is that it can dehusk and cut a mature coconut in 10 seconds compared to a skilled worker, who will take an average of 13 seconds to do the same process."	"The machine clamp roller catches the coconut and pushes it towards the rotating spike rollers. Each spike roller rotates inwards at different speeds, thus allowing the coconut to rotate in its place and initiate the dehusking process. The spikes slide against the shell of the coconut and focus their force on the coir. Afterwards, the nut drops onto the cutting platform and activates the cutting clamp to push forward. The saw will cut the coconut into two parts and drop into the catchpan below."	(Alcantara et al., 2010)
	"Design Of an Automated Coconut Dehusking Machine with Radio Frequency Control and Lead Screw Mechanism"	"The average time taken to dehusk a coconut was 114 seconds. Compared to the manual method with a dehusking time of 513 seconds per coconut, the designed machine has a notable reduction in dehusking time."	"The machine uses electric motors to drive lead screws, which translate rotational action into linear movement. Effective husk removal is made possible by a tearing force mechanism attached to the lead screws and the machine's operations are coordinated by an Arduino with a "C" programming. A Radio Frequency (RF) module was used to automate the dehusking process. Control action of the RF module activates the rotation of the upper motor while the motion of the lower motor lifts the coconut placed in the coconut holder to the dehusking knife, where a tearing force would be exerted on the husk of the coconut."	(Adebimpe et al., 2024)
	"Design, Manufacturing and	"The average dehusking speed is 10-12 seconds/coconut."	A 1.5-kilowatt 220-volt electric motor is used for driving a hydraulic pump.	(Kwangwaropas, 1991a)

	Testing of the Hydraulically Operated Coconut Dehusking Machine"		The oil is delivered 50 kg/cm2 under working pressure at 14.2 liters/minute to feed the reducing circuit and sequence circuit to operate the lifting and dehusking mechanism."	
	"Development of a Modified Dehusking Machine for Local Varieties of Coconut"	"Performance test shows an efficiency of 90.4 % and dehusking of 80 coconuts per hour. No distortion of extracted fibre length was observed. It is appropriate for use in the sub-Saharan region."	"The machine consists of two rollers made up of mild steel with spikes, shafts, an electric motor, spur gears, block bearings, and a mild-steel frame. Torque and speed reduction required for de-husking were calculated for the average Nigerian coconut of 300-450 mm length, and 160-206 mm diameter."	(Olorunfemi et al., 2022)
	"Enhancing Coconut Processing Efficiency: Design and Evaluation of a Cost-Effective Coconut De-Husking Machine"	"Testing demonstrated that the machine consistently outperformed manual methods, reducing de-husking time to an average of 96.4 seconds compared to 164.8 seconds for traditional techniques…The machine achieved an efficiency rate of 80%, with a throughput capacity of 0.0086 kg/s, significantly higher than the manual method's 0.005 kg/s."	"The machine was designed to address key performance factors such as frame stability, blade strength, and spring tension."	(Adedipe, 2024c)
	"Design and Development of a Coconut Dehusking Machine (Machine Component Design)"	"The machine's average de-husking efficiency and capacity are 90.42% and 222 coconuts per hour, respectively."	"One electric motor (2 hp, 1500 rpm) is used to drive two shafts using a combination of pulley and belt. In between the motor and the shafts, one box of worm gears is used to reduce the rotation speed from 1500 rpm to 21 rpm (ratio 70:1). Two metal cylinders with a series of spikes are used to remove the husks from the coconut fruit and are attached to the rotary shaft."	(Azmi et al., 2015)
	"Design and Development of a Motorized Coconut Dehusking Machine"	"A dehusking capacity of 271 nuts per hour was obtained at an angular speed of 60 rpm. A dehusking efficiency of 100% was obtained when the machine was operated at an angular speed of 50 rpm and 70 rpm using different nominal diameters of nuts ranging from 212 mm to 248 mm and 248 mm, respectively. The dehusking efficiency decreased to 67% when the machine was operated at 60 rpm using nuts with a nominal diameter of 178 mm."	"…tested to evaluate its performance in terms of dehusking capacity, de-husking efficiency, percent nut damage and energy consumption at different angular speed of dehusking rollers and nominal diameter of nuts; three levels of dehusking roller's angular speeds (50 rpm, 60 rpm and 70 rpm) and three levels of nuts' nominal diameters (178 mm, 212 mm and 248 mm) were used."	(Galvan et al., 2018)
	"Development of Dry Coconut Dehusking and Deshelling Machine 3460"	"The maximum average value of percent husk removal was 85.42% and was observed at 55 rpm dehusking roll speed and 12.5 mm dehusking roll gap. The minimum time required to dehusk the coconut was 38.82 seconds at 65 rpm speed and 50 mm gap. The maximum average percent shell removed was 63.6% at 15 rpm deshelling speed. The minimum time required to deshell the coconut was 0.5 s at 30 rpm deshelling roll speed."	"The average weight, average length, breadth, and thickness of dry coconut were 323.52 g, 180.34 mm, 134.07 mm, and 126.44 mm, respectively. The majority of dry coconuts were egg-shaped, and very few were of pear shape. The average thickness and moisture content of husk were found to be 23.33 mm and 10.94 %, respectively. The average weight, length, breadth, and thickness of dehusked coconut were found to be 138.96 mm, 92.03 mm, 77.41 mm, and 77.04 mm, respectively."	(NALIAPARA, 2022)
	"Design and Development of	"Moreover, the machine performed above 92%	"The device is equipped with a limit switch to count the coconuts that have	(Calderon et al., 2023)

	Coconut Dehusking Machine Using Raspberry Pi”	efficiency in all the test cases, which significantly revealed the efficiency performance of eighty-seven percent (87%) overall efficiency performance out of one hundred fourteen (114) coconuts in ten series of actual testing.”	been dehusked and a 16 x 2-sized LCD for displaying several dehusked coconuts. Furthermore, the device is operated by 2 horse-powered Electric motors at a rotational speed of 1,800 rpm under a 220-volt main power source. A gearbox, roller chain, and sprocket with 60 x 3 in sizes are used extremely to decrease the speed and at the same time may increase the torque of the motor.”	
	“Modification and performance evaluation of the NCAM motorized coconut dehusking machine”	“The performance evaluation shows that the efficiency of the machine was 90.1% while the average capacity is 122 coconuts per hour.”	-	(Jimoh et al., 2023)
	“Development of Power Operated Coconut Dehusker”	“The average dehusking time required to dehusk one coconut was 30.6 seconds, and output capacity was 118 nuts per hour, which is 40 per cent higher than the manual dehusker. The average dehusking efficiency of the developed power-operated dehusker was 96.62 per cent.”	“It consists of main frame, electric motor, gearbox, cam and follower, lifter, holding mechanism, and splitting mechanism, etc. The power from the electric motor was transmitted to the gearbox. The coconut is fitted in two jaws, developed for holding nuts on both sides. The cam fitted on the gearbox shaft operates the lifter and blade for cutting coconut at the outer periphery. Coconut has to be rotated by the operator for 3-4 cuts on the coconut periphery to loosen the husk.”	(Patil et al., 2023)
	“Design, development, and performance evaluation of a power-operated coconut Dehusker”	“The average dehusking time for a developed power-operated coconut dehusker was 13.34 seconds with dehusking efficiency and output capacity of 98.42 and 180-200, respectively.”	“The developed dehusker has the parts like dehusking blade, supporting stand, electric motor with gear reduction arrangement using pulleys and worm gears, crank wheel, and connecting chain. The strokes at the dehusking blade were 27 strokes per minute, and these strokes/min were reduced from 1425 rpm at the electric motor.”	(Ghosal et al., 2014)

Discussion

A rigorous comparative analysis of coconut dehusking systems elucidates discernible performance stratifications corresponding to varying degrees of mechanization. Manual dehusking apparatuses, exemplified by the designs of (Kwangwaropas, 1991b; K & Naik, 2020), retain widespread popularity attributable to their low production expenses and mechanical straightforwardness. These models typically function within a time frame of 30–35 seconds per coconut, exhibiting hourly throughput capacities that oscillate between 80 and 100 coconuts. The 97% dehusking success rate reported by K & Naik signifies a degree of operational reliability; however, the labor-intensive characteristics of these systems impose physical exertion and constrain prolonged usage. Fahrurrazi et al. (2022) further illustrated that even mechanically augmented rams within manual configurations remain substantially reliant on user intervention, consequently diminishing ergonomic efficiency. Semi-automatic systems represent a substantial advancement in both throughput and operational consistency. Pascua et al. (2018) documented an 85.23% dehusking efficiency utilizing a machine capable of processing 240 coconuts per hour, powered by a 7.5 hp gasoline engine. In a similar vein, Onyenanu & Uwadibe (2024) attained a 90% efficiency rate at a throughput of 120 coconuts per hour, while Kwangwaropas (1992) evidenced a throughput of 22.2 seconds for every 2 coconuts employing a hydraulic configuration. Notwithstanding these enhancements, semi-automatic systems remain hindered by their reliance on manual loading procedures and the necessity for periodic maintenance. Anuar (2022) further highlighted those considerations regarding energy consumption and apparatus weight (186.9 kg) persist as critical factors for implementation in decentralized rural environments. Automatic systems eclipse other categories in terms of performance, realizing superior productivity with minimal human involvement. Ghosal et al. (2014) documented an efficiency rate of 98.42% alongside a throughput of 200–271 coconuts per hour, whereas Galvan et al. (2018) substantiated optimal operational performance at 60 rpm for nut diameters ranging from 212 to 248 mm. Alcantara et al. (2010) reported complete dehusking and segmentation accomplished in a mere 10 seconds per coconut through the utilization of synchronized rollers and clamps. Adebimpe et al. (2024) employed a radio-frequency-controlled lead screw mechanism, diminishing dehusking duration from 513 seconds in manual operations to 114 seconds, thereby reflecting a fivefold enhancement. Nonetheless, the intricate nature of sensor integration, elevated costs associated with motors, and requisite skill sets for operational management and maintenance continue to obstruct widespread adoption in economically disadvantaged regions. The summary of the findings is presented in Table 2 and Figure 3.

Although automatic machines are extremely efficient, their high capital investment and technological difficulties limit scaling in under-resourced situations. Semi-automatic systems provide a practical compromise, resulting in significant performance gains while keeping manageable costs and complexity. Manual systems, despite their lower efficiency, continue to meet specific niche needs when economical concerns and mechanical simplicity take precedence over speed.

Table 2: Comparative Performance Metrics of Coconut Dehusking System Types

System Type	Avg. Dehusking Time (sec/coconut)	Capacity (coconuts/hour)	Efficiency (%)
Manual	30–60	60–100	90–97
Semi-Automatic	22–60	120–240	85–90
Automatic	10–30	200–271	90–100

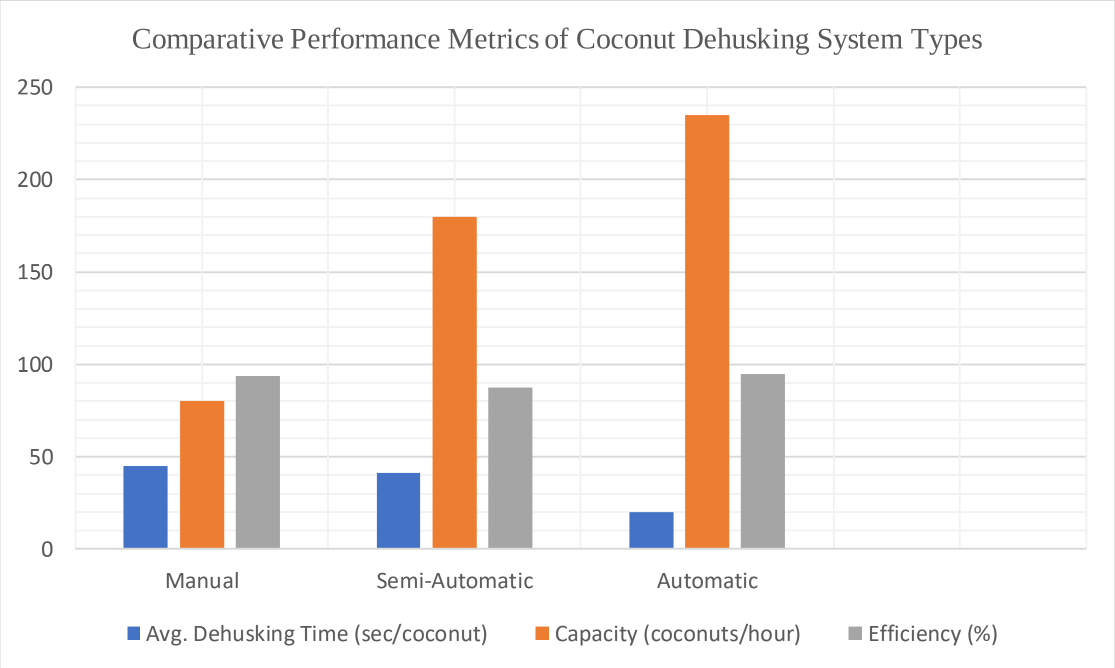

Figure 3: Graphical Representation of the Comparative Performance Metrics of Coconut Dehusking System Types

Conclusion

This review elucidates the progressive transformation of coconut dehusking technologies, transitioning from manual, labor-intensive implements to advanced automatic systems. The investigation emphasizes that although traditional manual huskers remain both accessible and economically viable, their limited throughput (60–100 coconuts/hour) and substantial physical demands constrain their overall efficiency and ergonomic viability. Semi-automatic devices present a pragmatic compromise, attaining higher throughput (up to 240 coconuts/hour) and moderate energy consumption; however, they still necessitate manual loading and regular maintenance. Automatic dehuskers, especially those that integrate hydraulic systems, lead screws, and sensor technologies, offer superior performance efficiencies (up to 271 coconuts/hour, 98–100% efficiency) with diminished operator engagement. Nevertheless, their intricate design, substantial initial investment, and operational complexity impede widespread implementation in rural or resource-constrained environments. The results indicate a prevailing global trend towards mechanization, alongside an increasing focus on ergonomic, economic, and sustainable methodologies for coconut processing.

To enhance the performance, accessibility, and sustainability of coconut dehusking technologies, the following targeted strategies are proposed:

- To increase energy efficiency and guarantee suitability in off-grid, rural settings, make use of renewable energy sources (such as solar-powered drives or hybrid systems).
- Create low-cost, modular automatic dehuskers with user-friendly interfaces and reduced maintenance specifically for smallholder farmers.
- To confirm the robustness, throughput, and safety of new designs in practical settings, carry out extended field testing and set standard performance benchmarks.

To lower manufacturing costs and encourage circular production methods, use locally produced resources in machine fabrication, such as recycled metals or bamboo-reinforced frames.

Conflict of Interest

The author declares no conflict of interest.

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Author contributions

All the authors contributed to the development of the work. All authors read and approved the final manuscript.

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