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Original Article

Development, Construction, and Testing of a Dehulling Machine

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Abstract *- Traditional methods of dehulling legumes and cereals such as sorghum, cowpea, maize, and groundnuts rely heavily on manual techniques, including palm rubbing and the use of pestle and mortar, which are labor-intensive, time-consuming, and inefficient. In this study, these limitations are addressed by designing, fabricating, and rigorously testing a novel motorized dehulling machine specifically tailored for legumes (cowpea and groundnut) and cereals (maize and sorghum). Operating on abrasion and centrifugal force principles, the machine effectively separates hulls from kernels through shear and impact interactions within the dehulling chamber. The motorized dehuller demonstrates significant advancements in dehulling efficiency and speed, achieving maximum efficiency of 85% for groundnuts in just 3 minutes, 81.3% for cowpeas over the same duration, and 64.3% and 83.3% for sorghum dehulling at 3 and 20 minutes, respectively. With a feed rate capacity of 4 kg of seeds every two minutes, this machine significantly improves over traditional manual methods by drastically reducing the time and effort required while maintaining high performance. Moreover, the design underscores the feasibility of developing high-performance agricultural machines using locally available materials and accessible technology, making it a transformative step toward modernizing small-scale agricultural processing.*

Keywords *- Dehulling, Seeds, Machine, Design, Hulls.*

1. Introduction

A dehulling machine strips away seed coats, enhancing the utility of seeds. These seed coats serve as protective layers for the valuable, edible grains enclosed within. Dehulling, in essence, involves the meticulous removal of the outer pericarp and testa, commonly referred to as the hull, during the processing of cereals, legumes, nuts, and oil seeds [1]. Among the array of edible grains and seeds that benefit from dehulling are chickpeas, sorghum, maize, soybeans, lentils, beans, peas, sunflowers, and peanuts. The hulls or seed coats of legumes, in particular, are unsuitable for consumption, necessitating their initial removal. This elevates primary legume processing, particularly dehulling, to a paramount step. Notably, dehulling not only reduces cooking time and mitigates the presence of antinutrients but also elevates the protein quality, palatability, and digestibility of pulses [2]. It is imperative to underscore that different legumes exhibit substantial variation in nutrition, flavor, structure, and culinary applications. Traditional methods of dehulling, often involving laborious techniques like the use of pestle and mortar, are time-consuming and physically demanding, typically carried out by women. In contrast, the utilization of a purpose-built dehulling machine stands as a superior alternative. It offers speed and precision, yielding well-refined seeds [3]. A dehulling machine typically features an electric motor indirectly connected to the shaft through V belts. These belts facilitate the necessary friction required to effectively dehull seeds by separating kernels from their seed coats [4]. While traditional techniques have served their purpose for generations, modernized dehulling machines drastically expedite the process, excelling at removing seed coats or hulls [2]. Dehulling, being a pivotal operation in post-harvest pulse handling, assumes a crucial role in the processing and incorporation of pulses into everyday diets [2]. Consequently, the design prioritizes the removal of seed coats from kernels as a fundamental consideration. The work of Ogunjirin et al. [5] focuses on the development and fabrication of a medium-scale motorized dry bean seed dehulling machine, utilizing an abrasive disc design to efficiently remove the seed coat from dry beans and other seeds. The main components of the dehulling machine include eight abrasive discs attached to a shaft within the dehulling chamber, which facilitate the dehulling process, while the chaff is expelled through a slot beneath the polishing chamber. The performance evaluation of the machine reported an output capacity of 1.04 tons per hour and an overall efficiency of 83.60%, demonstrating its effectiveness in seed processing and potential to enhance value addition in bean production. The description of the design, fabrication, and performance evaluation of a groundnut dehulling and separating machine aimed at enhancing oil extraction from groundnut seeds is reported by Adenıgba and Sedara [6]. The main components of the developed machine include two dehulling rollers, rubber beaters, a screen, a blower unit, and a seed and chaff outlet, all powered by a 3 hp electric motor. The performance evaluation reported optimal dehulling efficiency of 95.80%, separation efficiency of 81.40%, and minimal mechanical damage of 11.01% at a dehulling roller clearance of 7.35 mm and a speed of 700 rpm, with a machine capacity of 97.98 kg/h achieved at 750 rpm and 7 mm clearance.

The development and optimization of an African oil bean seed dehulling machine, aiming to enhance its performance parameters such as throughput, dehulling efficiency, mechanical breakage index, and labor requirements, were done by Ehiem et al. [7]. The main components of the dehulling machine include a feeding unit, dehulling unit, and discharge compartment, with specific dimensions designed for effective operation. The study reports that the machine achieves a maximum throughput of 41.09 kg/hr at a speed of 700 rpm and a boiling time of one hour, while the highest dehulling efficiency recorded is 95% at 448 rpm after four hours of boiling. Additionally, the research highlights the relationship between input variables (time, speed, and labor) and output variables (throughput, dehulling efficiency, and mechanical damage index), providing insights for optimizing the machine's performance.

The design and development of a low-cost sesame dehuller aimed at optimizing the dehulling process for sesame seeds are reported by Gojiya and Gohil [8]. The developed machine comprises three main components: a stand frame, a feeding and dehulling unit, and a power transmission system, which includes a screw auger that utilizes friction and abrasion to detach the hull from the seeds. Performance evaluations reported a dehulling efficiency of 79.29% under optimal conditions, with significant improvements noted in efficiency as dehuller speed, soaking time, and dehulling time increased.

Additionally, the economic analysis indicated a benefit-cost ratio of 1.95 and a payback period of just 11 months, highlighting its feasibility for small and medium-scale sesame processing industries. The design and preliminary evaluation of a dry cowpea dehulling machine to improve the efficiency of cowpea processing, which traditionally relies on labor-intensive manual methods, were conducted by Babalola et al. [9]. The main components of the developed machine include a hopper, power transmission drive, dehulling chamber, polishing chamber, sieves, discharge chute, and an agitator. Preliminary performance tests revealed that the machine achieved a maximum dehulling efficiency of 98.75% for the Oloyin variety and 97.43% for the Brown Drum variety, with a throughput capacity of 450 kg/hr when operated at a constant speed of 358 rpm, demonstrating its potential for enhancing cowpea production value chains.

Despite the advancements in dehulling technologies for specific seeds such as beans, groundnuts, sesame, and cowpeas, there remains a significant gap in the development of a versatile, motorized dehulling machine that can efficiently handle a broader range of seeds, particularly legumes like cowpeas and groundnuts, and cereals such as maize and sorghum. Existing designs often target single seed types or rely on optimal conditions, such as specific soaking or boiling times, which may not be feasible for mixed or large-scale operations. Furthermore, many of these machines exhibit limitations in throughput, dehulling efficiency, and adaptability across different seed types with varying sizes, textures, and structural compositions. A novel design tailored for legumes and cereals would address these challenges by incorporating innovative mechanisms to handle diverse seed properties, minimize mechanical damage, and improve throughput and efficiency. This study aims to fill this gap by developing a cost-effective, multi-functional dehulling machine, enhancing the value chain for these essential crops, and meeting the growing demand for efficient, scalable, and versatile processing solutions in both smallholder and industrial contexts.

2. Materials and Methods

This section presents a comprehensive overview of the materials, methodologies, calculations, and factors considered during the development of the dehulling machine. Sorghum, maize, cowpea, and groundnut samples were obtained from a local Johannesburg, South Africa market. Similarly, the materials used for constructing the dehuller were sourced from local suppliers within Johannesburg.

2.1. Design Consideration

A machine must not only exhibit practical correctness and reliable performance but also possess the capability to effectively execute the intended tasks of the proposed application. Moreover, it is desirable for a dehulling machine, beyond efficient performance, to consistently meet process requirements throughout its service life while incorporating design elements of durability and user-friendliness.

During the design phase of the dehulling machine, the following key factors were conscientiously considered:

- Availability of raw manufacturing materials
- Budget constraints
- Mechanical and physical properties of the materials
- Power requirements
- Ease of assembly and disassembly
- Safety considerations
- Resistance to corrosion, wear, and rust
- Operational speed of the mechanism

The design of the dehulling machine carefully integrated these essential prerequisites and functionalities, focusing on features such as continuous production and a well-regulated dehulling mechanism [10, 11].

2.2. Design Calculations

The design of the machine's components was guided by the mechanical and physical properties of the seeds involved [12]. In addition to these design considerations, the process incorporated fundamental dehulling machine principles, an understanding of seed characteristics (both legumes and cereals), and effective modeling of the dehulling process to inform the design calculations. The primary objective was to develop a machine capable of efficiently dehulling seeds while enhancing the overall dehulling process. To achieve this, several critical design factors were addressed, including the volume of the dehulling chamber, the dimensions of the feed hopper, the rotational speed of the pulley, the length of the belt, the diameter of the shaft, the estimated power required for effective dehulling, and the expected feed rate. The calculations, detailed in Equations 1-14, were instrumental in determining the sizes and specifications of the various components of the dehulling machine, as depicted in Figure 1.

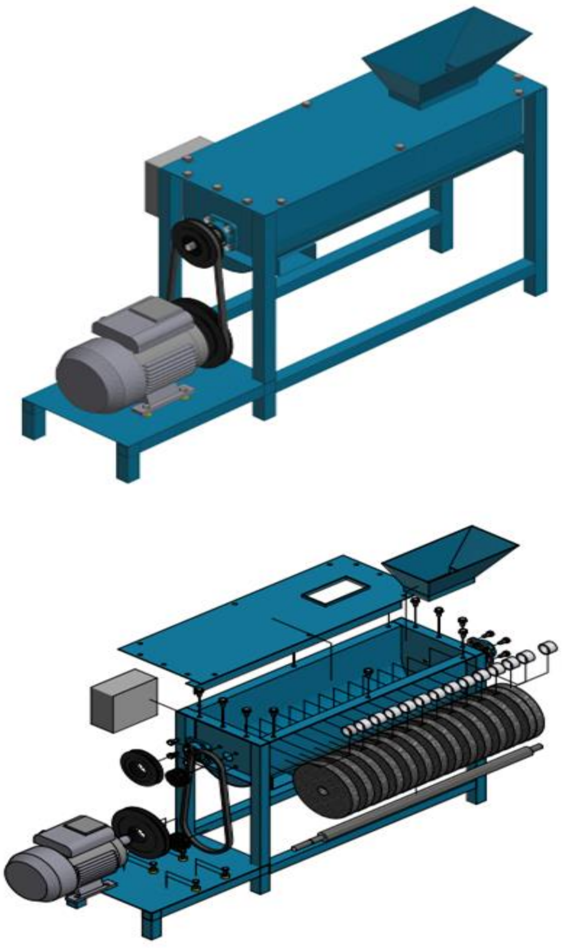

Fig. 1 Dehulling machine model

(1) Feed hopper design

$$A_1 = (l \times b) + (\sum \text{Parallel side of the trapezium section}) \times h \quad (1)$$

$$A_2 = (l \times b) \quad (2)$$

$$V = \frac{h}{3} \times \left(A_1 + A_2 + \sqrt{(A_1 + A_2)}\right) \quad (3)$$

(2) Design of the dehulling chamber

$$V_{dc} = \pi r^2 l + lbh \quad (4)$$

$$V_s = \pi r^2 l \quad (5)$$

$$V_d = (\pi r^2 l) \times \text{number of discs} \quad (6)$$

$$V_{spacer} = (\pi r^2 l) \times \text{number of discs} \quad (7)$$

$$V_{seeds} = V_{dc} - V_{disc} - V_{shaft} - V_{spacer} \quad (8)$$

(3) V belt Calculations

$$L = \frac{\pi}{2}(d_2 + d_1) + 4x + \frac{(d_2 + d_1)^2}{x} \quad (9)$$

(4) Torque

$$T = F \times d \quad (10)$$

(5) Power and efficiency

$$P_o = T \times \omega = T \times \frac{2\pi N}{60} \quad (11)$$

$$\text{Efficiency} = \frac{\text{Power output}}{\text{Power input}} \quad (12)$$

(6) Bearing Calculations

$$L_{10} = \frac{60NL_{10h}}{10^6} \quad (13)$$

(7) Speed on shaft

$$\frac{RPM_1}{RPM_2} = \frac{D_2}{D_1} \quad (14)$$

Table 1 shows the design parameters, symbols, units and the value computed for each of the parameters.

Table 1. Summary of calculated values

Design Parameter	Symbol	Unit	Value
Motor			
Torque	T	Nm	21.58
Power rating	P	kW	2.8
Shaft Torque	T	Nm	83.47
Shaft			
Mass	m_s	kg	5.267
Volume	V_s	m^3	0.000672
Weight	W	N	51.67
Reaction Supports	$R_A = R_B$	N	99.96
Torque	T	Nm	83.47

Feed hopper			
Area top part	A_1	m^2	0.0566
Area bottom part	A_2	m^2	0.0131
Total volume	V_T	m^3	0.0167
Dehulling chamber			
Circular volume	$V_{circular\ part}$	m^3	0.013
Rectangular volume	$V_{rectangular\ part}$	m^3	0.01996
Total volume	V_{total}	m^3	0.03296
Discs			
Volume	V_d	m^3	0.010996
Spacers			
Volume	V_{SP}	m^3	0.000281
Volume of legumes to be fed in the dehulling chamber			
Volume	V_{seeds}	m^3	0.0281
V belt (Pulley belt)			
Length	L	mm	1000
Bearings			
Radial load	P, F_r	N	25.84
Bearing life	L_{10h}	Millions rev	1800
Dynamic load capacity (**C**)	L_{10}	N	314.33
Shaft Speed RPM			
Speed	V	RPM	983

Fig. 2 A pictorial view of the fabricated dehulling machine

Fig. 3 A pictorial view of the fabricated dehulling machine connected to a variable speed drive (VSD)

2.3. Construction and Description of the Machine

Figures 2 and 3 illustrate the dehulling machine, showcasing its design and structure. The materials were carefully selected for their combination of local availability and high-quality attributes. These include mild steel, pulleys, shafts, angle irons, square tubes, taper locks, rubber bushes, motors, and belts, ensuring the desired functionality was achieved within a cost-effective budget. A typical dehulling machine comprises several key components: the feed hopper, dehulling unit (featuring rotating discs), dehulling chamber, motor, discharge chute, and frame [13]. The feed hopper, constructed from mild steel in a trapezium shape, has dimensions of 150 mm in height, 305 mm at the top section, and 155 mm at the bottom section, with a 60-degree inclination to enable the smooth flow of seeds into the dehulling unit. The dehulling unit, or mechanism, consists of rotating discs separated by spacers, all housed within the dehulling chamber. The schematic of the dehulling unit is shown in Figure 6, and the dehulling disc specifications are 25 x 32 x 200 mm, separated by the spacers of 25 mm lined by washers on the sides. The discs are mounted on a mild steel shaft of 30 mm to make the discs rotate. The rectangular frame that serves as the unit's support is made of angle iron and square tubes, measuring 1044 x 288 x 600 mm high. A 2.8-kilowatt gasoline engine provided the machine's power, which was then transferred to it using pulleys, belts, and a shaft.

2.4. Working Principle and Machine Components

The device operates on the principles of impact and centrifugal forces. The prime mover is activated and allowed to run for a brief period to bring the machine up to its operational speed. A consistent, gradual inflow of 4 kg of seeds is introduced through the hopper, ensuring controlled flow through the lower hopper opening and onto the rotating discs within the shelling unit. Inside the dehulling unit, the seeds are set in motion, colliding with the walls of the dehulling chamber and the rotating discs. These collisions weaken and ultimately break the hulls. After dehulling, the hulls and seeds are discharged through the chute for subsequent separation. Standard engineering procedures were followed during the design process, meticulously considering parameters and dimensions to ensure optimal functionality.

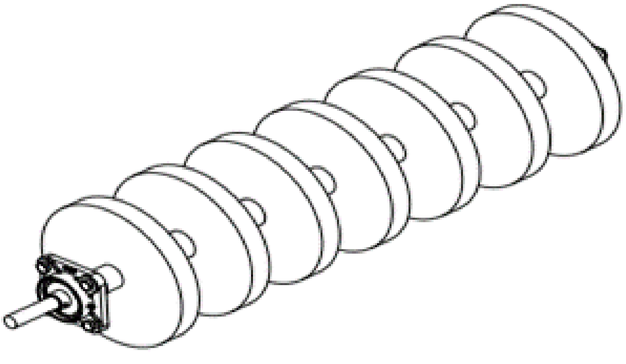

Fig. 4 Schematic of the dehulling unit

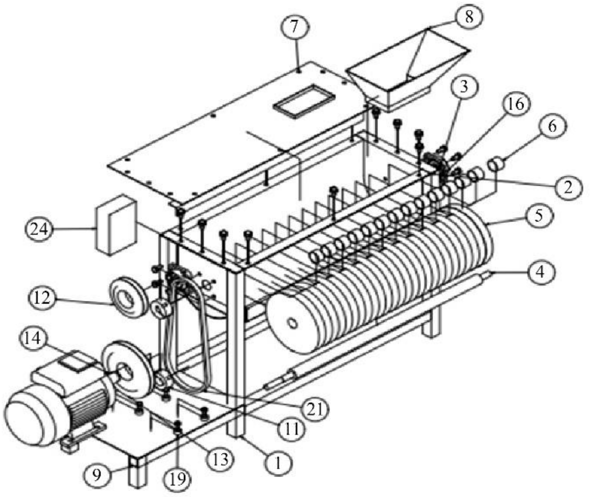

Fig. 5 Exploded view of the dehuller

The machine components are shown in Figure 5 and this consist of : (1) Frame; (2) Dehulling chamber; (3) Front + back cover; (4) Shaft; (5) Discs; (6) Spacer; (7) Top cover; (8) Hopper; (9) Engine frame; (10) (11) Taper lock; (12) Pulley; (13) Rubber bushes; (14) Motor; (16) Bearing; (21)V belt; (24) Control panel. Detailed descriptions of the sizes are provided in Appendices A.1 to A.10.

3. Results and Discussion

The dehulling machine is designed exclusively for hull removal in legumes and cereals, specifically for groundnuts, maize, Bambara nut, cowpea, and sorghum. This machine is tailored for application in rural areas, where small-scale dehulling is prevalent and in demand. It is equipped to process and dehull a capacity of 100 - 120 kg/h of seeds. The machine operates efficiently at a fixed speed of 600 rpm.

A comprehensive investigation was carried out to examine key dependent factors, including machine capacity, shelling efficiency, and overall machine efficiency. This analysis was conducted at two distinct moisture levels: 8.10% and 32.52%. During testing, the machine operated under low moisture conditions (8.10%) for cowpea dehulling and at higher moisture levels (32.52%) for maize processing. Only dry particles were introduced into the machine for both cowpea and maize to assess their impact on machine output, dehulling efficiency, and overall performance. It was observed that the machine achieved its highest output and efficiency levels at the lower moisture content. Moisture levels were accurately measured using an Ohaus moisture analyzer. Small samples of cowpea and maize were evenly distributed on an aluminum plate for analysis without prior grinding. The samples were vacuum-dried at 100°C, and the moisture analyzer provided results after a 10-minute cycle. The results indicated an inverse relationship between kernel efficiency and moisture content, where a decrease in moisture content corresponded to an increase in kernel efficiency.

Working on seed dehulling and threshing, the feed rates between a range of 1 kg/m and 2 kg/m were used. The feed rate values of 1 and 2 kg/m were tested to evaluate the performance of the dehulling machine. The federate was estimated using the following Equation:

$$\text{Feed rate} = \frac{\text{dehulled seed}}{\text{dehulling time}} \times 100 \qquad (15)$$

The operational speed of the seed dehulling machine was initially set at a fixed rate of 600 rpm. To thoroughly evaluate the dehulling process, assessments were conducted at varying speeds using a Variable Speed Drive (VSD) controller, which enabled precise adjustments to the motor's speed. The motor, mounted on the machine, facilitated multiple tests to determine the optimal speed for achieving the highest dehulling efficiency. Specifically, two speeds were tested: 300 rpm and 600 rpm, with three to four trials conducted at each speed to ensure accurate performance evaluation.

To evaluate the effectiveness of the dehulling process, four different types of seeds, as previously mentioned, were introduced into the machine's hopper during operation. Undehulled seeds, dehulled seeds, and broken seeds were separated and weighed, with the results meticulously recorded. Dehulling efficiency was determined by calculating the proportion of dehulled seeds to the total number of seeds processed. The overall machine efficiency was assessed based on the quantities of dehulled and undehulled seeds [14].

$$\text{E} = \frac{\text{dehulled seeds}}{\text{dehulled seeds+unhulled seeds}} \times 100 \qquad (16)$$

The results for sorghum, cowpea, maize, and groundnuts are presented in Tables 2-6. Two separate tests were performed on sorghum at different intervals to evaluate its performance. The initial test revealed that sorghum requires a longer dehulling duration than other grains. The efficiencies for a machine runtime of 3 minutes are shown in Table 2.

Figures 6a, 6b and 6c depict the unhulled sorghum, dehulled sorghum, and broken sorghum seeds, respectively. According to Table 2, the machine achieved a maximum efficiency of 64.3% after 3 minutes, leading to additional tests and further observations being recorded.

Table 2. Efficiency calculations of sorghum test 1

Seeds inserted (kg)	Speed (RPM)	Machine running time (min)	Dehulled Seeds (kg)	Undehulled Seeds (kg)	Breakage (%)	% Efficiency
1	300	3 min	0.3	0.3	0.4	50
2	600	3 min	0.9	0.5	0.6	64.3

Fig. 6(a) Undehulled sorghum

Fig. 6(b) Dehulled sorghum

Fig. 6(c) Sorghum broken seeds

Table 3. Efficiency calculations of sorghum test 2

Seeds inserted (kg)	Speed (RPM)	Machine running time (min)	Dehulled Seeds (kg)	Undehulled Seeds (Kg)	Breakage (%)	% Efficiency
1	300	20 min	0.6	0.3	0.1	66.7
2	600	20 min	1.5	0.2	0.3	83.3

The second sorghum test, which was carried out at a speed of 300 rpm and 600 rpm, generated more comprehensive and informative results than the initial dehulling test. The machine achieved an impressive 83.3% after 20 minutes, as reported in Table 3.

The efficiencies corresponding to a machine running time of 3 minutes are provided in Table 4. Figures 7a, 7b, 7c and 7d show, respectively the unhulled cowpea, the dehulled cowpea, the cowpea hulls and the cowpea broken seeds. As per Table 4, the machine achieved its maximum efficiency of 81.3% at the speed of 600 RPM.

Table 4. Efficiency calculations of cowpea

Seeds inserted (kg)	Speed (RPM)	Machine running time (min)	Dehulled Seeds (kg)	Undehulled Seeds (kg)	Breakage (%)	% Efficiency
1	300	3 min	0.4	0.4	0.2	50
2	600	3 min	1.3	0.3	0.4	81.3

Fig. 7(a) Undehulled cowpea

Fig. 7(b) Dehulled cowpea


Fig. 7(c) Cowpea hulls


Fig. 7(d) Cowpea broken seeds

Table 5. Efficiency calculations of maize

Seeds inserted (Kg)	Speed (RPM)	Machine running time (min)	Dehulled Seeds (Kg)	Undehulled Seeds (Kg)	Breakage (%)	% Efficiency
1	300	3 min	0.2	0.8	1	12.5
2	600	3 min	0.1	0.6	1.3	14.3


Fig. 8(a) Undehulled maize


Fig. 8(b) Dehulled maize


Fig. 8(c) Maize hulls


Fig. 8(d) Maize broken seeds

The efficiencies corresponding to a machine running time of 3 minutes are provided in Table 5. Figures 8a, 8b, 8c and 8d show the unhulled maize, the dehulled maize, the maize hulls and the maize broken seeds, respectively. As per Table 5, the machine achieved its maximum efficiency of 14.3% at the speed of 600 RPM. The efficiencies corresponding to a machine running time of 3 minutes are provided in Table 6. Figure 9a, Figure 9b and Figure 9c show, respectively the unhulled groundnuts, the dehulled groundnuts and the groundnuts' hulls. As per Table 6, the machine achieved its maximum efficiency of 85% at the speed of 600 RPM.

Table 6. Efficiency calculations of groundnuts

Seeds inserted	Speed (RPM)	Machine running time (min)	Dehulled Seeds (kg)	Undehulled Seeds (kg)	Breakage (%)	% Efficiency
1	300	3 min	1.4	0.6	1.6	70
2	600	3 min	1.7	0.3	1.8	85

Fig. 9(a) Undehulled groundnuts

Fig. 9(b) Dehulled groundnuts

Fig. 9(c) Groundnuts hulls

When seeds were not fully dehulled during the first pass through the machine, a second pass effectively completed the dehulling process. Observations during the experiments indicated that the number of seeds loaded into the machine at a time significantly affected the number of undehulled seeds. This highlights the importance of maintaining an optimal feed rate to enhance the dehulling process. The dehuller demonstrated a processing capacity of up to 120 kg per hour when operated with a feed rate of 4 kg/min.

4. Conclusion

This study successfully designed, fabricated, and tested a novel motorized dehulling machine tailored for legumes (cowpea and groundnut) and cereals (maize and sorghum). The machine, operating on the principles of abrasion and centrifugal force, demonstrated significant improvements over traditional manual methods, achieving efficiencies of up to 85% for groundnuts, 81.3% for cowpeas, 64.3% for sorghum (after 3 minutes), and 83.3% for sorghum after 20 minutes. The processing capacity of the machine reached 120 kg/h at an optimal feed rate of 4 kg/min, underscoring its potential for small- to medium-scale agricultural applications. The findings highlight the machine's ability to enhance productivity and reduce labor demands, making it an effective solution for rural and smallholder farming communities. Using locally sourced materials and accessible technology ensures cost-effectiveness and scalability, promoting broader adoption and modernization of agricultural processing in developing regions.

Future Directions

While the results are promising, further improvements can enhance the machine's versatility and performance:

- **Multi-Seed Adaptability**: Design refinements to optimize dehulling for a wider range of seeds, including hard-to-process cereals such as maize, which showed relatively lower efficiencies.
- **Material Durability**: Exploration of alternative materials or coatings to reduce wear and extend the lifespan of critical components, particularly in high-friction areas.
- **Automation**: Integration of sensors and control systems for real-time monitoring and adjustment of feed rates and operational speeds to maximize efficiency and minimize breakage.
- **Energy Efficiency**: Optimization of power usage to improve sustainability and reduce operational costs.
- **Scalability and Mobility**: Development of portable or modular designs to expand their utility in diverse agricultural settings.

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References

[1] T.O Omobuwajo et al., "Design, Construction and Testing of a Dehuller for African Breadfruit (Treculia Africana) Seeds," *Journal of Food Engineering*," *Journal of Food Engineering*, vol. 42, no. 3, pp.173-176, 1999. [CrossRef] [Google Scholar] [Publisher Link]

[2] Umaid Singh, "Methods for Dehulling of Pulses: A Critical Appraisal," *Journal of Food Science and Technology*, vol. 32, no. 2, pp. 81-93, 1995. [Google Scholar] [Publisher Link]

[3] Michael W. Bassey, and O.G. Schmidt, *Abrasive Disk Dehullers in Africa: from Research to Dissemination*, International Development Research Centre, pp. 1-109, 1989. [Google Scholar] [Publisher Link]

[4] Olugbenga Abiola Fakayode, David Eyo Akpan, and Olayemi Olubunmi Ojoawo, "Size Characterization of Moringa (*Moringa oleifera*) Seeds and Optimization of the Dehulling Process," *Journal of Food Process Engineering*, vol. 42, no. 6, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[5] O.A. Ogunjirin et al., "Development of a Medium Scale Motorized Dry Bean Seed Dehulling Machine," *Journal of Agricultural Mechanization (AGRIMECH)*, vol. 2, pp. 35-45, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[6] Ademola Adenıgba, and Adewale Sedara, "Design, Fabrication and Performance Evaluation of Groundnut Dehulling and Separating Machine," *Turkish Journal of Agricultural Engineering Research*, vol. 2, no. 1, pp. 104-123, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[7] J.C. Ehiem et al., "Determination of Optimum Performance Parameters of a Developed African Oil Bean Seed Dehulling Machine," *Umudike Journal of Engineering and Technology*, vol. 8, no. 2, pp. 1-12, 2022. [Google Scholar] [Publisher Link]

[8] Devanand Gojiya, and Vanraj Gohil, "Design and Development of Low-Cost Sesame Dehuller and its Process Standardization," *Journal of Food Science and Technology*, vol. 59, no. 11, pp. 4446-4456, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[9] Ayoola Abiola Babalola et al., "Design and Preliminary Evaluation of a Dry Cowpea Dehuller," *Agricultural Engineering International: CIGR Journal*, vol. 25, no. 2, pp. 254-262, 2023. [Google Scholar] [Publisher Link]

[10] Sunil Chikkaballapur Krishnappa, Shanmugasundaram Saravanan, and Venkatachalapathy Natarajan, "Development and Performance Evaluation of Foxtail Millet (Setaria Italica L.) Dehuller," *Journal of Food Process Engineering*, vol. 45, no. 6, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[11] Sunday Samuel Sobowale, "Design, Construction and Performance Evaluation of a Twin-Screw Extruder," *Agricultural Engineering International: CIGR Journal*, vol. 19, no. 4, pp. 181-186, 2017. [Google Scholar] [Publisher Link]

[12] Peter Pelumi Ikubanni et al., "Moringa Seed Dehulling Machine: A New Conceptual Design," *Journal of Production Engineering*, vol. 20, no. 2, pp. 73-78, 2017. [Google Scholar] [Publisher Link]

[13] SB Adejuyigbe, and BO Bolaji, "Design, Fabrication and Performance Evaluation of Beans Dehuller," *Journal of Science and Technology (Ghana)*, vol. 25, no. 1, pp. 125-132, 2005. [CrossRef] [Google Scholar] [Publisher Link]

[14] E. A. P. Egbe, and B. O. Roland, "Design, Fabrication and Testing of a Wet Legume Dehulling Machine," *American Journal of Mechanical Engineering*, vol. 4, no. 3, pp. 108-111, 2016. [Google Scholar] [Publisher Link]

Appendix 1

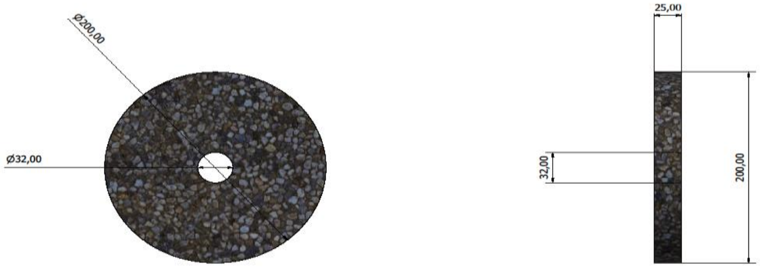

Fig. A1. Abrasive disks

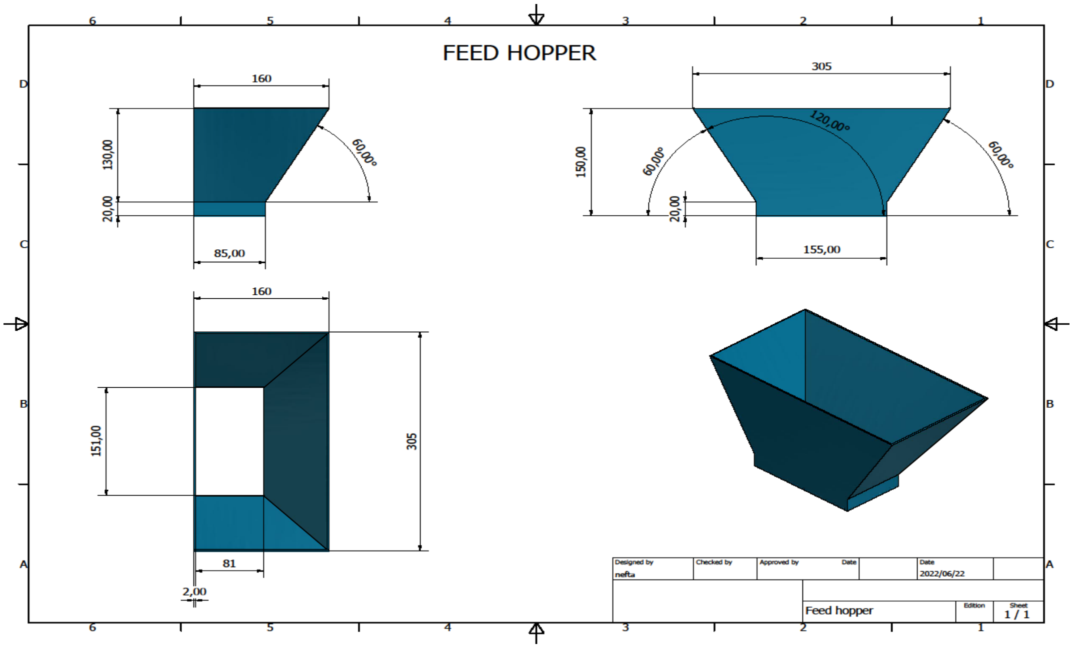

Fig. A2. Feed Hopper

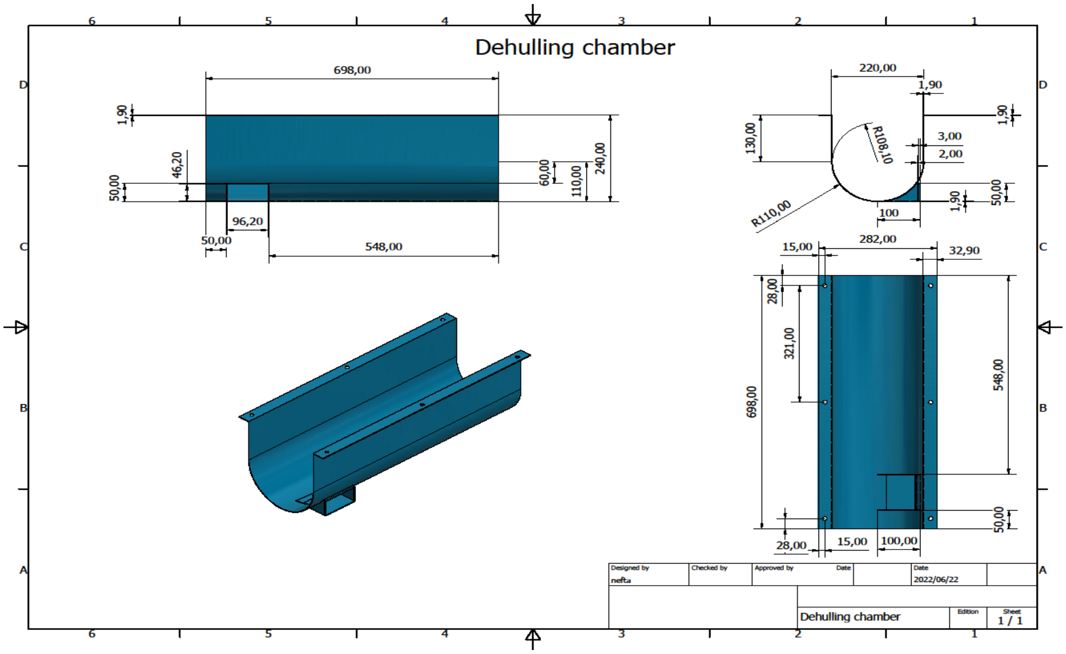

Fig. A3. Dehulling chamber

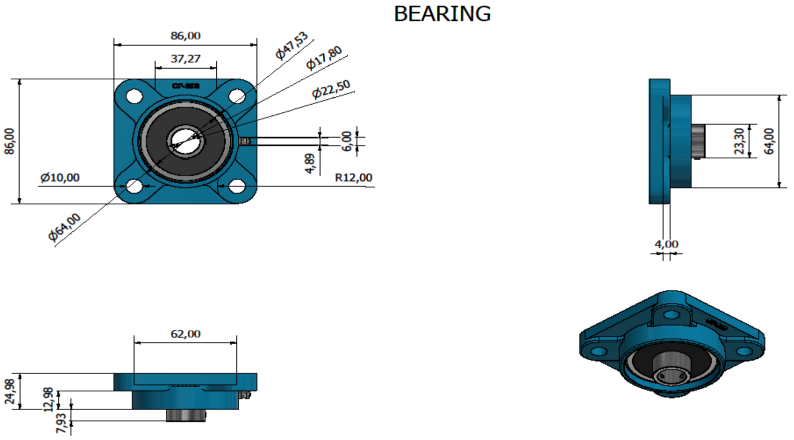

Fig. A4. Bearing

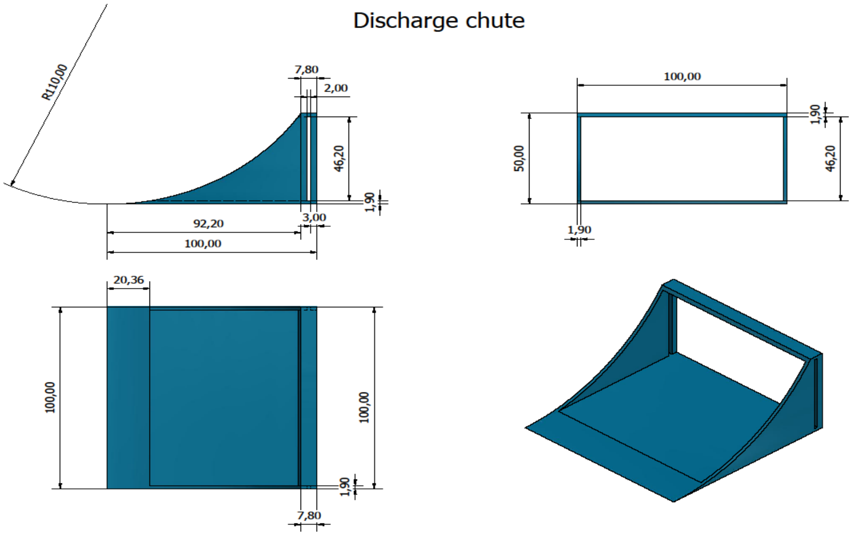

Fig. A4. Discharge chute

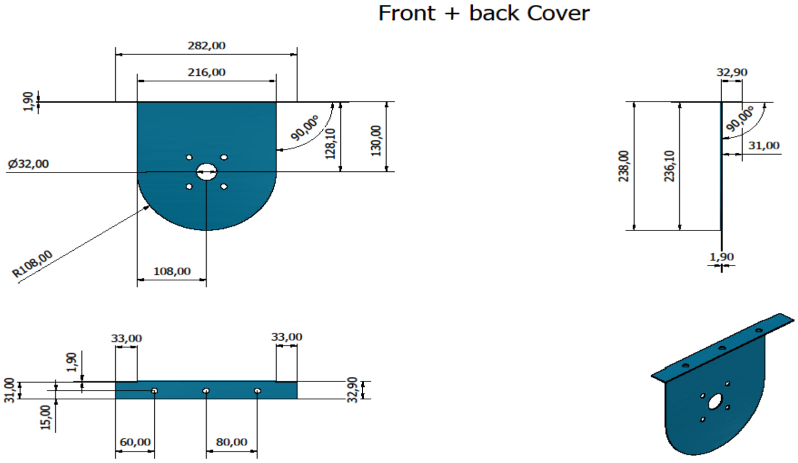

Fig. A5. Front and back cover

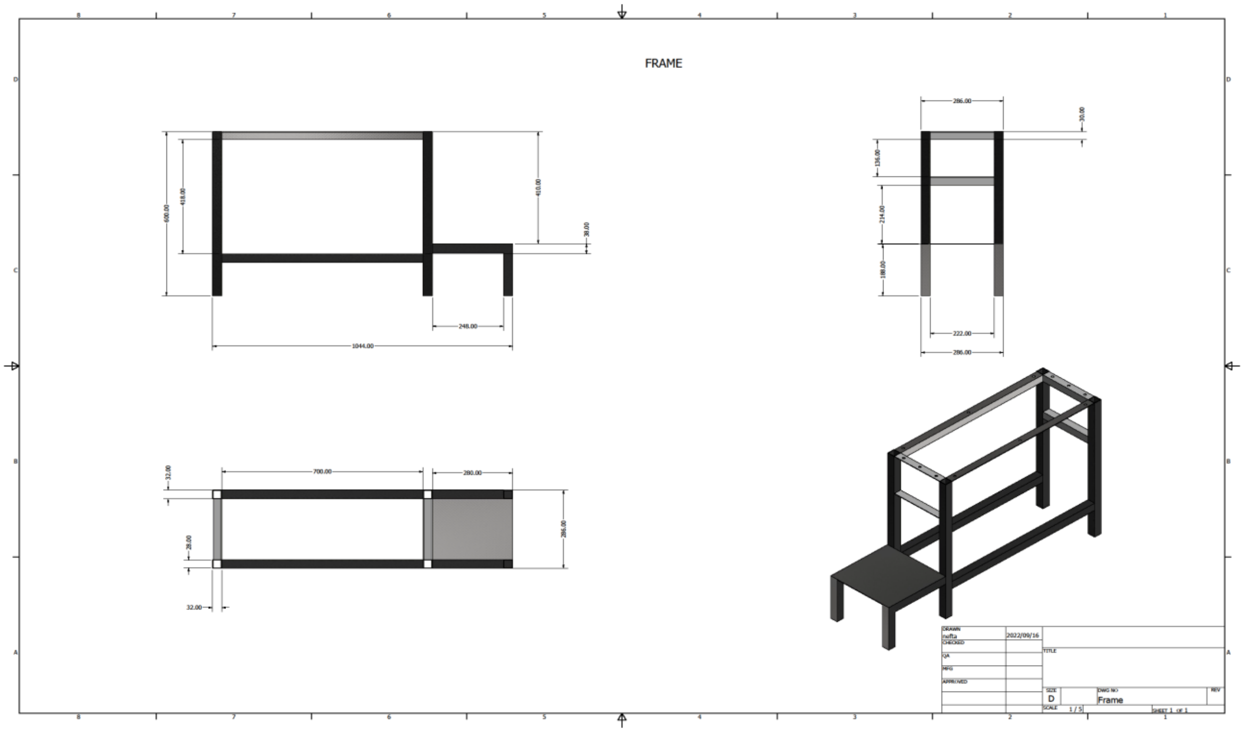

Fig. A.6. Frame

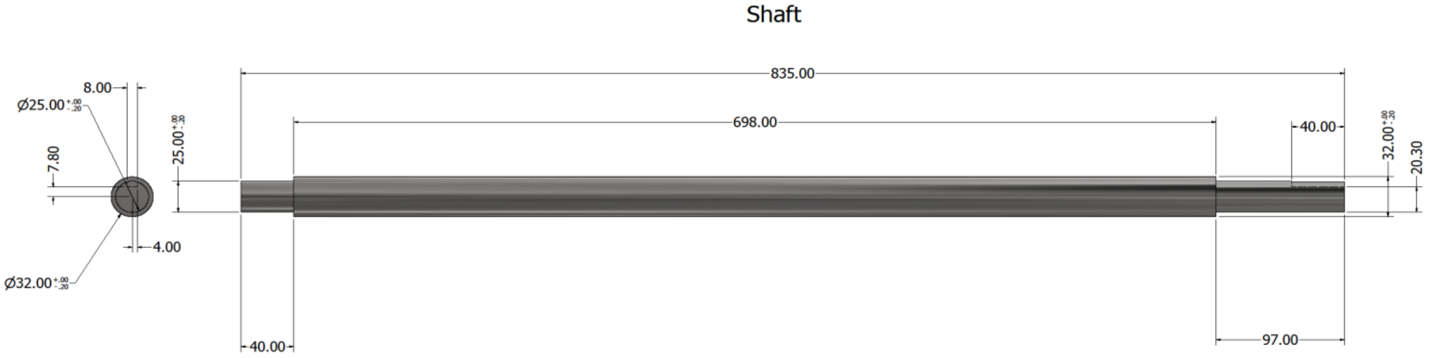

Fig. A.7. Shaft

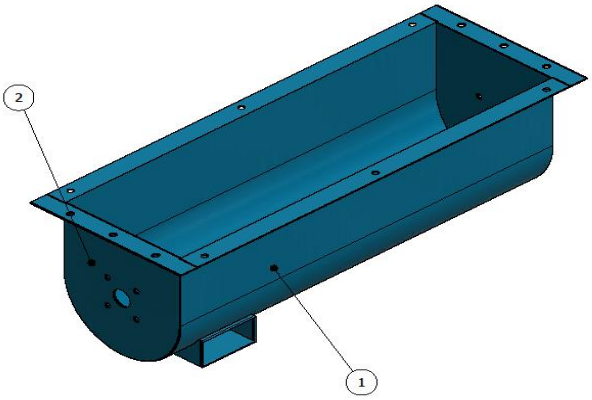

Fig. A.8. Dehulling chamber with no cover

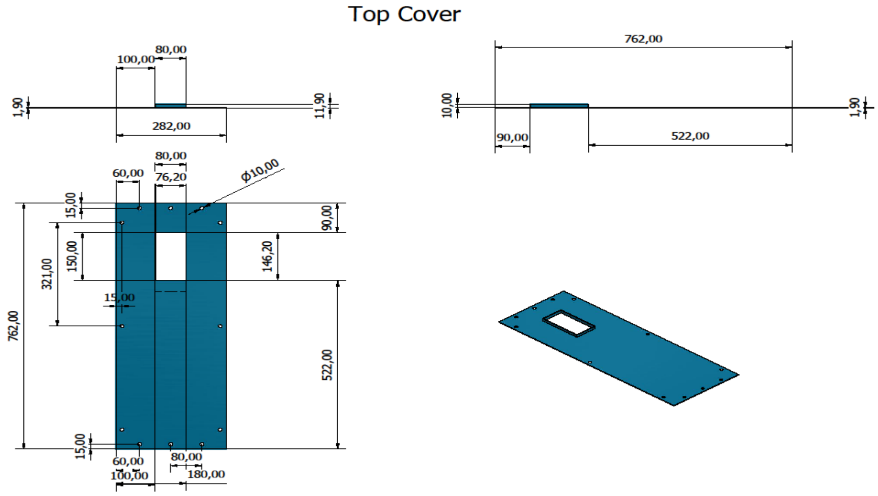

Fig. A.9. Top cover

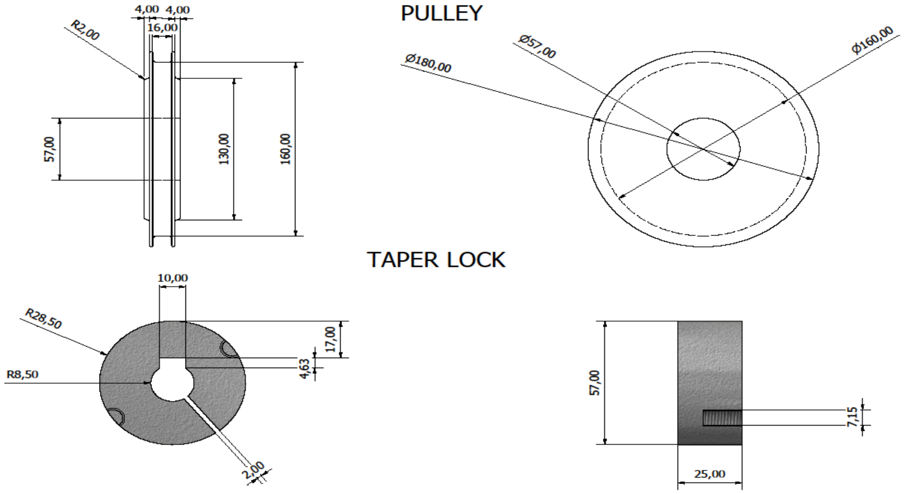

Fig. A.10. Pulley and taper lock