Journal of Applied Agricultural Science and Technology *ISSN: 2621-2528*
3 (2): 309-318 (2019)

DEVELOPMENT OF COCONUT DEHUSKER MACHINE FOR SMALL SCALE INDUSTRY

Fithra Herdian *, Sri Aulia Novita, Indra Laksmana, Mohammad Riza Nurtam, Rildiwan, Zulnadi

Department of Agricultural Technology, Politeknik Pertanian Negeri Payakumbuh, 50 Kota, Indonesia

*Coressponding author
E-mail: f.herdian@yahoo.com

Abstract. *West Sumatra-Indonesia has potential to plant coconut due to the coastal location, sunshine level with average temperature 27^{o}C. Coconut is a very productive plant. Coconut dehusking is one of the process that take a lot of time and energy. Most of the farmer still using human manual labor with the help of tools made of iron or wooden crowbar that is mounted standing vertically with blade facing upward about 80 cm from the ground. To increase the quantity of coconut products, it is designed the coconut dehusker machine. The main component of machine were two rollers that rotate each other in opposite directions with each roller embedded iron-shaped nails that work to tear the coconut husk. Each roller has a different rotational speed. This machine has dimensions of 98 cm x 51 cm x 95 cm. Roller length is 50 cm and diameter 4 inch. Power source of the machine is an 2 HP electric motor, the speed was reduced by using 2 speeds reducer with the ratio of 1:20 and 1:30 respectively. From the performance test of this machine can dehusk 100 coconut per hour. The operational basic cost of the machine equal to Rp 129.89 per coconut (about 1 cent) and Break Event Point is 12.387 coconut per year from the result of performance test. From the economic analysis machine can be concluded that the use of this machine is better when compared to human labor which has limitation to duration and capacity.*
Keywords: *coconut, dehusker machine, small scale industry*

1. Introduction

West Sumatera- Indonesia located in west part of Sumatera island with Coastline stretched along the provinceand the climate with temperature around 27^{0}C make this province very suitable for coconut trees. West sumatera have about 87.528 Ha coconut land and produced about 79.617 ton coconut each years.

Coconut husk is not as popular as fruit and coconut shell. Thought it has high economic value (Chauhan & Arya, 2018). However, the task such as stripping, decomposition and separation of cocofiber and cocopeat shoud be done (Ngadiman et al., 2018).

Coconut dehusker is the most consuming part of manpower and time. Some traditional tools are used are machete, silo, and semi-mechanical tools. With that

https://doi.org/10.32530/jaast.v3i2.125

consideration the research team tried to make coconut dehusker mechine to improve the quality and quantity of coconut processing (Jacob & Rajesh, 2012).

Some improvements of existing design such as increase the effectiveness of stripping by modifying the blade, reducing the risk of damage of shells by adding a wedg,e on the side of the blade, finding the optimal torque, rotation speed, and the angle of the blade with algorithm tools like PID control. This research is done to increase utilization of coconut husk and to make design and producing coconut dehusker machine.

2. Material and Methods

Functional Design

Literature and survey to stakeholders such as coconut farmers, distributors and retailers was condusted before deciding the appropriate method of solving problems of dehusking machine (Deokar, Malaviya, Mistry, Chaudhari, & Dutta, 2017) (Widananto & Purnomo, 2013).The design is done based on the problems found in the field and has been established problem-solving methods based on the results of the discussion of the research team. The making of drawing design base on problem-solving and the needs of stakeholders. Determination of components of machinery, tools and supporting materials.

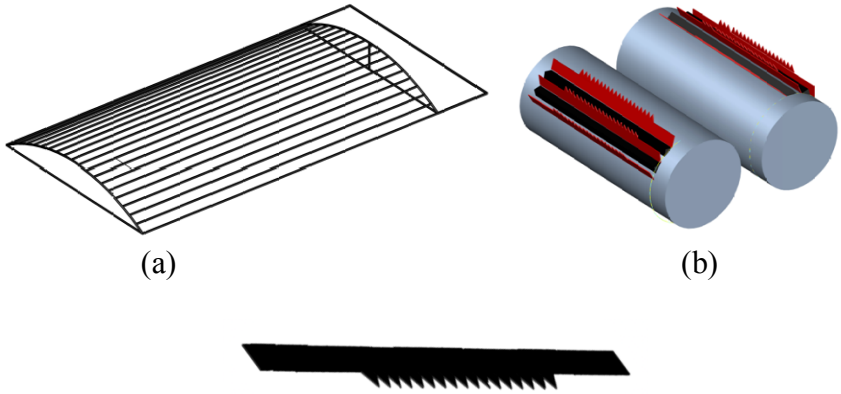
Some issues which were found during manufacturing process are dehusking blade modifications and the slope of the knife to improve the effectiveness of stripping, additional of wedge on the side of knife to reduce potential damage to the shell, determination the optimal rpm and adding a reversing switch on the edge of the machine and easy to reach by the operator and adding a pressure handle to the top of the engine, serves to increase pressure on the coconut and as a safety device

Table 1. Functional design

Main Function	Consideration	Component
Dehusking coconut and does not cause shell damage with efective and eficient performance	- As operator aids to increase pressure on the shell and can increase the effectiveness of stripping. - Operator safety tools	Top handle operator
	Place of position of knife implement	roller
	Implemen of coconut dehucking	knife
	Power source	electric motor
	Power transmition	chain and gear
	Reduction of rotation	Speed reducer
	Container and separation of coconut fiber and cocopeat	Container and separator of coconut husk

	Rotation control	VFD Inverter
	Revertion rotation	Revertion control

Structural Design



(a) (b)

(c)

Fig. 1. (a) Handle, (b) Roller and (c) Knife

Figure 1 shows the handle that has function to protect and it will switch off the machine when it open. The two rollers has opposite direction. On the roller the knife is installed for shredding the husk of coconut. Figure 2 shows the machine design.

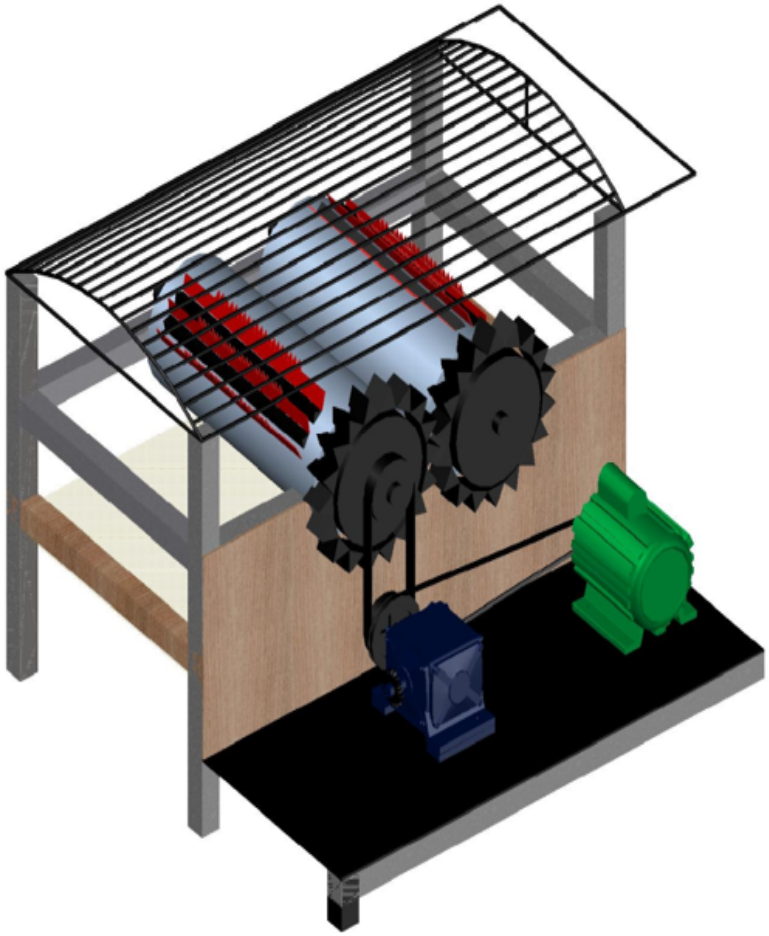


Fig. 2. The coconut dehusker machine

Circuit Model of rotation control

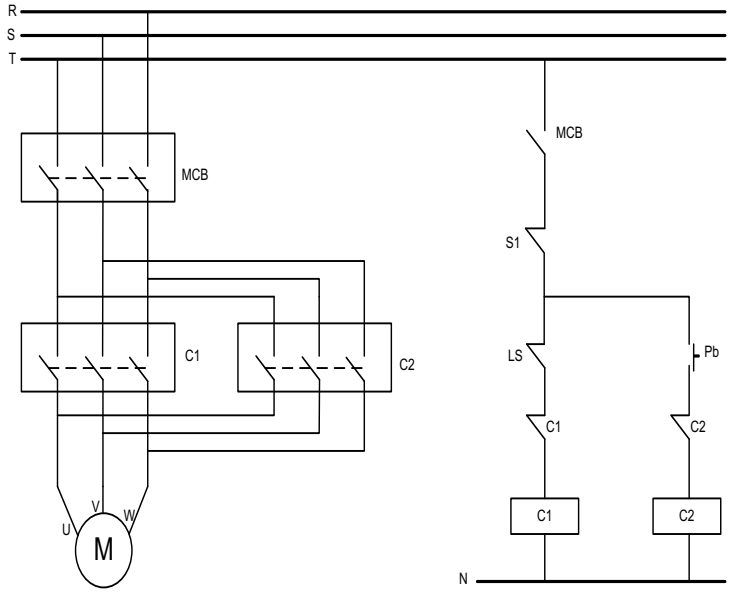


Fig. 3. Circuit diagram of the motor

The circuit in figure 3 is a series of motor rotation controller for coconut dehusker. C1 is the main contactor. When the machine works to peel the coir, then this contactor switch will be in connected state, this switch connects 3 phase motor with utility. Whereas C2 actives, then the motor will work in the opposite direction.

For controlling the speed the motor is connected to Variable Speed Drive inverter . Programming this inverter can make the machine be more efficient and effective for dehusking.

Performance Test

Performance tests include: capacity, stripping perfection, tested from observation and percentage of material damage. Capacity are calculated using a formula :

$$CP\left(\frac{piece}{hours}\right) = \frac{Q\ (piece)}{T\ (hours)}$$

CP = Capacity (piece/hours)

Q = Quantity (piece)

T = Time (hours)

Economical Analysis

The economical analysis of the machine can be calculated using fixed cost, variable cost and number of working hours per year and the effective working capacity of the machine. Similar analysis have been used in: Nurmeji et al., (2019); Prayogi et al., (2018); Womsiwor et al., (2018); and Jabbar et al., (2018) here are some calculated variables:

Break event point:

BEP aims to know the minimum production volume so that the income will cover the total cost of production. BEP can be calculated using the equation:

$$BEP = \frac{FC}{\left\{PSP - \left(\frac{RMP}{\eta}\right) - \left(\frac{VC}{CP}\right)\right\}}$$

BEP = Break event point (piece/years)

FC = Fix cost (Rp/years)

VC = Variable cost (Rp/hours)

PSP = Product selling price after processed by machine (Rp/piece)

RMP = Raw material prices (Rp/piece)

η = Rendement

CP = Capacity

Fix cost component:

$$FC = D + I$$

FC = Fix cost (Rp/years)

D = Depreciation machine (Rp/years)

I = Capital interest (Rp/years)

Depreciation of the machine:

$D = (P - S)/N$ (straight line methods)

D = Depreciation of the machine (Rp/years)

P = Machine price (Rp)

S = End price of machine (Rp)

N = Economic life (years)

Capital interest :

$$I = \frac{r(P+S)}{2}$$

I = Capital interest (Rp/years)

r = Interest rate of bank (%)

P = Price of machine (Rp)

S = end price of machine (Rp)

Variable cost :

$$VC = M + W$$

VC = Variable cost (Rp/hours)

M = Maintenance cost (Rp/years)

Maintenance cost:

$$M = \frac{2\%(P - S)/}{100 \text{ hours}}$$

M = Maintenance cost (Rp/years)

P = Price of machine (Rp)

S = End price of machine (Rp)

Operational costs are the expenses which are related to the operation of a business, or to the operation of a device, component, piece of equipment or facility.

$$CGP = \frac{\left\{\left(\frac{FC}{n}\right) + VC\right\}}{EC}$$

CGP = Cost of goos processing (Rp/kg)

FC = Fix cost (Rp/years)

VC = Variable cost (Rp/hours)

n = Working hours per years (Hours/years)

EC = Effective capacity (kg/hours)

3. Result And discussion

Design and Performance Test

Inovation in this research relates to a cylindrical double roller for dehusking coconut coir equipped with an elbow peeler to hold the coconut shell so that it does not break when the coconut is peeled and the coconut coir toothed so as not to accumulate in the roller. Some machine which has almost similar machine design such as in (Putera, Intan, Mustaqim, & Ramadhan, 2019) Coconut dehusking is one of the processing step that takes a lot of time and energy. Coconut peeler machine is aim to increase the quantity of coconut products.

The main components of the machine are two rollers that rotate in opposite directions with each roll having an iron-shaped that serves to tear off the coconut husk. Each roll has the same rotational speed. This machine has dimensions of 98 cm x 51 cm x 95 cm. The length of the roller is 50 cm and the diameter is 4 inches. Engine power is 1 phase electric motor, 1 HP and speed 1400 rpm, speed is reduced by using 1 (one) speed reducer with 1:20 ratio and sprocket and chain with ratio 1: 4.

This machine is arranged braking and reversing direction of rotation using contactor. The blade is made in a serrated manner so that the pressure produced is greater. To prevent

rupture of coconut shell, mounted elbow holder parallel to roller. Meanwhile, to remove the fiber then mounted serrations opposite the blade.

Performance Test

The performance test shows the machine capability to dehusk 100 coconut per hour. Following table show the result of performance test:

Table 2. Performance test of the machine

No	Variable	Unit	Nominal
1	Machine Price	Rp (IDR)	10000000
2	End Price	Rp (IDR)	1000000
3	Interest rate	%	12
4	Work time per day	Hours per day	6
5	Work time per year	Hours/year	1878
6	Operator wage	Rp/hour	12500000
7	Acumulated depretiation of equipment	Rp/year	1800000
8	Maintenance cost	Rp/hour	1080
9	Energy cost	Kwh (Kilowat Hour)	2200
10	Fix cost	Rp per hour	2520000
11	Interest rate cost	Rp/ year	720000
12	Variable cost	Rp/ year	15780
13	Processing cost	Rp/piece	23
14	Break event point	Piece/year	9084

Several factors affecting engine capacity were type and volume of coconut, skill of operator and speed of RMP roller

If added with time operator replace the shell, we can assume total time consume approximately 30 second/piece with RPM about 50. machine have 1500 watt power, 3 phase. To improve safety, effectiveness and comfort of operator machine added pressure handle on top of this machine.

Economic Analysis

The economical analysis of the machine can be calculated using fixed variable cost, fixed cost and number of working hours per year and the effective working capacity of the machine. Folowing table show the result of economic analysis. Figure 2 shows the machine design.

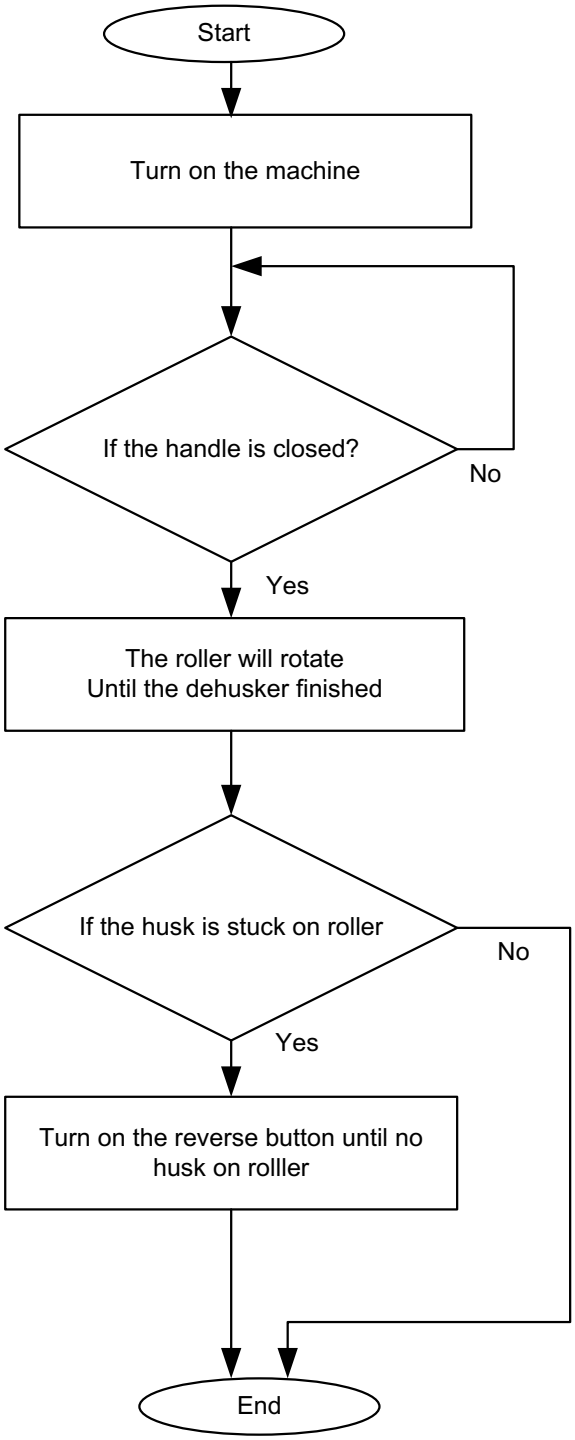


Fig 6 . Flowchart of operational machine

Fig. 8 . The coconut dehusker machine

Based on the above performance test is recommended for future work to reduce acumulation coconut fiber by modification sharp implement with conical and to change the slop of roller to make shell easier rolling.

Acknowledgment

The author would like thank to Ministry of Research, Technology and Higher Education of Indonesia who has funded this research through the University Collaboration Research Scheme of Higher Education.

References

Chauhan, N., & Arya, N. (2018). Coconut fiber: A natural versatile material. *International Journal of Chemical Studies*, *6*(6), 555–561.

Chauhan, N., & Arya, N. (2018). Coconut fiber: A natural versatile material. *International Journal of Chemical Studies*, *6*(6), 555–561.

Deokar, K., Malaviya, K., Mistry, K., Chaudhari, P., & Dutta, M. (2017). Design and Manufacturing of Coconut De-Husking, Cutting and Grating Machine. *International Journal of Engineering Science and Computing*, *7*(4), 6571–6574.

Jabbar, R. J., Ihsan, S., Gusnedi, P., & Zuladha, A. (2018). Rancang Bangun Mixer Adonan Kerupuk Tipe Horizontal. *Agroteknika*, 1(2), 89-98. https://doi.org/10.32530/agtk.v1i2.26

Jacob, J., & Rajesh, K. S. (2012). Design and fabrication of coconut dehusking machine. In *2012 International Conference on Green Technologies (ICGT)* (pp. 155–159). IEEE. https://doi.org/10.1109/ICGT.2012.6477964

Ngadiman, N., Kaamin, M., Abd. Kadir, A., Sahat, S., Zaini, A., Nor Zentan, S. R., … Wan Amran, W. H. A. (2018). Panel Board From Coconut Fibre And Pet Bottle. *E3S Web of Conferences*, *34*, 01014. https://doi.org/10.1051/e3sconf/20183401014

Nurmeji, Lisman, F., Yuni, Syahriza, R., Nurtam, M. R., Djinis, M. E., Irzal, & Amrizal. (2019). Rancang Bangun Alat Pemipil Jagung Sederhana. *Agroteknika*, 2(1), 11-19. https://doi.org/10.32530/agtk.v2i1.30

Prayogi, G., Wahyudy, R., Yogaswara, S., & Primayuldi, T. (2018). Rancang Bangun Mesin Pengupas Tempurung Kelapa. *Agroteknika*, 1(2), 77-88. https://doi.org/10.32530/agtk.v1i2.24

Putera, P., Intan, A., Mustaqim, F., & Ramadhan, P. (2019). Rancang Bangun Mesin Pengupas Sabut Kelapa. *Agroteknika*, *2*(1), 31–40. https://doi.org/10.32530/agtk.v2i1.31

Widananto, H., & Purnomo, H. (2013). Rancangan Mesin Pengupas Sabut Kelapa Berbasis Ergonomi Partisipatori. In *IENACO* (pp. 1–8).

Womsiwor, O., Nurmaini, N., Zikri, A., Hendra, H., Amrizal, A., Yudistira, Y., & Batubara, F. (2018). Rancang Bangun Mesin Pengupas Dan Pencuci Singkong Tipe Horizontal. *Journal of Applied Agricultural Science and Technology*, 2(2), 11-19. https://doi.org/10.32530/jaast.v2i2.40