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The Performance Design of Betel Nut Cutter in Rural Areas

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ABSTRACT

Betel nut is one of leading agricultural commodity in Indonesia. The economic prospect of Betel Nut could support financially the people which resided in country-side to a new level of prosperity. The increasing of betel nut demand especially which derived from outside of country such as India and Thailand of the Betel Nut which is used as the raw material for medicine and cosmetic products will need new machine design of betel nut cutter to supply the demand. Current process of betel nut manufacture is still use a hand-tool for cutting the Betel Nut in rural areas. It takes lot of time and resulted low productivity. The design of the machine betel nut manufacture provides the solution to increase the productivity and low production cost because of cut in half process is still manually. This equipment can produce the cutting work with average 300 Betel Nut per hour. The force resulting from lever is 0.03 N and the cutting speed for 1 fruit only takes 4 seconds. This equipment is able to cut in half of two or three the Betel Nut in one time. This cutting machine prototype has been used widely in rural area of Riau province like village of Penyalai-Kuala Kampar, district of Pelalawan and several villages in the district of Indragiri Hilir.

KEY WORDS: *Betel Nut, Forces, cut, Time, performance.*

1.0 INTRODUCTION

Machine denotes the medium of exchange in manufacture. The equipment is needed to process the rural agriculture commodity effectively, efficiently and safely to obtain the optimized production process. Appropriate technology is one of technology which applied in rural areas to assists in the betel nut process. Based on the survey, the farmer community is in need of betel nut process machine where the machine design should consider concerning low cost of construction, easy operation and maintenance, portable and high production capacity when compare to the manual process. Therefore, the machine design provides benefit to farmer community.

Refer to the observation in rural areas of Riau province, the betel nut is able to be potential commodity to drive the economics growth of rural industry. In addition, the high demand of betel nut continuous to increase each year will trigger this commodity to be a valuable price product. The current betel nut process is still using the simple tools traditionally. Therefore, In order to increase the production capacity of betel nut in rural areas is to be the reason to propose a new model of betel nut cutting process. The design of this equipment was conducted compactly and simple to be used by any people. This equipment is also consists of machine elements that easy to construct and maintenance with the result that low cost construction and operation by considering the production capacity of betel nut will reach to 20 kg per hour. When compare to traditional simple tool, the production capacity reach only 20 kg per 3 hours. So the new design of betel nut cutter machine will contribute to optimize the production capacity.

Betel nut has mean value of price higher than other agriculture commodities. By cutting in half will make the betel nut selling price more valuable. The traditional cutting process of betel nut will consume time too long. When refer to cost of production, it will be expensive and reduce the benefit. Therefore, the aim of this machine is to provide the optimization of production capacity efficiently and effectively.

2.0 LITERATURE REVIEW

Nithin et al (2015) presented a study of betel nut husking machine and developed the model design of machine. The process is called husking of green betel nut. This machine consists of 4 parts of component such as blade, blade holder, rotating ring and base

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holder. The working system is to peel off the betel nut completely with resulted in round betel nut (No splitting). The design is simple which is driven by hand and it is able to produce to 5 kg per hour. Whereas betel nut which peel manual process will obtain the production rate of 3 kg per hour. This equipment is able to increase the production capacity.

Wanida et al (2006) made design of betel nut slitting machine that applied in appropriate technology for Thai agriculturists. This machine produces slitting betel nut product which dried in the sun later, in order to be used as raw material in chemical industries. There are two parts of the machine; container part used for keeping and feeding the betel nut fruits to the next part, and cut part used for slitting the betel nut. The iron box is used for keeping the betel nut fruits before they are conveyed to the cut part by the belt conveyor. the machine capacity is 70 kg /hour and generated good result of the fresh slit betel nut.

Nwakaire et al (2011) conducted a design of maize thresher in rural dweller in order to support the farmers to process their agriculture products efficiently and effectively and contributing to the increase of the net profit in rural areas. Maize thresher machine is similar to milling process in modern industry widely used in many agriculture products. In the working system, maize threshing machine used an electric motor as a prime over. This machine saved the cost production up to 56.6%. By using an electric motor, the optimization of production capacity will be obtained.

3.0 THEORETICAL CONCEPT

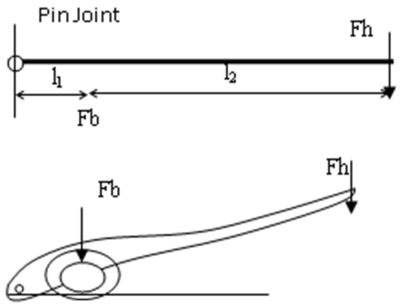

Figure 1: Free Body Diagram of Betel Nut Machine

Figure 1 displays the free body and diagram and describes the working principle of betel nut cutting process, the force acting on rotating lever can be configured as follow:

$$F = m.\omega^2.r \quad (1)$$

Where m is cutter blade mass (kg) $= \rho v$, ρ is mass density (kg/m^3) and v is blade volume (m^3), ω is angle velocity defined by Δθ/Δt (rate of change of angle over time), r is radius of blade. For cutting velocity V_p can be defined by the equation as follow:

$$V_p = s/t \quad (2)$$

$$s = 2\pi r \quad (3)$$

Where:
s = Circle movement,
r = Radius of blade.

Based on the testing of betel nut that cut in half, the force is acting on blade is about 14 *kgf*, by hanging load on cutter blade without using hand movement. The torque will be resulted as the equation below:

$$T = F.r\ (N.mm) \quad (4)$$

The rate of production capacity can be defined by deividing over the time consume to cut in half in one second. The efficiency of cutting betel nut can be stated as follow:

$$\eta = \frac{W_s}{W_h}\ \% \quad (5)$$

Where:
W_s = Weight of betel nut before cutting (kg)
W_h = Weight betel nut after cutting (kg)

The force works on the cutting process applied by hand to press the lever which cut in half of betel nut as shown in figure 1. The forces can be figure as follow:

$$F_b F_h(l_1 + l_2) = F_b l_1 \quad (6)$$

Where
F_b = Cutting Force
F_h = Hand Force

4.0 MATERIAL AND METHODS

4.1 Methodology

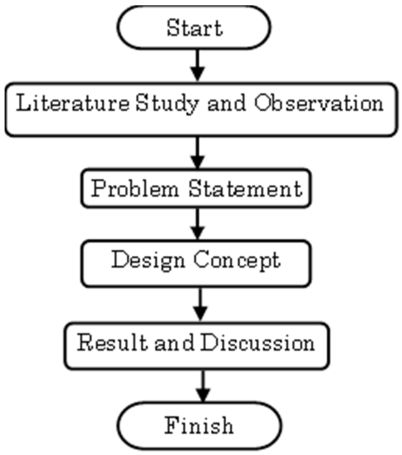

Figure 2: Flowchart of betel nut cutting machine design

The method used in the study was carried out with three stages. Firstly, conduct a survey to the farmer community in order to gather information concerning the problem of betel nut processing manually. Secondly, designing the betel nut cutter

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machine according to the needs of the farmer community and the materials and components used consist of blade, iron armature, rubber and bolt. Thirdly, testing of betel nut machine and to evaluate the performance of betel machine by discussing with farmer community whether the problem has been resolved by the design tool. The working principle of the betel nut tool is to push power/dynamic force on the blade toward the surface of the betel nut that provided by the holder.

4.2 Design Consideration

The method used in the study was carried out with three stages. Firstly, conduct a survey to the farmer community in order to gather information concerning the problem of betel nut processing manually. Secondly, designing the betel nut cutter machine according to the needs of the farmer community and the materials and components used consist of blade, iron armature, rubber and bolt. Thirdly, testing of betel nut machine and to evaluate the performance of betel machine by discussing with farmer community whether the problem has been resolved by the design tool. The working principle of the betel nut tool is to push power/dynamic force on the blade toward the surface of the betel nut that provided by the holder.

4.3 Design Calculation

The blade moves as far as 35° for 3 to 4 seconds (t) in the acceleration angle(ω) = 0.2 (1 / sec) with distance (s) 31 cm produces 1 piece of betel nut. The cleavage blade is given an additional weight of the weighing above the blade of 5 kg and the blade weighs of ½ kg (for stabilizing during cutting process). The shape of the tool can be seen in figure 3. The betel nut can be placed above the frame either 2 or 3 pieces for once cutting process. It will take time for 4 to 5 seconds.

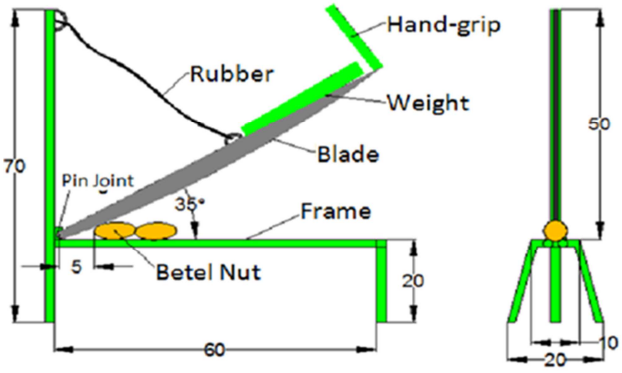

Figure 3: Configuration of betel nut cutting machine

4.4 Performance Analysis

Based on the results of betel nut cutting process, the form of splitting betel nut produces in average same size. The cutting efficiency is one (1), since the weight of the betel nut either before cutting process or after cutting process produces the same weight. The blade of betel nut cutting machine was ordered in particular to the blacksmith. For safety working, the use of rubber instead of spring was applied to hold the blade and the rubber is easier to look for then the spring in rural areas.

4.5 Working System of Equipment

Figure 3 shows the description of the betel nut cutting machine. This tool consists of blade, frame, beam, rubber and weights. The working system as follows:

1. The blade is raised approximately 35^0.
2. The betel nut is placed on top of an iron rod of frame.
3. Afterwards, the blade is moved down with a hand push.
4. The betel nut is split into two parts in equal size

5.0 RESULT AND DISCUSSION

5.1 Result

Based on the performance design of the betel nut cutting machine, some results are obtained as follows:

1. Cutting Force (F_p)
   Based on the design, in order to make the lighter betel nut cutting machine, the blade is added a ballast weight in the form of a round iron with a weight of 5.5 kg, the blade has radius of 50 cm in middle position and it will take time of 2-3 sec and the lifting angle of 35^0.Then the cutting force on the blade when driven by 0.4 N.
2. Cutting Velocity (V_p).
   The velocity of the cutting blade starts from the top position with opening angle of 35^0 and it takes time for 3 to 4 sec (0.05 min) and the radius 0.5 m. So the cutting speed for 1 betel nut is 3.8 m/min.
3. Production Capacity
   The ability of the betel nut cutting machine either 2 or 3 pieces of betel nut for once cutting process with time taken of 3 to 4 sec. Production capacity may range between 800-900 pieces / hour.
4. Size and Dimension of the machine
   The betel nut cutting machine has specification such as height 20 cm, length 60 cm and width 10 cm. Materials used consist of armature iron, blade, bolt of 8 mm, iron bar holder of 70 cm high, rubber to support the holder. The description is shown in figure 3.
5. Use of betel nut cutting machine
   The result of betel nut cutting machine design has been widely used by farmers in Riau province rural areas, especially in the sub-district of Kuala Kampar, Teluk Meranti, Tembilahan and Pekanbaru as shown in figure 4

Figure 4: Shape of Design Machine

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Figure 5: Working System of Machine

Figure 6: Results of Splitting

Figure 7: Splitting Working Process

Figure 8: Shape of Splitting Result

6.0 CONCLUSION

Based on the above results, it can be described that the betel nut cutting machine is easy to use than the manual traditionally. In addition, this betel nut cutting machine can be used for by all ages like children, adult and old man because the machine is designed as portable machine. The betel nut cutting machine has been widely used in sub-district of Riau Province such as Penyalai, Teluk Meranti and Tembilahan. In other words, the betel nut cutting machine is easy to develop, material ability is ubiquitous with low price and simple installation and in accordance with the needs of the community.

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