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Fabrication and Testing of Abaca Fiber Decorticator

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Abstract. The design and fabrication of an abaca fiber decorticator is to automate the stripping process of extracting abaca fiber. Decortication is the mechanical process of fiber extraction (stripping the fiber from its sheath). Manual method of fiber extraction requires large force to be applied as an effort therefore consuming so much time and energy from the farmer. Thus, there is a need for its mechanization to increase productivity. The design uses a drum roller attached with twelve, foot-long, angle bars, equally spaced around the drum. Each angle bar is fastened by two threaded bolts to keep in place. The drum roller is driven by a 1.5hp electric motor. The project was completed in 41 days, where series of testing and modifications were made to obtain the most desirable output. For the fiber quality test, the fiber output reached the S2 quality which has a buying price of Php80.00. It was evaluated and assessed by the Philippine Fiber Industry Development Authority. For the performance test, the decorticator performed best when the leaf sheaths were cut 1.5 meters long and were divided into two. The designed and fabricated electric motor-powered abaca decorticating machine has a fiber recovery rate as high as 4.378% and can generate an average daily income of Php2926.00.

1. Introduction

A fisherman's net for catching fish, a farmer's hat against sunlight, a rancher's rope for his livestock, a mother's basket full of vegetables, the paper bills we use to pay, and many more. In almost all areas of life, we rely on the different products made out of a common raw material, abaca fibers. Unlike other materials, abaca fibers are undeniably favorable especially when it comes to quality and strength. With lignin content as high as 15%, it is prized as the strongest among natural fibers for its great mechanical strength, resistance to saltwater damage, and long fiber length – up to 3 m [1].

Abaca, also called Manila hemp, is extracted from the leaf sheath around the trunk of the abaca plant (*Musa textilis*) [2, 3]. Up until now, the manual method of extraction is adapted especially to farmers in the hinterlands. It consists of the following steps: harvesting (cutting of each stalk into strips), tuxying (separation of primary and secondary sheaths), stripping (pulling the strips to separate the pulp from its fiber), and drying (removing the moisture content usually through sun-drying) [4]. Although it looks simple, it requires extra effort and constant practice to master these steps. This method showed several problems such as time consuming, low production rate, prone to human errors and requires more workers and skilled laborers especially for mass production purposes. The same burden was experienced by the abaca farmers in Sitio Dungga, Barangay Malaunay, Valencia Negros Oriental.

A decorticating machine will greatly help these farmers conserve effort while maximizing time. Fabricating the machine eliminates the crucial and tiring step of tuxying, thus, greatly increasing the production process for about twice or thrice more than the usual. Thus, this study was undertaken to design a fabrication of abaca fiber decorticator.

2. Organization of the Text

2.1 Review on Related Literature

Abaca fiber is extracted from the leaf sheath around the base of the abaca plant. Harvesting of abaca stalks usually takes place between 18 and 24 months from the first shoots [4]. When mature, an abaca plant will have about 12 to 30 leaf stalks, each approximately 12 to 20 feet high. Subsequent harvest is done at 3 to 4 month intervals. There are two stages in the harvesting process: (1) topping, when the leaf stalks are cut at the base of the petiole with a knife or a sickle, and (2) tumbling, when the stalks are tumbled down with the use of a bolo knife.

After tumbling, the cut stalks are put in a pile, ready for the next step: tuxying. Tuxying is the process of extracting the fiber from the leaf sheaths. A specially-made tuxying knife is used to make an incision through the inner and middle layer of each sheath, close to the base or butt end to remove the outer layer[5].

The strips, or "tuxies", obtained from this process are then put through a cleaning process, called stripping, in which all pulpy material is scraped off and the strands of fiber are freed. In the Philippines, the two common stripping methods in use are hand-stripping and spindle stripping. Hand-stripping (hagotan) is a simple yet laborious method. The strip, or tuxy, is inserted between a block and the stripping knife, and then pulled with force from the tip end of the tuxy to separate the fiber from any waste. The spindle stripping method involves winding the fibers around a tapered-shaped spindle which is kept in motion by an electric motor or an engine. A spindle stripped fiber tends to be whiter and more lustrous than a corresponding grade of hand stripped fiber[6].

Fibers recovered vary from 1.5% to 2% by weight of the freshly cut stalks. The abaca fibers are then left out to dry naturally in the sun. Once the abaca fibers have dried out sufficiently, they are transported to a warehouse where they are sorted according to quality. The best grades of abaca are fine, lustrous, light beige in color and very strong. Quality is then determined by color, texture, fiber length, strength, and cleaning[7].

2.1 Methods

From the objective to design and fabricate an electric-powered abaca fiber decorticator machine that would aid in elevating production output and efficiency, a comprehensive and systematic plan is made. This is accomplished through following the following steps:

a. Planning Stage

In this stage the researchers gather information from books, journals, internet, and conduct interviews with the authorities. This stage focus in the planning of making a mechanical abaca fiber decorticator that is more convenient and efficient than manual design. The researchers will discuss their plans with the adviser in designing the project and also discuss to their client (farmers) in order to meet the clients satisfaction of the design.

After all data needed are gathered, the researchers will start working on with the design of the mechanical abaca fiber decorticator. Materials and equipment will also be specifically determined and gathered or purchased in this stage.

a.1. Conceptual Component of an Electric-Powered Abaca Decorticator

There are four major components of the abaca decorticating machine – machine frame, driving mechanism, holding mechanism and the stripping/beating mechanism. The machine frame is the structural framework that holds and supports all the other mechanism. It must be firm and sturdy so that there will be minimal vibration. The second component is the driving mechanism composed of an electric motor with a belt drive system, and rotating shafts with pulley sheaves of 5:7 speed ratio. And the last component is the stripping/beating mechanism which is basically a roller with blades equally spaced around it and a stripping block.

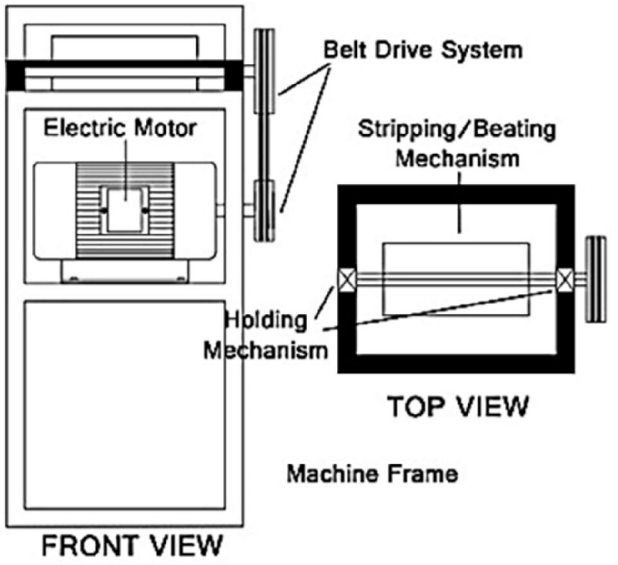

Fig. 1. Conceptual design of an electric-powered abaca decorticator.

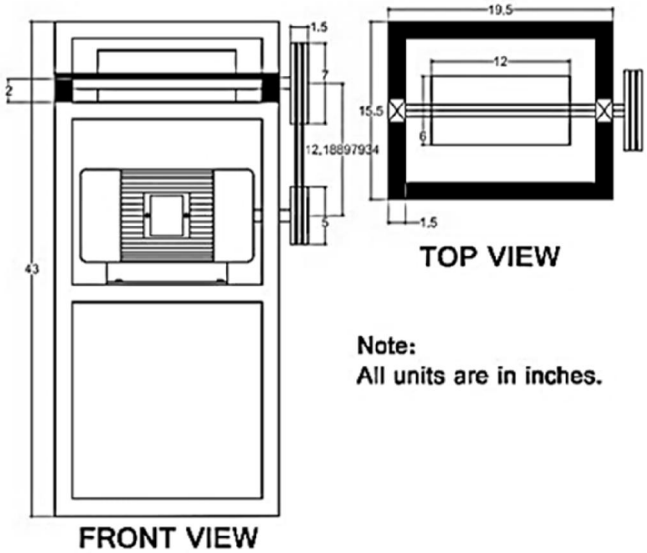

Fig. 2. Dimensions of the electric-powered abaca decorticator

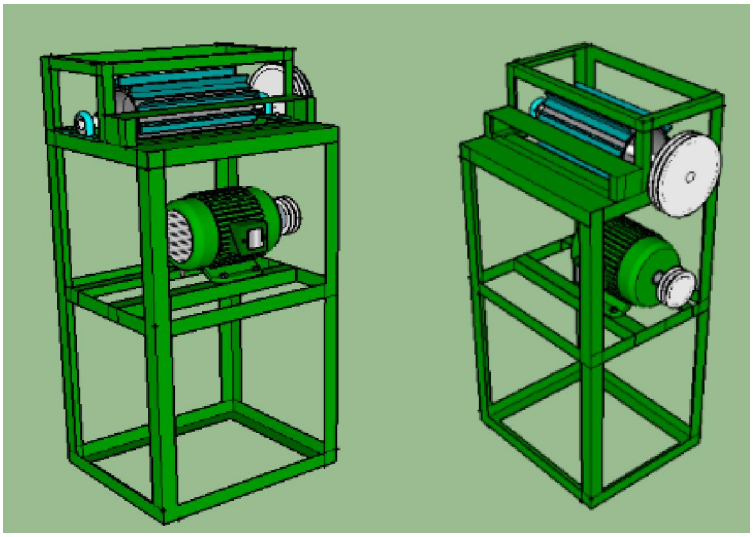

Fig. 3. 3D perspective of the electric-powered abaca decorticator

a.2. Machine Frame

The machine frame (Figure 3.4) was welded and constructed from angle bars (1.5” x 1.5”) for rigidity and strength. It is very important for the frame to be geometrically designed to give stability to the whole structure and to withstand vibration.

Fig. 4. Machine frame.

a.3. Driving Mechanism

The driving mechanism was composed of a 1.5Hp electric motor, two A42 belts and two pulley sheaves (5" and 7" diameter). It also used a 1" diameter shaft where the roller is attached.

a.4. Stripping/Beating Mechanism

The stripping/beating mechanism was made of two parts. First is the roller made of a 12" long and 6" diameter metal pipe attached with 12 (1"x 1") angle bars equally spaced around its body. The second is the stripping block made from a piece of metal.

b. **Fabricating Stage**

After the thorough planning and consultation of the design, the approved design was fabricated. When the fabricated and/or purchased parts were ready, assembling followed. All parts were machined and assembled at Mindanao Sibulan Machine Shop (MSMS) located at Airport Area, Sibulan, Negros Oriental. Figure 5 below shows the assemblage of all the parts.

Fig.5. Assemblage of all the parts

c. Testing Stage

To test the effectiveness of the machine, series of experimentations were undertaken. In this stage, we can identify if the machine performs well by evaluating its performance both in fiber recovery and cost. It is also in this stage where numerous modifications were made to conform to the general objectives of the study.

c.1. Procedure to follow when operating the abaca fiber decorticator:

1. Before starting the operation, ensure safety by checking if the machine parts, bolts, sets screws, keys and other accessories are securely engaged.
2. Rotate the roller or the pulley connected to the roller manually to check for any obstruction.
3. It is now okay to start the operation. Listen attentively to the sound of the electric motor. If it changes beyond the normal, turn it off immediately. Check also for the temperature of the motor from time to time to avoid overheating.

4. When feeding, do not overextend your hand or it might be caught by the rotating blades.
5. When done using, always clean the machine from any dirt for it might damage your machine. Also, keep everything dry as much as possible or the machine might rust fast.
6. Lastly, check once again if the machine parts, bolts, sets screws, keys and other accessories are securely engaged.

Table 1. Schedule of Activities

Activity	Time Duration
Data Gathering and Discussion	5 days
Material Identification	5 days
Material Gathering	5 days
Machining and Assemblage of Parts	6 days
Testing and Evaluation	20 days
Total	**41 days**

Table 1 Schedule of Activities. This is the timetable showing the duration of completion of each task or activity. It started from the gathering of data through various research and interviews for 5 days. It was then followed by the identification of materials and the choosing of the right tools and equipment needed for the fabrication. Material specifications were also considered on this stage which lasted for another 5 days. After all preparations were made, materials were gathered and purchased for 5 days then brought to the machine shop for fabrication. Machining and assemblage of parts took 6 days to finish. Lastly, testing and evaluation with some necessary modifications were made for 20 days.

2.3. Results and Discussions

The designed and fabricated abaca fiber decorticator powered by an electric motor was tested and modified six times before it successfully produced a good quality of fiber. The components of the final designed and fabricated machine are: machine frames made of angle bars, a 1.5hp electric motor with a speed of 1740 rpm, a belt drive system: composed of two pulleys, 5 inches and 7 inches in diameter, and two A42 belts with a pitch length of 43.4 inches, a stripping/beating mechanism: composed of a 6-inch diameter roller with 12 equally spaced blades bolted around its body, a welded stripping block of 2-3mm clearance with respect to the roller blades and bearings on pillow block mountings to support the 1-inch diameter shaft. A switch was also installed for safety and comfort. The machine was evaluated through different tests. Fiber quality test is the top priority because this will determine if your fiber is sellable (at a high price) or not. After passing the first test, performance test followed where various variables are taken into consideration to identify to which conditions the designed and fabricated abaca fiber decorticator can perform best. Lastly, its business aspect was tested by determining its cost efficiency and fiber recovery.

3. Conclusions

The designed and fabricated electric motor-operated abaca decorticating machine has mechanized the then manual stripping method of fiber extraction. Compared to the manual method of production which is up to 10 kilos of fiber a day, the decorticator can produce an average of 36.575 kilograms of fiber a day. High production will greatly help the abaca

industries in general whose demand on fiber is very high and abaca farmers in particular to conserve time and effort but earning more.

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