Design, Fabrication and Testing of Pandanus Leaves Slitter – Presser

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Abstract

The Department of Science and Technology (DOST) – Aklan and Metals Industry Research and Development Center (MIRDC – DOST) designed and developed a manually operated Pandanus leaves slitter – presser as an alternative low cost leaf slitting and pressing device. The main objective is to flatten and even out bariw (Pandanus copelandii) leaves into quality pounded and softened leaf end-product. The pressing mechanism of the fabricated prototype is governed by metal rollers in synchronized rotation using spur gear such that when a metal-to-metal contact is established, the leaves are pressed and consequently flattened. On the other hand, the slitter assembly is comprised of blades which cuts the leaves; and spacer which is adjusted to achieve the required width. The prototype was tested at MIRDC by subjecting sun-dried, air-dried and wet bariw leaves samples to pressing and slitting. The roller gap was set to four micron (almost zero mm) and the thickness of the samples before and after pressing was measured using a digital Vernier calliper. Results showed that air dried bariw leaves had the best pressed condition as they reached the maximum potential for flatness. Sun dried leaves showed crack after pressing and the wet leaves tend to go back to their original form shortly after flattening. Slitting, on the other hand, was done at average strips for 5mm, 10mm and 15mm cuts, respectively. Overall, the prototype passed the functional testing and evaluation conducted and showed potential in providing a more efficient slitting and pressing of pandanus leaves.

I. Introduction

Pandanus, screw pine or pandan is a palm – like plant with variety of uses. Some of its notable importance include culinary, medicinal and industrial purposes. This project focuses on the industrial aspect, specifically on the use of bariw (Pandanus copelandii) leaves for handicrafts.

Craftsmen first collect pandan leaves, slice them into fine strips then sort for further processing. Finished products are ropes, colourful mats, jewelry boxes, decors and other weaved products of high quality. The whole process, from harvesting of raw materials to creating the finished product, is usually a tedious venture as everything is done manually. At the time this project was conducted, there was no existing pandanus leaves slitter – presser. There is a close machine known but is specific in pressing other variety of leaves and the slitter mechanism is not yet commercially available. It is for this reason that the Metals Industry Research and Development Center (MIRDC), an agency of the Department of Science and Technology (DOST), partnered with DOST-Aklan and LGU-Nabas to design and fabricate a prototype Pandanus Leaves Slitter - Presser for pressing and slitting bariw leaves. This project is in line with the aim of DOST – Aklan to establish a Common Service Facility to four barangays of the Municipality of Nabas that will serve as a venue for the process improvement of native bariw products. This is very fitting because Nabas is abundant of bariw plants with around 90 hectares plantation scattered all throughout the municipality and some are growing wildly along the mountain sides and forested areas. Moreover, bariw is the focus commodity of the Nabas Farmers' Information and Technology Services (FITS) Center wherein new technology on production and processing is being employed.

Objectives

The main objective of this project is to design and develop a manually operated Pandanus leaves slitter – presser as an alternative low cost leaf slitting and pressing device.

It specifically aims to:

1. flatten and even out bariw (Pandanus copelandii) leaves into quality pounded and softened leaf end-product ; and
2. test the functionality of the prototype by subjecting sun-dried, air-dried and wet bariw leaves samples to pressing and slitting.

Review of Literature

Pandan as Raw Material for Handicraft – Making

The species of pandan leaves used for weaving comes from the non – edible genus. These species contributes significantly to the traditional handicrafts industry as it is versatile enough to be woven into wide range of quality products such as mats, baskets, hats, wallets and even fancy items among others.

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There are several provinces in the country that engage in pandan weaving handicrafts as a means of livelihood. Some of these include the municipality of Luisiana in Laguna, Baybay City in Leyte, different municipalities in the Bicol Region and many others. In fact, Luisiana Laguna celebrates the Pandan Festival every April to showcase their local artistry through the different line of handicrafts made from pandan (Asian Secrets. Co, Undated; and Laguna Travel Guide, Undated).

Pandan Handicraft Industry in the Philippines

There are several programs implemented by local government and non – government organizations and cooperatives to support the local handicraft industry. For instance, the Non-Timber Forest Products (NTFP) - Task Force was established to address the emerging livelihood needs of upland forest peoples, particularly those who depend on NTFPs as well as to alleviate poverty. The Task Force, which is a collaborative network of Philippine grassroots based non-government organizations and Peoples Organizations, focuses on NTFP development and management issues in the context of sustainable tropical forest management. NTFPs are the resources derived from the forests other than timber. Edible plants such as honey, herbs, spices, bamboo, resins, natural dyes, essential oils, ornamental plants, fibers gums are examples of NTFPs (FAO, 2002; Michelle Arts, 2008).

However, a study titled "Analysis of the Contribution of the Pandan Handicraft Industry to Community Economic" was conducted in 2009 to analyze the perceived degree of contribution of the pandan handicraft industry to community economic development in the municipality of Luisiana, Laguna and the results revealed that the contribution of the pandan handicraft industry to community economic development was low. The said result can be attributed to several factors such as poor production and management system, poor marketing system, inadequate knowledge and technical skills on the adoption of new technology, weak linkages with government agencies and private entities, and inadequate technical, institutional and financial support.

Hence, the implementation of the One Town, One Product (OTOP) program wherein the local chief executives of each city and municipality take the lead in identifying, developing and promoting a specific product or service with a competitive advantage. In line with this, the Uplifted in Baybay City, Leyte, the Plaridel Women's Association for Rural Development (UPWARD) organization in Baybay City Leyte was assigned as the OTOP Center to boost pandan handicrafts-making enterprises (Department of Trade and Industry, 2008; Philippine Commission on Women, 2013).

Roll Pressing

Roll compaction is a form of high – pressure agglomeration. The method requires a roller press, which exerts mechanical pressure on a powder or other dry bulk material as it is forced between two counter - rotating rolls. This pressure compresses the material into compacts, which are either briquettes or sheet, subsequently passed through a mill to produce granules (Wennerstrum, 2000).

Although roll press compaction was predominantly applied in metal sheet or bar rolling, in the early 1960s a new emphasis was placed on rolling of powder metals or briquetting granular materials. At that time, information about the design of a roll press for powders was only of empirical nature. Thus, there existed a need for a mathematical model describing the relationships between the material properties, the press dimensions and operating parameters to aid engineers and operators in design and operation of roll presses for compaction of granular materials. Johanson was one of the first to fill this void by providing the means to determine the press dimensions and roll forces necessary to apply the required pressure to a material with specific properties which were attained experimentally (Balicki, 2003).

The roller press typically consists of a pair of rotating, shaft – mounted rolls of equal diameter. The rolls are mounted on bearing blocks and powered by a motor linked to a drive assembly. The roll gap is the distance between the rolls at their closest point and depends on the pressure applied and the amount of powder passed between the rolls (Wennerstrum, 2000).

Slitting

There are three basic mechanical types of web separation, or slit methods employed today. These are the burst or razor slitting which uses only one knife to slit the product; score or crush cut slitting wherein one knife is used to accomplish the web separation such that the web is actually pinched or scored apart by the cutting blade against a hardened plate or bottom roll at about 70 PSI of downward pressure; and shear slitting which makes use of the top and bottom knives working in conjunction to form a scissor cutting action that separates the web. Each of these types has its own advantages and disadvantages. While the first two are less expensive to set up and operate, produces poor quality cut. Whereas the last type is a bit more costly to install and maintain produces fine edge cut quality at high cutting speed rates (Principles of Shear Slitting, Undated).

Methodology

Project Development

The development of prototype was done at the Metals Industry Research and Development Center. The facilities are composed mainly of the machine shop, welding shop, assembly area and painting area for finishing of parts and components.

The prototype was first designed to have both pressing and slitting operations. The pressing mechanism is governed by three rollers, two of which are fixed and the other is adjustable such that the rollers press each other to flatten bariw leaves. On the other hand, the slitter assembly is comprised of blades and spacer. The blade cuts the leaves while the spacer is adjusted to attain the required width. The concept design was created using the CAD Software, NX.

Fabrication was done after a thorough design review. The prototype was fabricated in accordance to the specifications in the Terms of Reference. The materials and their corresponding sizes were all accounted for and strictly followed.

Testing of the Prototype

Like any other test procedures for a newly – develop equipment, the unit was first checked for interference and fits in each sub – assembly. The parts and components were inspected for dimensional accuracy and it was checked for customer's specifications and requirements. Then the equipment was tested without and with load. Results were documented and the roller press manual was prepared for use during the training and operation of said machine. After ensuring that test results are in accordance with the requirements and specifications, the equipment was cleaned and prepared for finishing touches.

As for the testing proper of the workability of the prototype, the initial condition of bariw leaves such as thickness, length and width prior to pressing and slitting were taken. Then, the characteristics of the bariw leaves were tested by subjecting them to pressing and stripping action under the dried and wet condition.

Results and Discussion

Figure 1 shows the concept design, generated from NX, and Table 1 summarizes the technical specifications, materials, major parts and their corresponding description. Figure 2 shows the fabricated Pandanus Slitter – Presser.

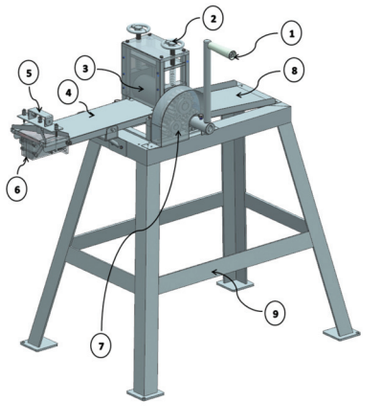

Figure 1. The Pandanus Slitter – Presser concept design generated from NX Software.

Figure 2. The fabricated Pandanus Slitter - Presser

Table 1. Technical specifications and major parts of the Pandanus Slitter – Presser.

MAJOR PARTS	DESCRIPTION	MATERIAL
1 Crank Mechanism	drives the machine. The operator rotates the handle clockwise as the crank mechanism transmits the rotary motion to gears and pressers to start pressing operations.	painted mild steel
2 Plunger	adjusts the compressibility of the roller presser. The operator can select the clearance effect of flatness on the *bariw* leaves.	mild steel
3 Roller Presser	presses the *bariw* leaves.	tool steel
4 Inlet Guide Sheet	supports the slitting assembly and guides the *bariw* leaves during feeding in pressing operation.	mild steel
5 Slitter Cover	covers the protruding blades and guide the *bariw* leaves during slitting operations.	painted mild steel
6 Slitter Assembly	comprises the slitter spacer and blades for slitting *bariw* leaves.	mild steel for spacer; high carbon steel for blade
7 Gear Assembly and cover	transmits rotary motion from the crank to the rollers, and a gear cover to protect the gear assembly.	tool steel
8 Outlet Guide Sheet	guides the pressed *bariw* leaves during pressing operation.	mild steel
9 Base Platform	holds the machine, 700 mm above the ground and made of angle bars welded together.	mild steel
Technical Specifications		
• single – point, metal to metal contact pressing		
• roller diameter: two 60 mm and one 75 mm		
• roller length: 128 mm		
• synchronized roller rotation using spur gear mechanism		
• synchronized adjustment of roller gap up to five millimeter (5 mm) distance		
• manual hand cranking method		
• roller speed: approximately 0.07 m/s		

Pressing and Slitting of Bariw Leaves

Random leaf samples were taken from the bariw roll. Three sun – dried, three normal dried and three wet leaves, respectively were subjected to pressing at ≤ 4 micron (almost zero mm). The roller gap of around four microns was adopted from previous testing since it is at this gap where pressing will likely be done without damaging the samples. Roller gap of more than four microns will be too wide, hence the samples passing through are left unpressed. Using a calibrated digital-type Vernier caliper, each leaf was measured for its initial thickness (before & after pressing) and width at five strategic points in the entire leaf length. Figures 3 to 5 shows the results of the different test conditions.

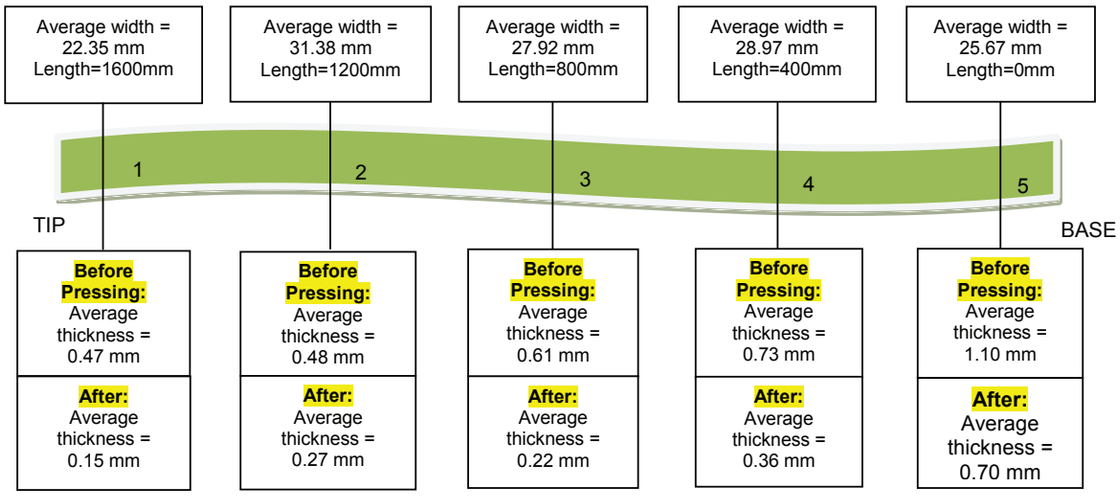

Figure 3. Pressing of sun – dried bariw leaves at ≤4 microns

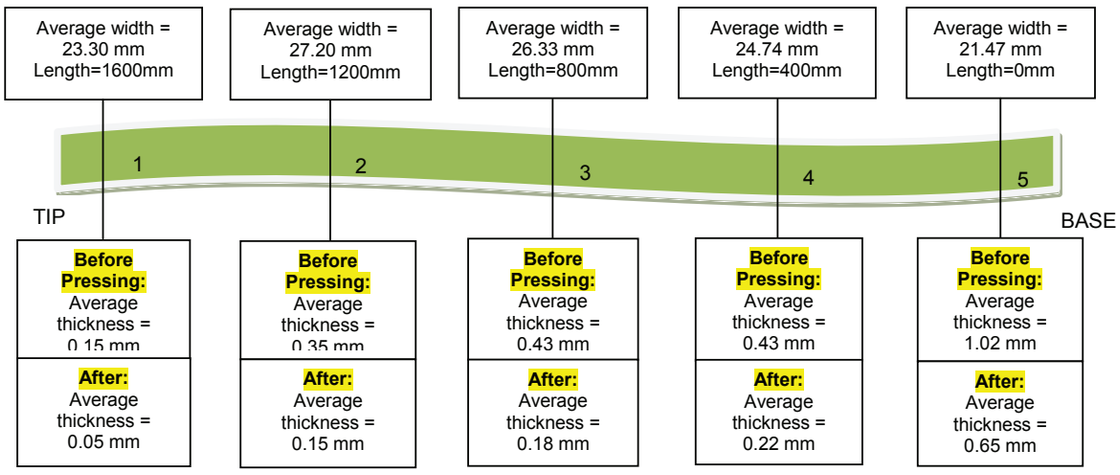

Figure 4. Pressing of air - dried bariw leaves at ≤4 microns

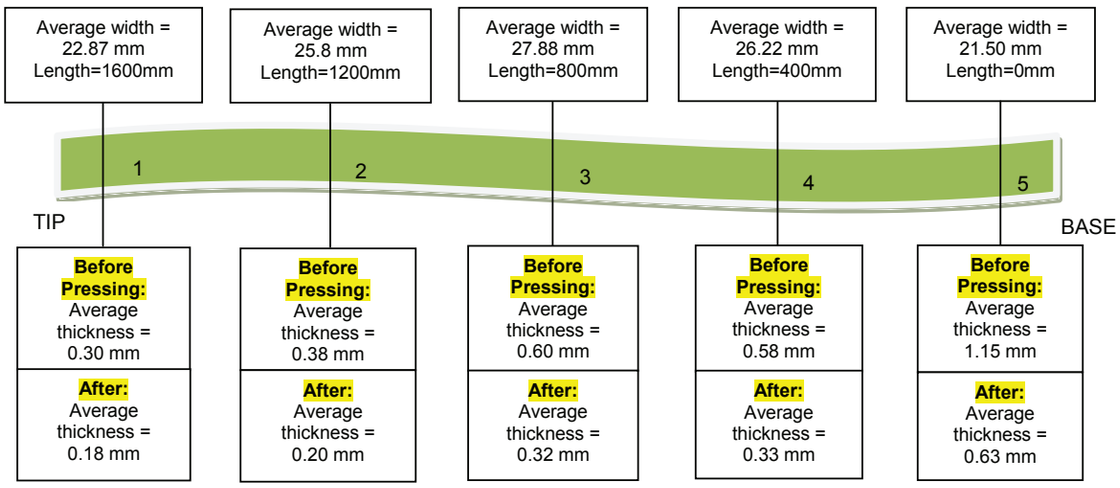

Figure 5. Pressing of wet bariw leaves at ≤4 microns.

Quantitatively, the results showed that the bariw leaves at different conditions had considerable change in thickness after pressing. Based from the feed-back of the stakeholders, the air-dried bariw leaves had the best pressed condition as the maximum potential for flatness was reached. Moreover, the flatness of the pressed air – dried leaves was sustained. On the other hand, the sun dried leaves showed cracks after pressing while the wet bariw leaves tend to get back to its original form shortly after pressing.

Slitting was done after pressing. The slitter spacer was adjusted to different widths to produce five millimeter (5 mm), 10 mm, 15 mm cuts, respectively. In handicraft making, pandan leaves are cut to different widths depending on the product to be woven. More elaborate designs would require shorter width. In the slitting operation performed, a single leaf was divided into an average of three strips when the slitter spacer was set to 5 mm; two strips at 10 mm cut, and one strip at 15 –mm cut, respectively. Figure 6 shows the slitting operation for the 5 mm cut. The strips produced had relatively fine edges.

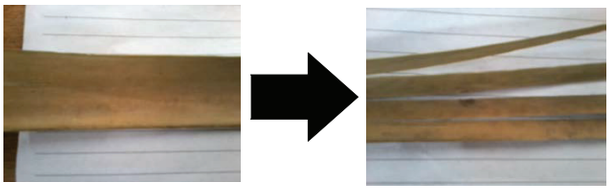

Figure 6. Result of the slitting of bariw leaf at 5 mm cut.

Adoption of the Machine

A week – long training about the developed Pandanus Slitter – Presser was conducted at Nabas, Aklan to test the functionality of the machine and to give the weavers hands – on pressing and slitting operations using the machine. The design, functionality and operation of the machine were discussed and an operations manual was provided. Figure 7 shows the training conducted at Nabas Farmers' Information and Technology Services (FITS) Center - Nabas, Aklan

Conclusion

The study was successfully able to develop a manual bariw leaves presser and slitter. Actual pressing of sun –dried, air – dried and wet bariw leaves were done at roller gaps of ≤ 4 microns, respectively. Results showed that air – dried leaves had the maximum potential flatness. After verification on the functionality and operation of the machine, it can be said that it is useful in improving the texture, unifying the thickness and slitting the leaves at preferred widths.

Recommendations

Based on the results of this study, the following are hereby recommended for future and follow –up research and development studies:

1. Conduct further field testing of the Pandanus Leaves Slitter - Presser in Nabas, Aklan as well as on other provinces that engage in pandan – based handicrafts.
2. Establish standard thickness for flattened bariw leaves that will yield the finest quality raw materials for weaving.
3. Conduct further study on developing pressing processes for bariw leaves.
4. Develop a motorized Pandanus Leaves Slitter – Presser to produce higher leaves pressing and slitting output per operation.

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Figure 7. Training conducted at Nabas FITS Center.

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