MECHANIZED PROCESSING OF LAUHALA

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THE AUTHOR

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Lauhala weaving is one of the leading handicrafts in the Territory of Hawaii. Leaves of the Pandanus, or hala tree, are used as the weaving material and are processed by traditional hand methods, which are very laborious. The material as purchased for weaving has increased five-fold in price in recent years, and its high cost is now considered the most important limitation on the weaving and sale of finished lauhala products.

Studies by the Industrial Research Advisory Council of the Territory indicated that there is an abundant supply of lauhala in areas where unemployment normally exists and that many people now unemployed would take up lauhala weaving if prepared leaves could be had at a reasonable cost. The Industrial Research Advisory Council requested that an investigation be made of the feasibility of mechanizing the processing of lauhala. It was thought that mechanized processing would lessen the drudgery and time spent in hand processing, reduce the cost per strip of lauhala, and enable the weaver to produce a more uniform finished product at lower cost to him.

**Previous Work and Present Methods**

There appeared to be no written records of any efforts to improve or mechanize the preparation of lauhala for weaving. Metal rollers powered by a small electric motor had been used to soften the leaves and seemed to be the only step toward mechanization. At the time this project was started, it was estimated that 90 percent of the leaves used were collected in a dry state, cleaned, scraped to remove thorns, flattened by rolling and unrolling, and finally rolled and tied in bundles of 100 leaves per roll. These bundles were then sold to the weavers.

The weaver or person who bought these bundles of lauhala, in this state of preparation, had to unroll the leaves from the bundle, soften and flex them by rolling and unrolling, and then cut them into strips of the desired width.

**Requirements for a Machine**

Mrs. Charlotte Jernigan, an adviser to IRAC on this project, suggested these requirements for a lauhala processing machine:

1. **Scraper:** A blade set to scrape the spines from the underside of the midrib and to make it thinner in order to press the leaf properly.
2. **Roller:** (a) To press the leaf flat, and (b) to press the strips, thus making them more pliable.
3. **Strippers:** Adjustable cutters to remove the midrib and spines from the edges and to cut the remaining portion of the leaf into strips varying in width from $\frac{1}{8}$ to 3 inches.

**Preliminary Work**

A preliminary study was made of the methods used in preparing the leaves and cutting them into strips by hand. Weaving establishments were visited, and the requirements of satisfactory leaf strips for weaving were observed. A mounting
Figure 1. Test stand, showing pressing rolls, gear drive, and spring loading of upper roll.

Figure 2. Lauhala stripping machine, showing frame, flattening shoes in operating position, and motor.

Figure 3. Stripping roll mounted in test stand. Upper roll has knives and spacers; lower roll shows matching slots.
Figure 4. Upper stripping roll disassembled, showing arbor with lock nuts and collar, spacers, and disc knives.

Figure 5. Gear reduction, electrical motor, and V-belt.

Figure 6. Drive for powering cutting head. A, drive jackshaft; B, drive sheave for the cutting head; C, gear attached to the cutting head.
stand was constructed on which each component part of the machine could be installed and tested. The stand was designed to subject the upper roll to adjustable-spring loading, with a fixed position for the lower roll. The lower roll was revolved with a hand crank and drove the upper roll with gears. Various types and shapes of rolls and devices were tested. Those that were proved to accomplish a particular operation efficiently were incorporated into the final machine. (See figure 1.)

**Description of Machine**

The main components of the final machine consist of a frame, flattening shoes, two sets of straight rollers, stripping rolls, and an electric motor.

**The Frame** consists of a base plate and two side plates. The side plates are designed to line up each of the above component parts consecutively so that the processing of each leaf can be accomplished in one operation.

**The Flattening Shoes** consist of two triangular-shaped steel shoes placed one on top of the other. The lower shoe has a V-shaped groove cut through the middle which centers and guides the midrib in the machine. This shoe is fastened rigidly to the frame. The upper shoe is spring loaded and can float up or down depending on the thickness of the leaf. A lever arm is connected to the upper shoe which raises it and enables the operator to insert a leaf between the shoes and into the feed rolls to start the processing operation. (See figure 2.)

**The Two Sets of Straight, or Feed, Rolls** soften and flex the leaf and pull it through the flattening shoes. The lower rolls have V-shaped grooves in the middle to help center and guide the midrib through the machine. The upper rolls are spring loaded to maintain a reasonably constant pressure regardless of the thickness of the leaf.

**The Stripping Rolls** consist of a cutting head and a matching roll. (See figure 3.) The cutting head is composed of an arbor, thin discs that are sharpened, and spacers of various widths that separate the discs to produce strips of a desired width. (See figure 4.) On the center of the arbor is a fixed collar. This collar is used to center the cutting head on the matching roll and also acts as a spacer for the two disc stripping knives that remove the midrib. There is a lock nut on each end of the arbor that is used to lock the spacers and disc stripping knives in place. The disc stripping knives are 1/16-inch thick and are larger in diameter than the spacers. The protruding part of the disc is thinned down to 1/64 inch and the exterior edge sharpened to a knife edge. When the cutting head is in position in the machine, the protruding edges of the stripping knives are engaged in matching slots in the lower roll. The cutting head is designed so that it can be removed from the machine, disassembled, and a new arrangement of knives and spacers installed.

The lower, or matching, roll has grooves 1/8-inch deep, 1/32-inch wide, and 1/16-inch apart cut around its perimeter. These grooves match the stripping knives at any spacing that may be used. The stripping rolls can produce leaf strips varying in widths from 1/16 inch to 21/2 inches.

A slicing action is necessary to obtain a smooth, finished cut. It was first thought that this slicing action could be produced by making the cutting head larger in diameter than the feed rolls and revolving it at the same speed as the feed rolls. This would give the cutting head a greater peripheral speed, thus producing the slicing action. This practice did not produce enough slicing action because the difference in peripheral speeds was not great enough. As a result the
The cutting head had to be driven independently from the feed rolls and at a much higher speed.

In the initial assembly of the component parts as a unit, the stripping rolls were put between the two sets of straight rolls. The procedure was first to flatten the leaf with the flattening shoes, then soften it with the first set of straight rolls, cut it into strips with the stripping rolls, and, finally, soften the strips with the second set of straight rolls. This order of processing distorted the width of the strips. The stripping knives are set accurately in the cutting head and will strip a leaf into accurate uniform strips. Softening the strips after they have passed through the stripping rolls also widens them. Because the leaf strips vary in thickness from one end to the other, some parts of the strips widened out more than other parts. This resulted in an uneven and distorted width strip. The use of these strips for weaving would result in an uneven finished product. It was concluded that all the flattening, softening, and flexing processes should be done before stripping. As a result, the two sets of straight rolls were put one after the other, and the stripping rolls were moved to the rear of the machine. This procedure produced strips of uniform width and a nearly uniform thickness.

The stripping machine is powered by a ½ H.P. electric motor that has a speed of 1,725 revolutions per minute. A V-belt is used to transmit the power from the motor to the clutch. A pulley-type clutch, which allows the motor and V-belt to run continuously, is used to start and stop the rolls. It is mounted on a jackshaft that revolves at 1,320 revolutions per minute. One end of the jackshaft drives a gear reduction, which in turn drives the feed rolls at 55 revolutions per minute, and the other end drives the cutting head at 1,320 revolutions per minute. (See figures 5 and 6.)

**Testing**

Upon the completion of the processing machine, tests were made comparing the cost of processing the leaves by hand and by machine. The tests were run at the Lanakila Crafts TB Center. Items considered included the flattening of the leaves, removing the barbed edges and the midrib, softening, and stripping. The machine does all this in one continuous operation, whereas hand processing requires that each step be done separately.

Mr. Shannon Walker, field representative of the Handicraft Sub-Committee for IRAC, conducted the tests and compiled the statistics. Three men from the Lanakila Crafts TB Center, who were inexperienced with the operation of the machine, were used as operators. One man cleaned the leaves, another operated the machine, and the third man sorted the strips. Mrs. Jernigan, who was an instructor in lauhala weaving, did the hand processing. The results of the tests are shown below.

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<th>BY HAND</th>
<th>BY MACHINE</th>
<th>SAVING</th>
<th>PERCENTAGE SAVING</th>
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<tbody>
<tr>
<td>Stripping cost per leaf</td>
<td>.028</td>
<td>.0141</td>
<td>.0139</td>
<td>49</td>
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<tr>
<td>Stripping cost per square foot of usable hala</td>
<td>.0715</td>
<td>.0245</td>
<td>.047</td>
<td>65</td>
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<td>Net usable hala per 100 leaves</td>
<td>39.16</td>
<td>57.53</td>
<td>18.37</td>
<td>47</td>
</tr>
<tr>
<td>(in square feet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net usable ¼-inch strips per 100 leaves</td>
<td>728</td>
<td>989</td>
<td>261</td>
<td>35</td>
</tr>
<tr>
<td>$7.15 labor cost will strip (in square ft.)</td>
<td>100</td>
<td>292</td>
<td>192</td>
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Notes

In the above calculations, labor cost is figured at $1.00 per hour.

"Labor for stripping" includes labor for cleaning, trimming, stripping, and sorting.

Machine tests reported cover the stripping of 1,500 leaves. It was found most economical to have three operators so that cleaning, stripping, and sorting would be done in one operation.

Lanakila Crafts has developed a use for the midrib as salvaged by the use of the machine that would increase the net usable strips to a saving of 461 strips, or increase the percentage to 63 percent.

Demonstrations

After the tests were completed, the machine was exhibited and demonstrated on five different islands. The first demonstration was given on the island of Hawaii at the Konawaena School in Kona for about 60 school teachers and interested people. The next demonstration was given in Hilo at the rehabilitation shop of the tuberculosis association. Here the weavers were using a larger amount of bleached lauhala than natural lauhala. Green leaves were processed through the machine, but, because of the brittleness of the leaves when they are in the green state, the rollers smashed them rather than flattened them. Only the natural lauhala could be processed through the machine. The final demonstration was given at the Future Farmers of America Fair held at Pahoa, Hawaii. It was suggested here that a pounding mechanism be incorporated to help the rolls soften the leaves. Several tests of hand pounding were made in the laboratory using wood, steel, and rubber beaters and anvils. Comparison of the hand-pound ed and machine-processed lauhala showed that the same degree of softness could be obtained by using stronger springs on the rolls to help break down the internal structure of the leaf.

On the island of Oahu, the processing machine was demonstrated at the Lanakila Crafts Center, the 49th State Fair, and a Home Demonstration Conference at the University of Hawaii.

In February 1952, the machine was taken to the island of Molokai. Demonstrations were given at Maunaloa and Kaunakakai. At Kaunakakai the demonstration was attended by 50 or 60 people, most of whom were lauhala weavers.

In the following months, the machine was exhibited and demonstrated on the islands of Maui and Kauai. On Maui the machine was demonstrated at the Maui County Fair and on Kauai at the Kauai Farmer’s Fair.

Ownership and Operation

It was first thought that a number of stripping machines would be purchased by IRAC and placed in locations adjacent to the natural supplies of lauhala. These machines were to be loaned out on a royalty or rental basis. But, because IRAC is itself neither a research organization nor a commercial organization but only administers and allocates IRAC funds, this arrangement was not feasible and had to be dropped.

In communities where most of the weavers are weaving only on a part-time basis, they were advised to purchase a community-owned and operated machine. This machine could be set up in a public place such as a community hall or a public school and its operations governed by a custodian. A community-owned machine
would serve a large number of people both efficiently and economically. The capacity of the machine is such that it could process enough weaving material in 1 hour to supply a weaver for 15 hours.

For a commercial weaving establishment or a person interested in producing leaf strips ready for weaving, an individually owned machine would be recommended.

Cost of Machine
To determine the cost of construction, one machine was built for the TB rehabilitation shop in Hilo at the Hilo Vocational School. The cost of building this machine was about $300. If this same machine had been manufactured in a commercial establishment, the cost would probably be closer to $400. On the other hand, the cost per machine may be reduced if the machines were manufactured in quantity by one concern. Because of these variable factors, no set price could be determined.

Drawings
Drawings of the lauhala stripping machines are available to the public for a small fee to cover reproduction costs. These drawings can be obtained by contacting Mr. Shannon Walker, field representative of the Hawaii Crafts Association, or the Agricultural Engineering Department of the University of Hawaii.

Conclusions
The mechanical processing of lauhala is definitely feasible. It is labor saving, time saving, and economical. Except for removing the ends and cleaning the leaves, the processing is accomplished in one operation. This includes flattening, softening, removing the barbed edges and midrib, and stripping. The machine has a high capacity output and also produces a uniform product. It is capable of producing more weaving material per leaf than hand processing. These factors contribute greatly to the economics of machine processing. The cost per strip of lauhala has been reduced about 50 percent. The only undesirable characteristic of machine-processed lauhala are the curved strips. Because some of the leaves are V-shaped in cross section and also curved when viewed from one side, the fibers near the midrib are shorter than those at the edges. When the strips are cut close to the midrib and parallel to the fibers, the finished strips are curved. The curve is not noticeable on narrow strips but is more pronounced on a wider strip. If a reasonably straight leaf is processed, this curve does not appear.

The machine in its present state can be established as a prototype for any reproductions contemplated in the future. Additions and modifications can be made to suit the conditions of the user.

Mechanical processing of lauhala, by removing the drudgery of hand processing, can help encourage more people to weave lauhala. A weaver can spend more time weaving better-finished products at lower cost to him. This definitely would increase the sale of lauhala goods both here in the Islands and on the Mainland.

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