Cassava Press – Product Service System

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Introduction

The goal of the ADE Ghana site team is to reduce the physical burden of gari producing women and enable them to reduce their cycle time, thus increasing gari production and ultimately their income. Although our main project this semester has remained the grater, we have started work on the press as we begin transitioning the grater project out of deployment and out of ADE. Looking towards the future, advancements in the pressing step also have the potential to deliver more social benefit than the grater because it would reduce the cycle time of gari production by more than the grater, and it would be cheaper to purchase because there are no expensive electrical components such as the motor.

The traditional method of pressing the grated cassava to remove liquid prior to frying involves lifting and placing heavy boulders onto the bags of cassava mash, which is time intensive, physically strenuous, and unsanitary. Each boulder can weigh around 50-100 lbs, and the cassava mash must be pressed for 3-4 days in order to remove enough liquid and cyanide as well as allow enough time for the fermented taste of cassava to develop. Mechanical presses for cassava such as the double screw press do exist in Ghana, but all of them are large, expensive, and not sold locally. There are no cassava presses on the market that are affordable and catered to the needs of the gari producers.

This project has been in the ADE pipeline for a few semesters already. Past semesters have brought several press design concepts to Ghana and co-designed with the gari producers, and the Spring 2013 team was able to build a press prototype as well as learn more about the relationship between cyanide toxicity and the pressing process, but no press prototype has been deployed for field testing yet. As the press is currently in early development phase, the goal for this semester was to develop and deploy a few presses on the trip to Ghana in May in order to test effectiveness, affordability, desirability, and user interaction.

This report is an overview of the work done on the press product-service system this semester. Since work has been done on presses in the past with various concepts sketched and prototyped, the component started in the red-yellow stage. Based on the past work, we decided to move forward and prototype a mini single-lead screw press.

Description

The ADE mini screw press is a small press that uses one central lead screw, unlike the large double lead screw presses that exist in Ghana currently as can be seen in Figure 1. The gari producers put a woven plastic bag, which is the same bag currently used to hold grated cassava, on the press by spreading the weave and threading the lead screw through the weave of the bag. After cassava is grated, the mash is placed into the bag that is on the press, and adjusted to sit evenly. The top wooden board and spacer are placed on the lead screw and the handle is threaded on. The woman holds the press steady with her feet up against the supports of the press and turns the handles, using her whole body. The press can put 1000-2000 lbs of pressure onto the cassava. The bag is left in the press for a day and then the cassava can be removed for frying.

Figure 1. The ADE mini screw press

Press Requirements:

In designing the press, we created a list of requirements that the new press should have, which are outlined below.

Effective – The press needs to be more effective than the current method that gari processing women use, which is loading large rocks onto bags of cassava mash to press for 3-5 days. They use 2-3 rocks and each rock ranges between 50 and 100 lbs. The stones need to be removed and rearranged after the second day of pressing in order to repack and retighten the bag. The new press will create enough pressure on the bag to reduce the amount of time that the pressing process takes, creating an opportunity for an increase in income, as the gari processors will be able produce more gari in a season.

Affordable – Given that the rocks that they use to press the cassava mash currently are essentially free, the press needs to be very affordable for gari women to be willing to buy it. There are still tests to be done regarding willingness-to-pay, but we know the women cannot afford large screw presses so that is a definite upper bound.

Hygienic - To be food-safe the press needs to be far enough off the ground so that dirt does not get into the cassava mash as with the current method. The press also needs to be designed in a way so that no rust or paint gets into the mash and no food is in contact with any metals other than stainless steel.

Operable by Women - The current rock press method requires the women to get their sons or husbands to help them lift the rocks. The new press should be safely operable by one woman.

Figure 2. The mini screw press in use

Produces high quality (and safe) gari - There is naturally occurring cyanide in raw cassava and when the cassava is being pressed it ferments, decreasing the toxicity. We know that cassava only sits for one day in large screw presses so the press will not take less than one day. Fermentation is also an important to the way the gari tastes in the end. The new press will allow sufficient fermentation as to not alter the end taste of the gari.

Traits:

Only one foot of the central screw is made of threaded screw and the other 2 feet is stainless rod. This is to reduce cost and make sure that the cassava mash is only in contact with stainless steel.

Planks of wood are used as pressing surfaces because they can be oiled with shea butter to be food safe and are much more affordable than sheets of stainless steel.

There are spacers between the handle and the top pressing plate so that the bag stays off of the plain steel lead screw.

The current prototype cost 130 USD, but this will decrease in future iterations. See the bill of materials in Appendix A for more information.

Assumptions and testing

Assumption 1: Gari producing women want a press

$500 Test: Interviews with gari producing women

On previous trips to Ghana, women have expressed great interest in a press. Each time we sold a grater, the women immediately asked for a press as well. They hate the current system of placing large rocks on top of the bag of cassava to remove the liquid as it is slow, unsanitary and very physically strenuous. Women have told us that they cannot physically lift the rocks themselves and rely on their sons and husbands to help them.

Assumption 2: We can design a press that is less expensive than a large screw press

$0.50 Test: 5 minute estimate of the cost of a single lead screw press

Using prices from McMaster we estimated that we could make a small single screw press for approximately $30. As we continued with testing, this proved to be a very low estimate.

$5 Test: Stress calculations for lead screw

With a safety factor of 2, a ¾" OD lead screw is the best option for a single screw press given that the press will put 2000 lbs of force on the bag of cassava.

$5 Test: Material quotes from Asante

Asante Johnson researched prices for lead screws made in Suame Magazine, as well as (Appendix B) some larger scraps. We saw from this data that as diameter increases, the price of the lead screw increases drastically. We also discovered that the nut is often more expensive than the lead screw in the U.S., which could be the limiting factor for the size of lead screw we can afford to use.

$50 Co-design with Asante/his shea butter press from thesis

Asante looked over initial sketches and provided feedback, as well as designed a press in parallel. His press is a mini double-lead screw press with an angle iron frame. He asked for stainless steel lead screws to be brought from the U.S. indicating that stainless lead screws are not readily available in Ghana. He also designed a small, single-lead screw shea butter press for his thesis that we used for reference. His designs can be found in Appendix C.

Assumption 3: We can make a press that removes liquid more effectively than the current rock press method

$5 Test: Pressed some cassava mash using ratchet strap press

The ratchet strap press was tested a few semesters ago in Ghana to little success. It had a lot of usability issues and did not remove much liquid. The test was mainly inconclusive as the cassava mash we pressed had already been pressed for a day already. We repeated the test here with a small bag of cassava mash. It was challenging to wrap the straps around the plates evenly and for the plates to press evenly on the bag. The bag sat for 3 days and had about a 20% reduction in weight. However, the large majority of water was removed on the first day. The distribution of the force from the straps was not distributed evenly, and therefore the cassava wasn't dried evenly. From this we know that the press needs to be easy to load evenly.

$5 test: Shearing test

We performed a "shearing" trial as an investigation into "pressing smarter" instead of just harder - thinking cells could be sheared to release more liquid. We could not get a thin enough layer of cassava mash to even get close to microscopic shearing. There may still be ways of removing liquid by a method more clever than creating as much pressure as possible.

$50 Test: Pressure -> water out test

Caroline Condon performed a test in spring 2013 where cassava mash was pressed with a variety of pressures and the amount of water removed was recorded.

$500 Test: Prototype of the press

We created the first prototype of the screw press in order to test pressing capability. This test has not been completed yet.

Assumption 4: We can design a press that is food safe

$0.50 Test: Sketches & Sketch Modeling
$5 Test: CAD
$50 Test: Prototyping

The first press prototype is food safe if used properly - the cassava mash and water expelled are only in contact with wood and stainless rod. More research is needed about how long wood can remain food safe when it is treated with shea butter.

Assumption 5: We can build a press that is operable by one woman

$0.50 Test: Sketches
$5 Test: Sketch Modeling
$5 Test: CAD
$50 Test: Prototyping

In calculations for lead screw sizes it was assumed that a woman could put 20 lbs of force on each arm to turn the handle of the press. The

height of the press handle was designed to be at elbow height, and the feet of the press are arranged in a way so that the woman can keep the press steady with her feet.

Assumption 6: The resulting gari will have a safe amount of cyanide

$5 Test: information about large screw presses from Ghana

It takes one day to press cassava mash in a large screw press, so as long as the cassava spends one day fermenting between being grated and being roasted it should be acceptable. If further testing shows that there is too much cyanide in gari produced using our press, we will have to instruct the producers to let it sit for another day or two before roasting.

Refinement

Although many press designs have been sketched, prototyped, and tested in the past, there has not been one deployed into the field for testing yet. We made a large step this semester in choosing a press design to prototype with the goal of deploying it into the field for a gari producer to use. A lot of thought also went into keeping the press as low cost and affordable as possible, which was not necessarily true in the past. Past semesters have also not kept good qualitative or quantitative documentation on press performance, which is something that we started doing (or will be doing). Quantitative characterizations of prototype presses, such as effectiveness, efficiency, desired moisture content, and qualitative ones, such as cleanliness and physical burden, are important to have for comparison between the traditional rock pressing method, large screw presses, and our mini screw press design.

The design for the mini screw press went through many design iterations throughout the semester and design choices were made keeping the requirements of low cost, food safety, effectiveness and efficiency in mind. The handle was constructed from a precision Acme nut rated to 2,000 pounds of force. While the nut did come at a high cost of $40, it was determined that it was a necessary price to pay in order to achieve sufficient pressing force. While it would be ideal for the entirety of the press to be constructed from food safe stainless steel, this is not financially feasible, thus stainless steel was only used for the portions of the press that will be directly in contact with food. Thus, the threaded rod that the nut rides along in order to apply pressing force was made of plain steel as it will not be directly in contact with the cassava. The straight rod, on the other hand was constructed of stainless steel as it is inserted directly through the bag of cassava. By welding a small section of plain steel threaded rod to a longer section of stainless steel rod, we were able to get the benefits of food safety at the lowest cost. Wood was chosen as the material for the plates to press the cassava bag as it is much cheaper than stainless steel and becomes fairly water resistant when treated with oil. The force spreaders were constructed of four pieces of plain steel strap as they too do not come in contact with the food and thus do not need to be stainless steel. The force spreaders were created with a pinwheel design consisting of four pieces of strap of equal length. Using four identical pieces simplified the manufacturing. The stand of the press was designed to accomplish many tasks in a simple design. The feet raise the bottom of the press off of the ground makes it more sanitary as the cassava will not come in contact with the dirt while also providing a place for the women to place their feet in order to provide a counter force when turning the handle so the entire press does not rotate. While the current design is functional and relatively low cost, many more iterations will be required in order to improve the user interaction and to reduce the weight. The mini screw press design will be brought to Ghana in May and so we can learn more about user interaction and the needs and requirements.

Conclusions

The press product-service system is integral to the venture's mission to provide social benefit to gari producers by reducing their physical burden and cycle time thus increasing their income. Its design will inform the retail cost, which will affect the business model as well as how many gari producers will purchase it. Our current assumption is that the press will have a larger market than the grater because it will be much more inexpensive, and it does not need to run on electricity, which means it will be usable by all accessible gari producers in Ghana. The

performance of our press will also indicate how much social benefit is received by the gari producers.

Crucial next steps include greatly reducing the cost of the press which will require an investigation into willingness to pay and possibly a new design to move away from using such expensive lead screws and nuts.

Appendix A – Bill of Materials

	price per unit	how much we used	price of what we used
tube	44.65	0.17	7.441667
1/4" - 3" bar	13.22	0.50	6.61
3/16"-2" bar	25.23	1.25	31.5375
Lead screw	34.77	0.33	11.57841
Nut	40.50	1.00	40.5
spacer tube	5.36	1.00	5.36
Bronze bearing	1.97	1.00	1.97
Washer	3.09	1.00	3.09
stainless rod	24.70	0.67	16.46502
Wood	1.50	4.00	6
Total			130.5526

Appendix B – Lead Screw Quotes from Ghana

Outer diameter (mm)	Length (ft)	Price (GHC)	Comments
18	4	15	Scraps – hard to find for this cheap
20	5	150	Made in Suame
32	12	250	Scraps – easier to find for this price

Appendix C – Asante's Screw Presses

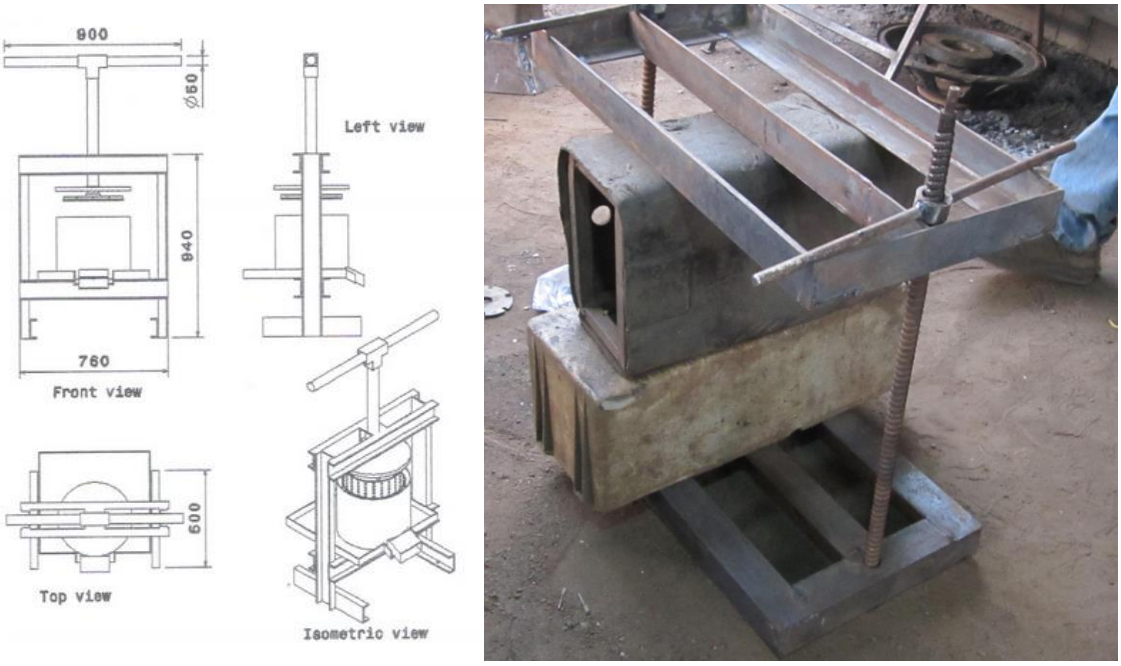

Figure A. Shea butter single-lead screw press & mini double-lead screw press

Appendix D – Previous Ideas

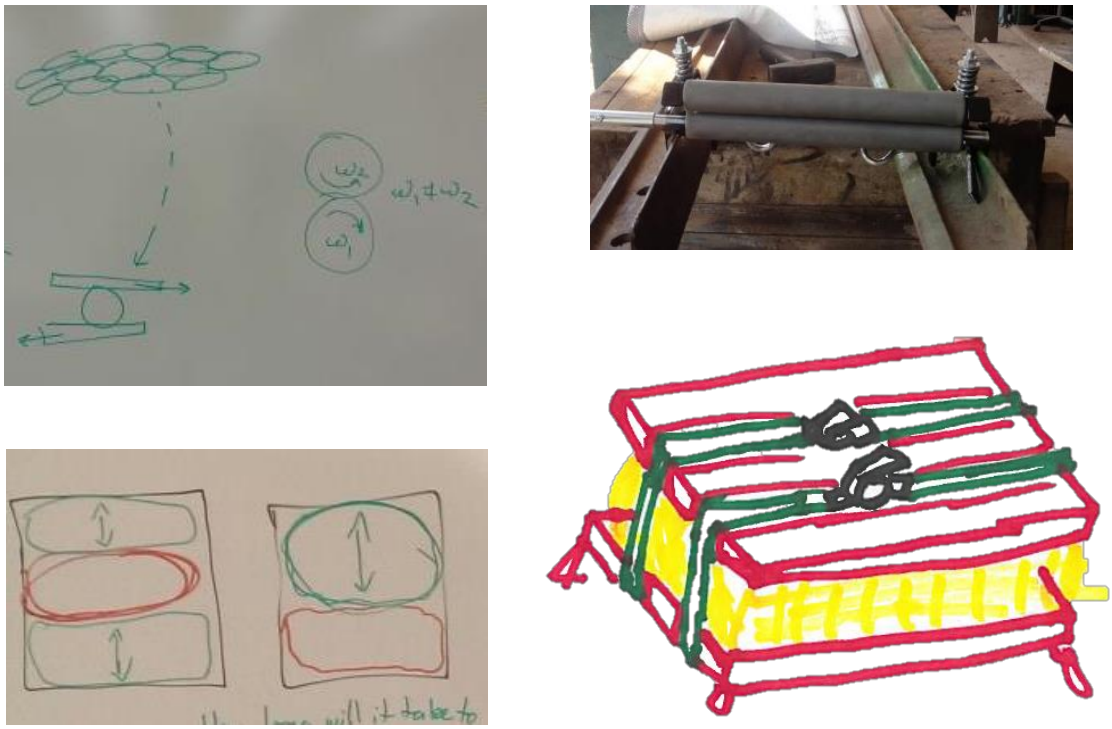

Figure B. Clockwise from top left – shearing, rollers, ratchet strap, inner tube

Appendix E – Decision Matrix

	Affordability	Effectiveness	Hygiene	Usability	Safety	Conclusions
Rollers						Turning pressing into an active process could take up even more of the women's time
Shearing						There could be more types of "press smarter", but shearing is not a viable idea
Ratchet Strap						Ratchet strap needs a lot of design work to increase usability but has potential for extreme affordability
Mini Screw press						Materials selection is crucial for safety and affordability
Inner tube						Hand pumping air could take too long to be worth it – more research needs to be done on pumps