Cassava Peeling in Boa Vista do Acará

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A farinha making community in Boa Vista do Acará peeling cassava by hand.

Abstract

During a two-week summit organised by IDIN (International Development Innovation Network) called IDDS Amazon (International Development Design Summit), concepts were developed with community members and the Organic Producers Association of Boa Vista do Acará to reduce the burden of producing farinha. The peeling of cassava was seen to be one of the most involved and burdensome activities in the process of turning cassava into farinha - at present, the skin is removed by scraping a machete or the sharp edges of tin cans over the cassava. Two approaches for automating the peeling of cassava were prototyped and demonstrated.

Context

Boa Vista do Acará is a small community based in northern Brazil accessible by boat from the city of Belém in the state of Pará. The primary markets for goods and produce are in Belém and are only accessible by boat. Most homes have electricity and limited cellular coverage.

Many families in the community generate income through traditional methods of planting and processing crops such as cassava or by harvesting and processing forest crops such as fruits and nuts. Their children increasing travel to nearby Belém for schooling and are learning these methods less and less, especially the more time consuming ones.

Certain families in the community have been producing farinha for decades and even generations. Farinha is a fried, granular flour made from peeled, dewatered cassava. Each of the families maintains a processing area next to their home that incorporates shelter, processing equipment, and a large wood-fired frying pan. Some families purchase cassava as an input while others grow their own on nearby farmland. The number of families engaged in the farinha making process has declined over the years. The heavy manual nature of the work being cited as one of the core reasons the newer generations are choosing to opt for other lines of employment.

Project Goals

To improve the process of removing the skin of cassava without detracting from the cultural heritage of making farinha from cassava.

Most of the main steps in making farinha from cassava are illustrated below. The fermentation step, which is used to make farinha d'água but not farinha de tapioca, is not shown.

Harvesting of cassava, roots are harvested by carefully / slowly pulling the stem of the plant — Harvested cassava

Unpeeled cassava, peeled cassava, and peelings — Peeling with a machete while bracing with the shin — A tin is also sometimes used for peeling

Grating of cassava using an electric grater — No guard is fitted to the grater — Injuries are common but could be addressed with simple modifications

Dewatering grated cassava using a tipiti, a woven fiber tube that constricts when stretched — A bag of rocks applied to a lever to stretch a tipiti

Emptying of tipiti — Sieving of the dried / grated cassava

Frying of sieved cassava (frying in this context means heating without oil) — Final product including farinha d'água and farinha de tapioca

Idea generation / grouping

Design Process

Project Framing
Cassava processing to make farinha is very burdensome. Clearing the fields for planting, peeling, and frying are the most burdensome stages of the process according to interviews and observations of producers. Fieldwork is the most burdensome stage; however, the time and resources available at the summit were not enough to pursue this challenge. Frying is also exhausting and time consuming, and it is the stage that makes the most difference in the quality of the end product and gives identity to the farinha. Peeling demands extreme physical work, and the way it is made nowadays can cause back problems and numerous small cuts to hands. Hence, improving the process of removing the skin of cassava was chosen as the focus of the project.

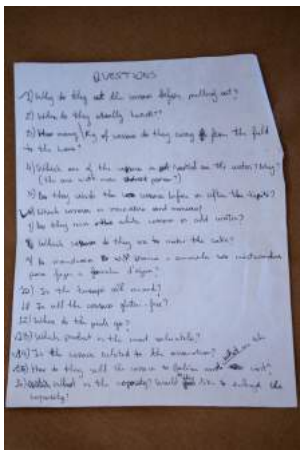
Value Proposition
The project aims to improve cassava processing in an efficient way so that the producers won't need as much physical energy as they need nowadays. In this way the process will be less time consuming while the production can be the same or higher. Also, the process will be more attractive to young generations, helping to perpetuate the tradition around cassava culture. While machines for automating the process exist at larger commercial scales, there are no known alternatives at the family level of production and any proposed solutions will need to be affordable. Furthermore, automation runs the risk of destroying the associated cultural traditions and identities, which must be preserved for local production to be meaningful and to maintain a rural heritage.

Design Requirements

- Environmental care
- Community strength
- Safety - no pinch point or entry points for hands, no contamination of food
- Peel removal - depth of cut 1 mm
- Burden - low forces, low engagement time
- Time to process - below 10 seconds per cassava or walk away per batch
- Size variation - different size of cassavas from 6 cm x 2,5 cm to 20 cm x 10 cm
- Low number of steps in operation
- Experience in using machine
- Maintainable
- Low cost

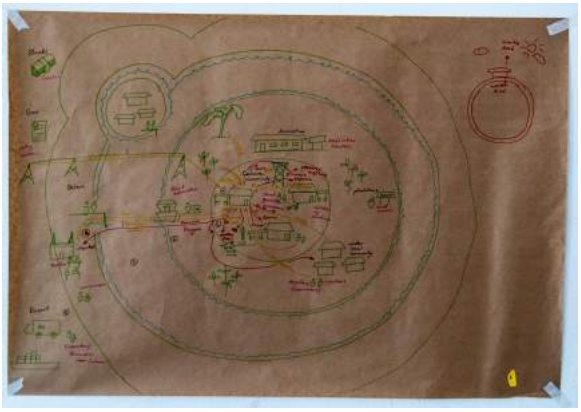
Process steps
An illustrated outline of many of the design process steps taken is provided below.

- Community engagement through conversations and interviews with farinha producers and other stakeholders.

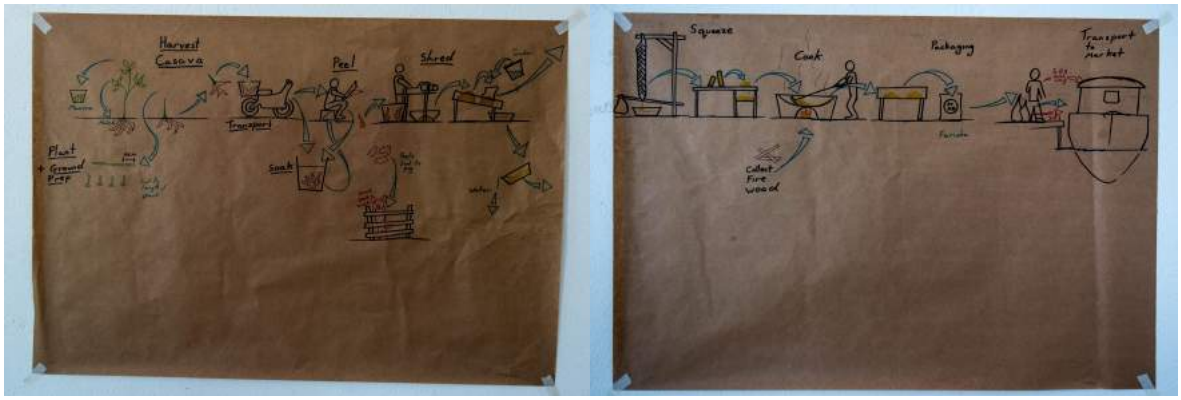


- Observation and execution in all stages of the farinha production by team members

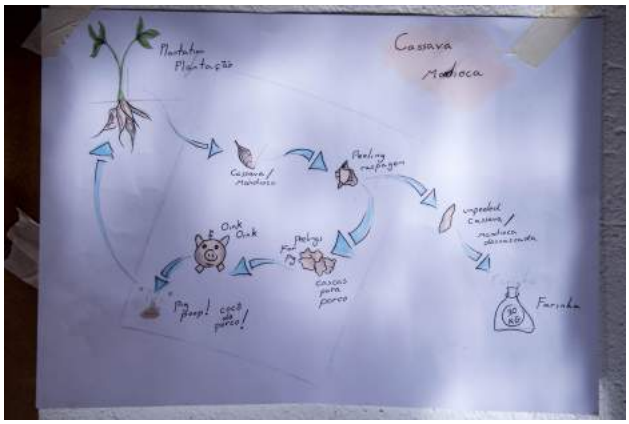
- Needs and yields analyses



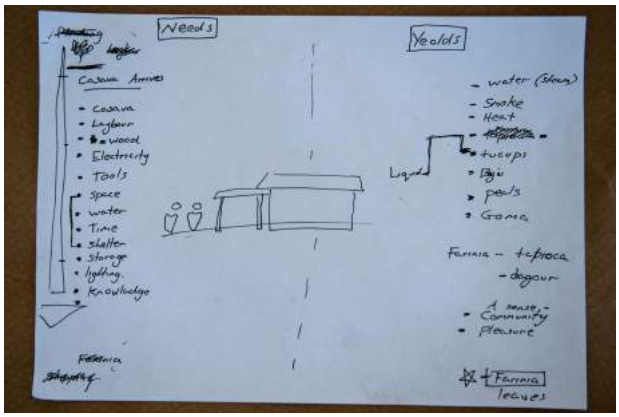
- Process and zone mapping



- System design map

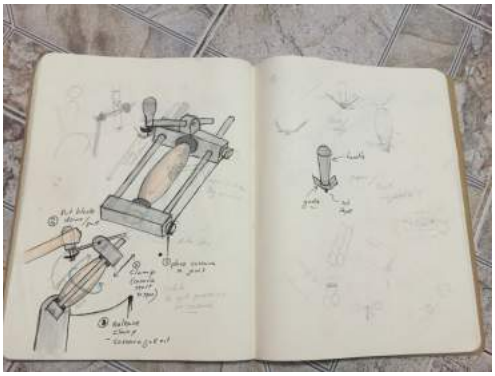


- Problem framing



- Interviewing stakeholders to determine the project direction between peeling and frying
- Secondary research of existing peeling techniques

- List of requirements



- Idea generation

- Idea selection through decision matrix was necessary because we didn't have enough time to prototype the 3 main ideas: tumbling, shaving and two sided can

- Two selection rounds and two ideas selected. Idea A: Tumbling and idea B: Shaving

- Sketch modelling (Concepts - tumbling machine, Spinning station, Flexible peeler, Ergonomic scraper.)

- Prototyping


- Testing, analysis, and experimentation

Technology / Final Prototypes

How it works - Idea A Tumbling
The basic idea for tumbling is to put more than one cassava at a time inside a rotating drum. The drum has an abrasive component on the inner wall to remove the first skin of the cassava as well as features to move the cassava around the drums. Secondary research indicated that industrial-scale tumblers are effective. Two configurations were prototyped.

Prototype (1)


Tumble built using a water cooler jug — Perforated strips with larger teeth were placed circumferentially

Prototype (2)

Tumble built using a water bucket — Perforated strips with smaller teeth were placed axially

Performance - Idea A Tumbling

Prototype (1)
As seen in the photos, the first prototype that was built peeled most parts of the cassava. At the same time, because of the size of the teeth made in the metal sheet, the cassava had also lost a lot of its biomass.

Most of the peel is removed in a short time but too much flesh is also removed

Prototype (2)
As seen in the photos, the second prototype that was built was able to peel most parts of the cassava with less loss of biomass. Nevertheless, curved areas of the cassava made it hard to remove all of the skin.

After 10 minutes of turning — After 20 minutes of turning

Bill of Materials - Idea A Tumbling

ITEM	SIZE	QUANTITY
Metal Sheet	**30x5 cm**	**5**
Wood glue	**20ml**	**1**
Rivets		**10**
Plastic pail	**20L**	**1**
Wood dowel	**25mm diameter**	**1**
Wood strips	**50mm x 25mm**	**11**
Screws with nuts	**M6 x 50mm**	**15**

Lessons learned - Idea A Tumbling

- Smaller teeth made in the metal sheet have a better performance than bigger teeth
- The tumbler can not spin too fast because the cassava will be pushed against the walls
- The tumbler should be fulfilled by 1/3 of its capacity
- Water makes the performance better because it is able to clean not only the cassavas but also the components inside the tumbler
- After 20 minutes rotating parts of the cassava that were not peeled have a high probability to not to have its skin removed

How it works - Idea B Shaving

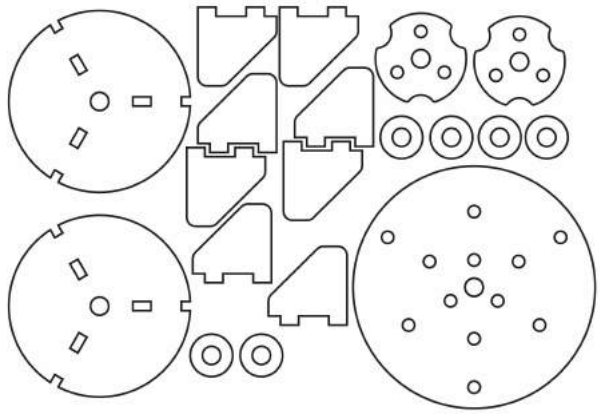
The shaving prototypes explore the removal of both the cassava first and second skins with a hard edge or blade whilst a mechanised rotational force is applied to the root. The concept looks at automating elements of the peeling process (rotation and grip) whilst retaining the judgement of the operator on the depth of and position of cuts. Two rigs were prototyped to test the transfer of a rotary motion from a power drill to a cassava and multiple cutting tool and a tool holder where built and tested on each.

Prototype (1) - Lathe
A frame was constructed with a sprung set of chucks . A cassava could be inserted between the blades of the chucks and spun using an electric drill. A range of cutting tools were tested on the spinning cassava.


Citrus peeling machine being used on a small cassava — Peeled cassava

Two sections of studding were mounted parallel within a wooden frame to create a runner on which one section of the check could be mounted and slide. A bungie cord mounted in two places was used to provide a clamping effect between the two chucks.

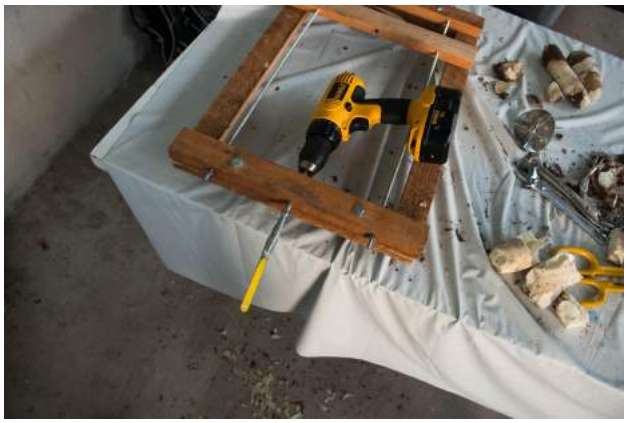
Chucks/holding systems were designed to centre the cassava and transfer a rotational force from an electric drill. Initial prototyping was done with Laser cut MDF parts and later with folded steel.



Laser cut parts — MDF / folded metal design

Chuck evolution

Prototype (2) - Flexible Shaft
The flexible shaft concept explores transferring the rotational force to the centre of the cassava rather than the outer edge. A 30mm slit was cut down centre of an m6 threaded rod to accommodate a 90mm length of a hack saw blade. The two components were tightly bound using duct tape and mounted in the frame pictured.

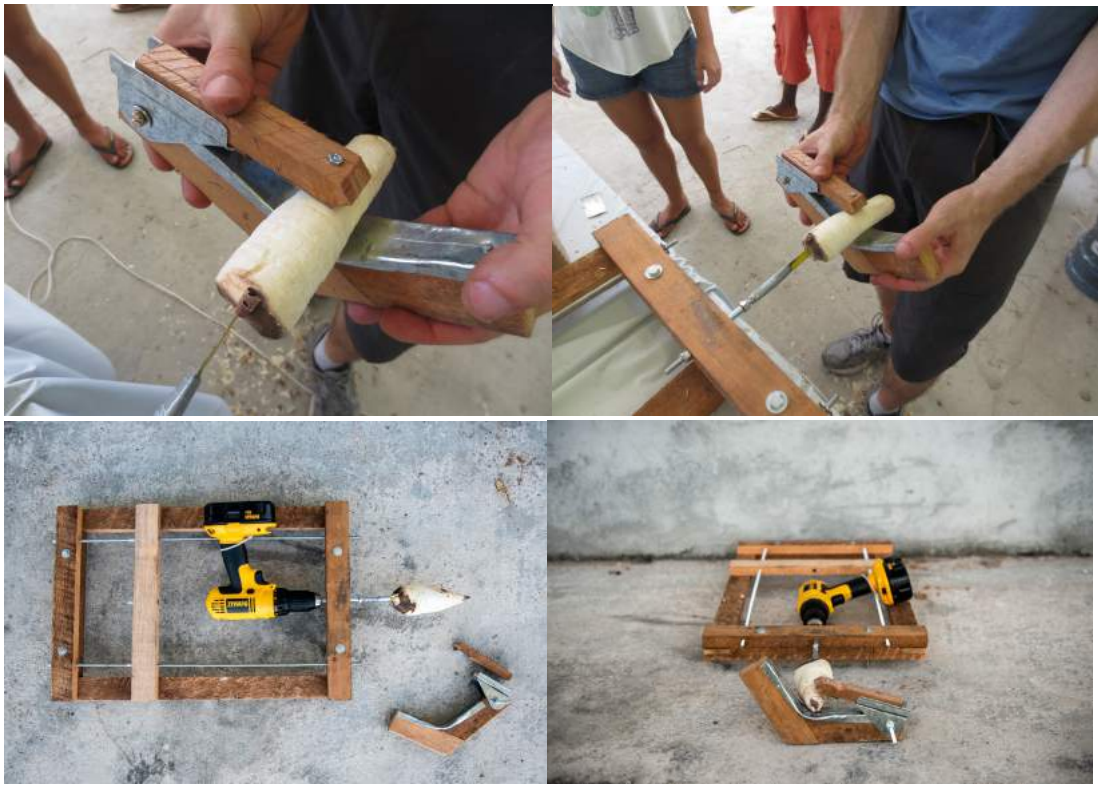


The original cutting tools were tried on this set up, the cassavas where supported underneath using a gloved hand. A new tool was developed which featured angled surface to centre the rotating cassava and a hinged platform which a tool could be held on. It was found that standing directly in front of the spinning axis was the most comfortable position to cradle the

cassava and apply pressure with a tool. It was also found that a small right angled fold (protruding 1-2mm) set at a shallow angle to the sides of the tool worked best. The flexibility of the steel allowed for it to be pulled against the side of the cassava using a glove to support the back.

Original cutting tools

A tool guide was built to centre the spinning cassava and allow for a peeling tool to be guided on to it. The tool included a smooth surface on which the cassava could be supported whilst rotating and a hinged arm which a tool could be placed. A cutting tool holder was created to allow variation of the angle of cutting blade, width, and depth of cut.



Bill of Materials - Idea B Shaving

Prototype (1) and Prototype (2)

ITEM	SIZE	QUANTITY
Sheet steel	0.6mm	300mm x 300mm
Wood glue	40ml	1
Epoxy glue	Few ml	1
Duct tape	Standard	15 cm
Nail	25mm	40
Wood	50mm x 25mm approx.	3m
Threaded rod	M6 thread	2m
Steel tube	6.5mm ID x 10cm	10
Nylock nuts	M6 thread	10
Spring steel saw blade	Hacksaw blade	1
Washers	M6	20

Performance - Idea B Shaving

Both prototypes successfully allowed for a rotating cassava to be cut to the desired depth through the first and second skin. Both showed potential, illustrating how rotational forces could be used to manipulate the roots over or against cutting / abrasive edges to remove the skin. More experimentation will be required to find out if the perceived benefits outweigh the standard tools (machete and tin can) used at present.

Prototype (1) - Lathe

Both skins removed using the lathe, removal from the ends near the chucks was difficult though

Prototype (2) - Flexible Shaft

Testing of the flexible shaft prototype

Lessons learned - Idea B Shaving

- Several tubers split whilst being spun between the chucks. A combination of of factors were likely to blame - the small surface area of the chuck connecting with the cassava, torque being applied from only one end, and the cutting tool requiring too much pressure to be applied to the side of the cassava.
- The peel was hard to remove on the ends of the cassava near the chucks, which was not a problem for the internal blade.
- Transferring the torque internally proved more successful than externally - the metal chucks tested caused the cassava to crack frequently during testing of tools. Alternative chuck designs that spread the force more evenly would likely prove more successful.
- The cutting tools that performed better were slightly angled on the horizontal and featured a hard right angle edge protruding 1.5 - 2 mm at a right angle from the blade.
- The guiding tool provided both a way of supporting the rotating cassava and guiding a tool on to the surface.

User feedback

Changing a process or improving it must be done with the end user and considering their feedback, otherwise project ideas have a high probability to make the process more difficult or unusable to the user. Every contact with the community, conversations and interviews, was fundamental to frame and develop the project. User feedback on the directions taken was obtained throughout. For example this is how peeling was chosen over frying as a process step to focus on. Feedback on the prototypes was obtained at the final event, which was as soon as the prototypes were function. Families that produce farinha witnessed demonstrations of and tried out the two ideas developed, tumbling and shaving. They showed considerable interest in tumbling because it processed more cassava at once and could be operated unattended.

Project Future

Next Steps

- An engine to automate the tumbler looping is highly desirable
- More tests with different components and features inside the tumbler is very important to keep improving the prototypes
- Exploration into robust flexible shafts would be desirable - an initial idea of using a spring to act as the flexible element of a shaft was discussed.
- Research in to the demand of cassava with both skins removed would help determine the future direction

Continuity / dissemination model

Team members made the following continuity commitments.

- Chris - Generate / visualise next round of concepts for both directions within the next 6 weeks.
- Bárbara - Not involved due to other commitments.
- Frank - Build and test a prototype tumbler in Tanzania in the shop he works in.
- Ben - Follow up with Deborah to investigate getting a prototype or small-scale commercial peeler to a community member or the association for testing. Investigate changing peeling practices in Ghana to be similar to those in Brazil to enable automated peeling in Ghana too. Investigate using waste starch in Ghana to make tapioca as is done in Brazil to create additional revenue and reduce waste.

Stakeholders

Summit community liaison

Débora Leal

Community Partners

APOBV - José (Pool)
Farinha Producers - Waldomiro, Luisa, João

Team members

Bárbara Bressan Rocha - barbara.bressan@gmail.com
Chris Natt - chris.natt@network.rca.ac.uk
Frank Kweka - frankjjkweka@yahoo.com
José Neto - jeoneto@icloud.com
Benjamin Linder, Design Facilitator - blinder@olin.edu

Cassava peel recycling system, the pig