

# Coffee Processing in rural Tanzania

Increase the productivity and reduce the human effort of the coffee pulping process for small-scale farmers in rural Tanzania.



## Acknowledgements

---

This documentation gives an overview about the work that was done during IDDS 2014 in Tanzania. Fieldwork was conducted in Leguruki, a small village located about 2 hours from Arusha town. The team worked to design solutions for the manual coffee processing of small-scale farmers.

We want to express our appreciation for the grateful support and interest we received in Leguruki. People were very curious, open-minded and willing to work with us. Also we would like to thank all the all organizers and facilitators. This project would not have been possible without their patience and advice.

# Table of Contents

---

Acknowledgements .....	2
Coffee Processing in rural Tanzania.....	1
Increase the productivity and reduce the human effort of the coffee pulping process for small-scale farmers in rural Tanzania. ....	1
Design Process .....	3
Problem Framing Statement & Value Proposition.....	3
Problem Framing Tree.....	4
The Leguruki Coffee Process.....	5
Summary of Design Process .....	7
Sketch Modeling.....	8
Impact Innovation Matrix.....	9
Prototype One.....	10
Testing & Survey .....	11
Survey Results .....	13
Technology & Final Prototype .....	18
Design Requirements .....	18
Final Prototype Function & Performance.....	<b>Error! Bookmark not defined.</b>
Final Prototype Cost .....	19
Final Prototype Test at Nane Nane .....	20
Viability & Next Steps .....	<b>Error! Bookmark not defined.</b>

# Coffee Processing in rural Tanzania

Increase the productivity and reduce the human effort of the coffee pulping process for small-scale farmers in rural Tanzania.

Coffee, a worldwide beverage, is more than a cup of good taste, especially to the people of the Leguruki in Tanzania. A cup of this good taste represents two weeks of hard labor from the coffee farmers.

From the coffee plant, only the red cherries are supposed to be picked. Picking is done in such a way to allow growth in the next coffee season. After being picked, the cherries are pulped, allowed to undergo fermentation, washing, drying, a second shelling, drying, and then roasting. They are then ground to a smooth powder whose mixture with hot water gives you that cup of good taste!

In Leguruki, the coffee world is divided into two; there are the factories that perform these processes quite easily with available motor-run machines, then there are the small-scale farmers who perform the same processes but with simpler machines, which have not the privilege of being motor-run. In the lives of the small-scale farmers, every process is a manual one, with pulping being the only process with an available machine. This advantage of the pulping process though is the major source of problem.

Pulping in coffee processing is the act of splitting the cherry to obtain the bean. Using manual machines his process requires a lot of human effort and causes much strain on the human body. The difference in size and ripeness of the beans affects the pulping process in the waste produced, which has an impact on the farmer's income. The pulping process affects all following stages of the coffee processing and is therefore one of the most important ones.



*Ripe cherries are red and soft.*



*Farmers grow Arabica and Robusta*



*Coffee dries for 2 days on the ground*

# Design Process

## Problem Framing Statement & Value Proposition

---

By improving existing coffee cherry pulping machines, we aim to lower the human effort, the working time and help to increase the productivity of small-scale coffee farmers of Leguruki in rural Tanzania.

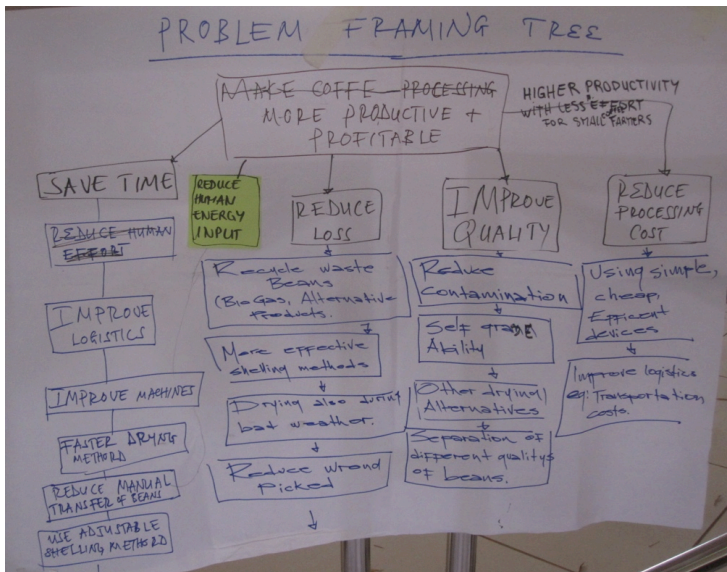
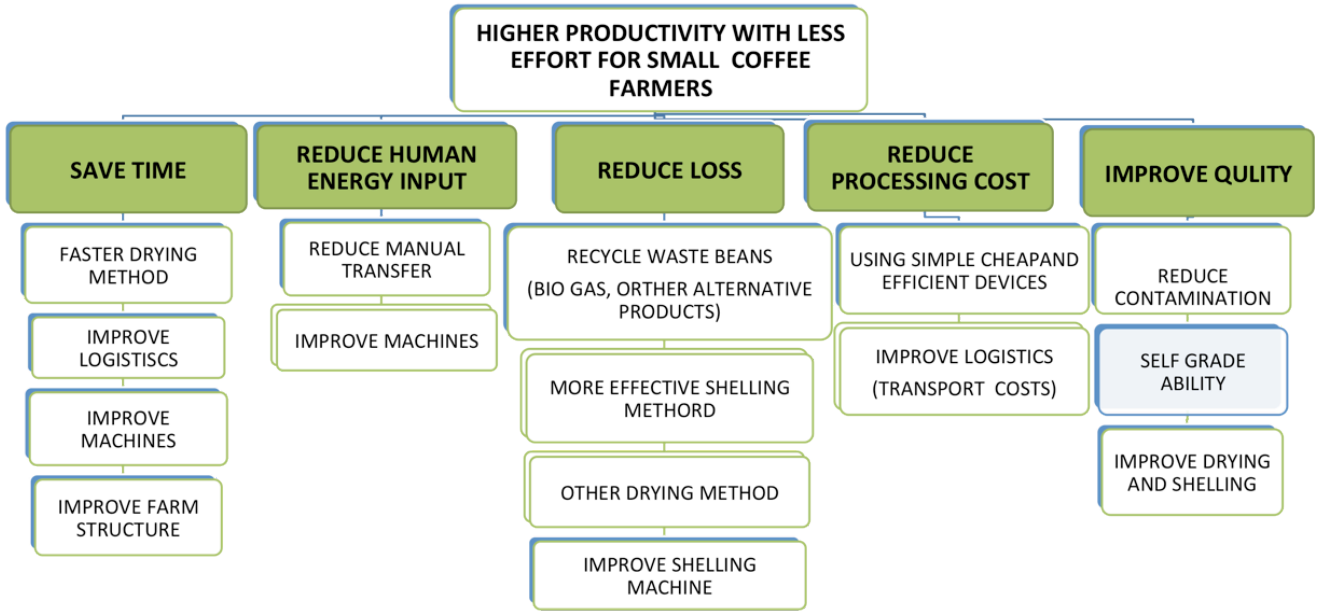
### **Saving Time**

Introducing the use of bicycles to power existing pulping machines instead of using hand-power could reduce the working time by half.

### **Reducing Human Energy Input**

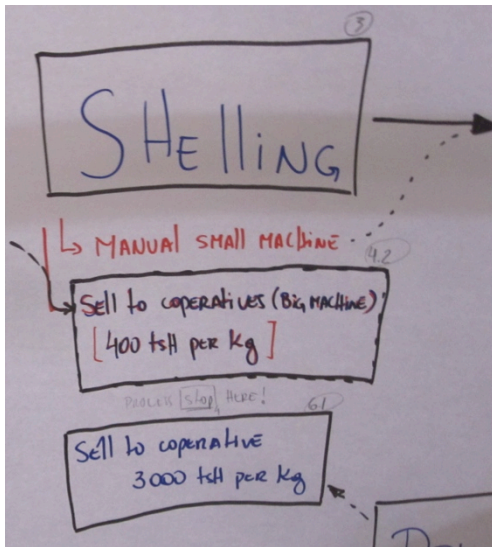
Farmer are currently pulping 15kg of cherries in 5-10minutes. By improving existing machines about 30kg of cherries can be pulped in the same time with less effort and strain on the human body.

# Problem Framing Tree



The team mapped out all potential ways on how the process could become easier with less effort and increased productivity. Information was gathered by field visits to Leguruki, through contacts to Brazilian coffee farmers and the internet.

## The Leguruki Coffee Process



Picking: ripe red beans: 1 Bucket in 2 hours

Pulping: 1 Bucket, 10 -20 minutes

Fermentation: within Bag for 12 hours

Washing: manually, high amounts of water

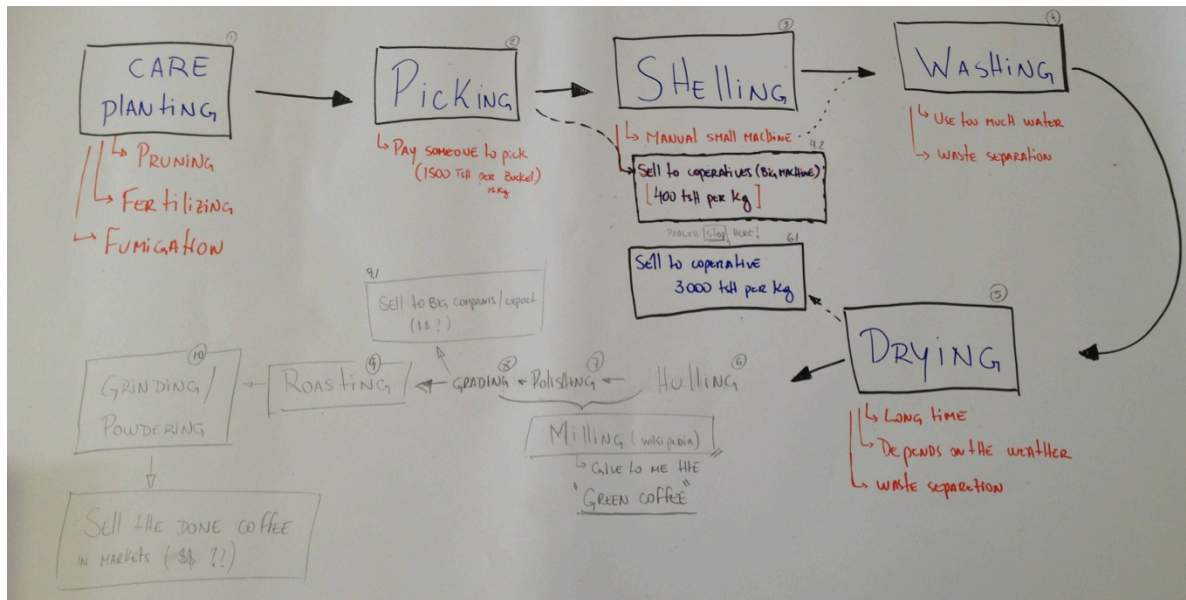
Drying: on drying tables and floor

2<sup>nd</sup> shelling: bigger factory

Grading & Sale

Roasting:

Grinding







## Summary of Design Process

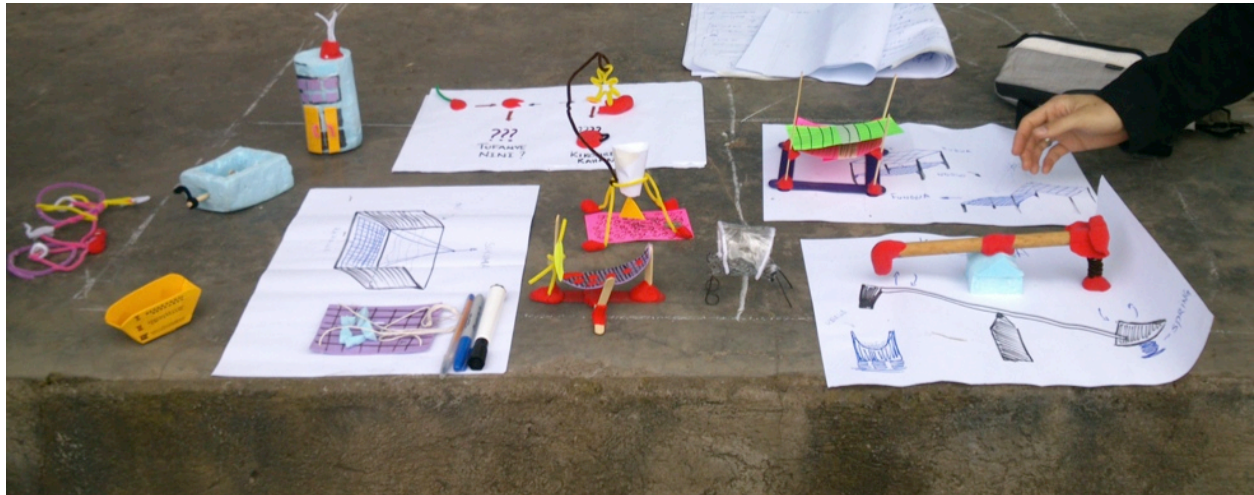
---

- 5-Day Research in the community Leguruki
- Identification of stakeholders: This activity pointed the team in the right direction in the next stage, which is gathering information on the problem at hand.
- Gathering of more information: In this stage, the team set out in the direction of the identified stakeholders and using 'Observe, Ask and Try' (OAT), necessary information was obtained.
- Drawing of problem framing tree and stakeholder analysis: The information obtained was then synthesized in a problem framing tree and a stakeholder analysis
- Sketch modeling: Sketch modeling represents the stage where the group made physical presentations of raw ideas in solution to various problems identified. This stage allowed feedback collection and helped the team in selection of the most outstanding problem of the coffee farmers.
- Problem framing statement and value chain: The writing of the problem framing statement succeeded the selection of the problem to solve.
- Idea generation: Idea generation is a stage of brainstorming of solutions to the identified problem. Here, all ideas are accepted in the beginning then analyzed to select a solution.
- First prototype building: Here, solutions were properly designed and built.
- Obtaining and analysis of user feedback: After building our prototype, we set out to Leguruki to test and obtain user feedback.
- Listing of design requirements and value chain revisitation: Based on feedback obtained, the team made a list of design requirements to obey in the final prototype building. Based on this feedback also, we revisited our value chain and made necessary adjustments to obtain the final one.
- Second prototype building: Following our design requirements and feedback from the community, we designed and built our final prototype.

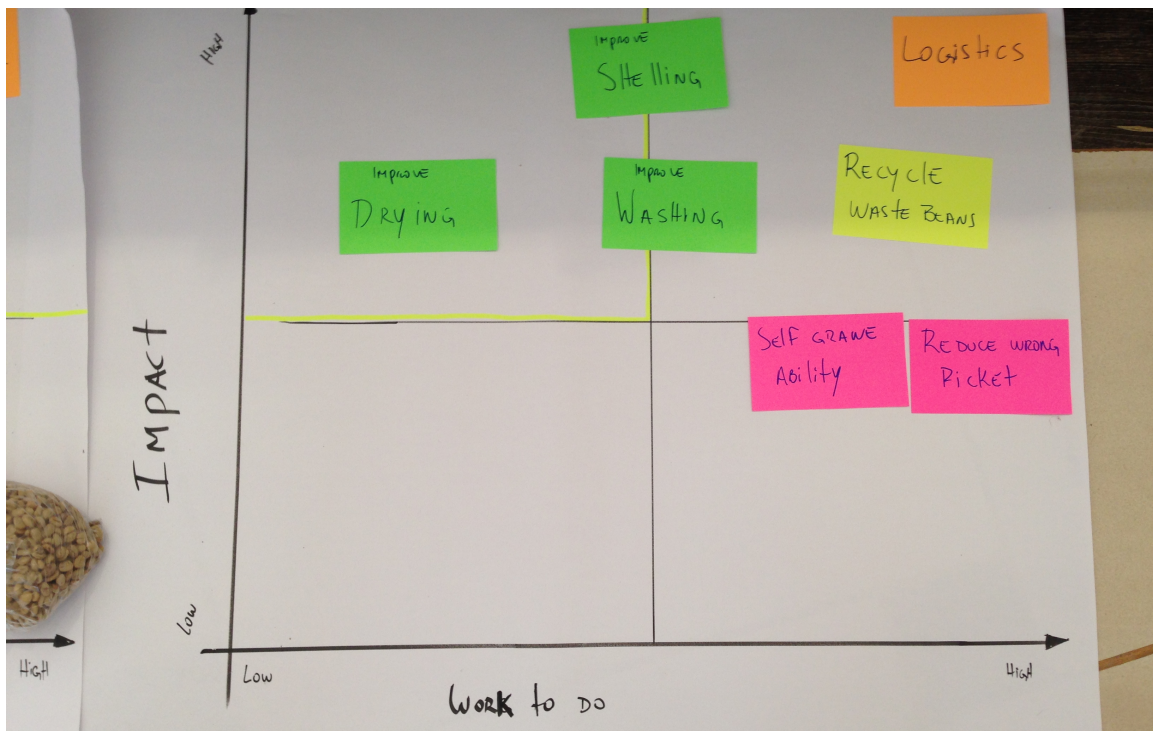
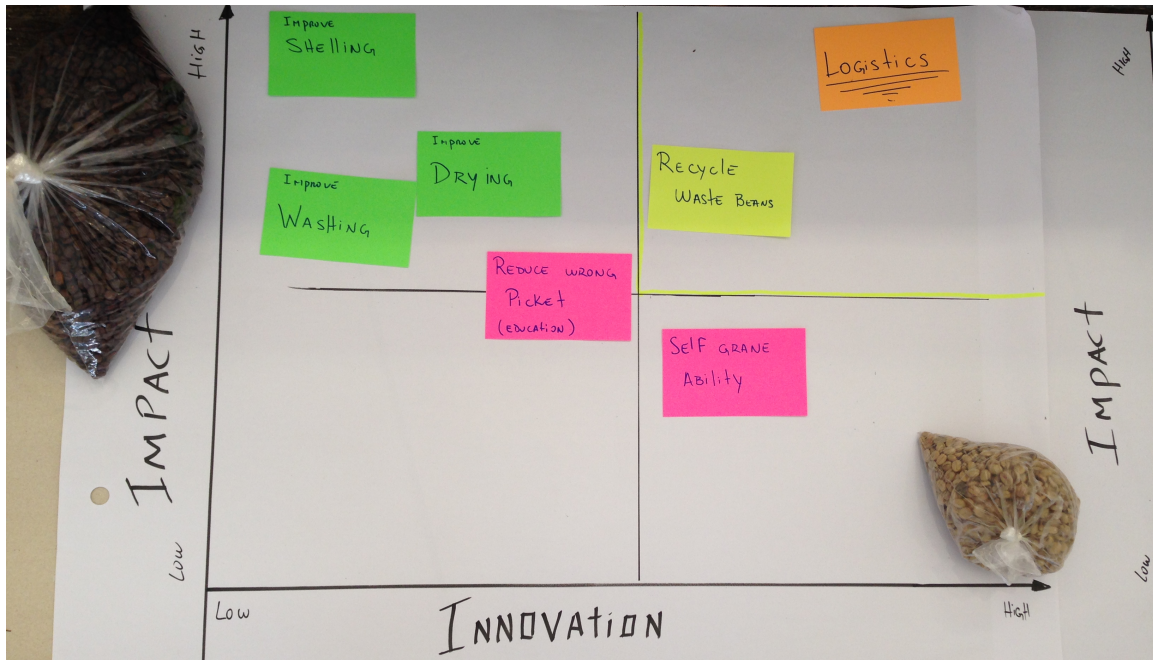
## Sketch Modeling

Building sketch models of initial ideas helped to gather first feedback from the community. The coffee team worked independently to build small versions of their ideas. After 2 hours each team member explained his idea to the group and together the team decided on a presentation strategy.

After returning to Arusha, the team used the collected feedback and analyzed which idea did receive the most attention and which one might have the biggest impact to the farming process.



# Impact Innovation Matrix



## Prototype One

The team decided to focus on the reduction of human energy input and started to prototype a pedal-power tool that can be attached to existing pulping machines.

Most parts are recycled bicycle parts and were found in Arusha. The chain and the gears are new.



## Testing & Survey

During our second community visit on July 28<sup>th</sup> we placed the functional pedal-powered prototype on a public space, invited people and asked, “Please test this machine, how would you use it?”

The prototype allowed two different **sitting positions**, a) a normal bicycle saddle above the pedals and b) a lower chair behind which allows women with cultural dresses to sit and pedal comfortably.

While people tested the machine, we **observed** and took notes. How intuitive are people using the machine? Do they look comfortable? Are they enjoying the process? Do problems occur? Which sitting position do they prefer?

We measured the **time** needed to pulp one 20L bucket of cherries, noted the time and challenges we observed.

Afterwards each user received an **interview form** to fill out. Some users also gave spoken feedback, which we noted on the forms. We asked for contact information and suggestions for improvements.

The following page shows the interview form.



## Interviews 28-07-2014

### Test of pedal-powered coffee pulping machine

1 Jina Name

2 jinsia Gender

3 umri Age

4 kazi Occupation

5 unajisikiaje kutumia mashine? How do you feel using the machine?

6 ina uhafadhali kulinganisha na mashine uliyokuwa unatumia mwanzo?

Compare this machine to the one you used before?

7 njia gani ulikuwa unatumia kumenya kahawa awali?

Which type of machine were you using before?

8 mda gani ulikuwa ukatumia kumenya kahawa debe moja kwa mashine ya kawaida?

How much time did you spend for shelling one bucket of coffee?

9 huwa unamenya kahawa mara ngapi kwa wiki? How often do you shell coffee per week?

10 una baisikeli? Do you have a bicycle?

11 unapenda kuendesha baisikeli? Do you like riding the bicycle?

12 watoto wako wanapenda kuendesha baisikeli? Do your children like riding the bicycle?

13 unafikiri kuna uwezekano wa kutengeneza mashine kama hii kwenye eneo unalo ishi?

Do you think this machine can be made in your community?

14 utapenda kutengeneza mashine kama hii? Would you like to build this kind of machine?

15 unafikiri mashine inaweza ikagarimu kiasi gani? How much do think this machine costs?

16 mashene kama hii kwa wewe ungenunua kwa bei gan? How much are you willing to pay for this machine?

17 tupe maoni yako kuhusu namna tunavyoweza kuboresha! Please tell us your ideas for improvements!

## Survey Results

Feedback survey												28 july
2014												
AGE	OCCUPATION	FEELING USING	MACHINE THEY HAVE	TIME SPEND BEFORE	OFTEN SHELL IN A WEEK	HAVE BIKE	LIKE RIDING	THE MACHINE CAN BE MADE	YOU LIKE	HOW MUCH COST	HOW MUCH YOU PAY	IDEA
32 male	farmer	different	hand machine	1min	2-3 times	no	yes	yes	yes	300000	300000	***
42 femela	work in a church	good	hand machine	1hour	3	no	yes	yes	yes	5800	6800	put the sit down
29 female	farmer	good	hand machine	5min	depends	yes	yes	yes	yes	400000	400000	higher the machine
30 female	studant	nice	hand machine	1hour	onces	no	yes	yes	yes	320000	310000	improve the chain
26 male	bussiness	good	hand machine	?	2-3times	no	yes	yes	yes	150000	180000	use sewing machine
35 male	?	very good	hand machine	10min	onces	yes	yes	yes	yes	80000	85000	higher the machine
14 male	studant	good	?	?	?	no	yes	yes	yes	?	?	improve the chain
40 male	V.E.O	good	hand machine	6min	2	yes	yes	yes	yes	?	40000	higher the machine
38 male	farmer	good	hand machine	10min	onces	yes	yes	yes	yes	800000	1000000	higher the machine
30 male	farmer	good	hand machine	10min	onces	no	yes	yes	yes	100000	100000	higher the machine
28 male	builder	very good	hand machine	20min	2	no	yes	yes	yes	80000	87000	improve the machine
24 male	enterprenuer	good	?	5min	3	?	no	no (no money to build)	yes	30000	80000	?
52 male	farmer	less efford	hand machine	7min	onces	?	yes	no (but he want to try)	fun	?	bargain	?
36 male	farmer	good	hand machine	minutes	onces	no	yes	yes	yes	250000	300000	improve sit and make more strong

Fourteen people between the age of 14 and 52 were interviewed. Only 3 women attended the test. The reason is, that pulping coffee is currently mostly done by men. Only 4 people replied to own a bicycle, but almost everyone likes riding them. When we met people on their farms we understood the reason for the small number of bicycles. The area is hilly and the street conditions are often very simple and do not allow riding bicycles. The coffee farms are spread out around Leguruki and the distances are far. More common than bicycles are motorbikes, which are suitable for the rough streets and distances. The few available bicycles influenced our design. Instead of designing a pulping station where existing bicycles can be attached for pulping we designed a permanent tool that can be attached to the most common pulping machines.

The willingness to pay for a pedal-powered tool for pulping coffee ranged from 6,800Tsh to 1 million Tsh. The target group of farmers usually has a stable income and already afforded other expensive tools for coffee processing. For example the most common pulping machine currently costs 1 million Tsh. Therefore the willingness to invest in labor-saving tools is high.



Most common ideas for improving the first prototype was the height. The pulping machine was placed on the ground and collecting beans and cherry waste was not convenient. People also asked for improvements on the chain, which came off several times during the testing.



People were very curious and willing to test the machine.

Especially children enjoyed using it. As the task became so much easier now, more people are able to do the pulping, whereas before men only did it.



The lower sitting position behind the prototype should allow women to use it without interfering with their local dress, a long wrapped skirt.

Women liked it but also tried the upper position and seemed fine with using both.





The team tested the prototype themselves too. Mwanaharusi found it difficult to use the lower position behind, as it harder to get enough energy. When you sit on the upper position you can use your body weight and the task becomes even easier. Since the lower chair was not attached to the frame the chain came off multiple times and people preferred the upper position.



Coffee Processing in rural Tanzania

# Technology & Final Prototype

## Design Requirements

Needs	What are we measuring?	How to measure it?
<b>Production &amp; Assembling</b>		
Easily accessible materials + tools	Are materials in shops or available for free	Visit material stores, observation of village
Affordable, low-cost	Price of materials	Compare prices
Ease of manufacturing	Can people build it themselves?	
Ease of assembling	Can people assemble it easily	How many people, weight of parts, time measuring
Ease of transport	Can people carry it or put on pushcart	Try ourselves, time for transport, weight of parts
Weather resistant	Are materials water resistant	Observe tools/machines that are kept outside
<b>Usage</b>		
Reduce effort for people	Is it easier than the process before	Test ourselves, test with users, interviews and time measurement
Comfortable usage for everybody	Are people feeling comfortable	Ask for peoples feedback, observe behavior
Safe to use	Are all tools safe, no sharp parts	Test, observe, ask
Ergonomically friendly	Are people feeling comfortable	Observe and ask
Save peoples working time	Is the process of pulping faster	Shell one bucket of beans by hand/ by pedal power
Increase Productivity of Coffee Pulping	Outcome of beans	Measure amount of beans and time needed
Ease of bean and waste collection	Are waste and beans separated	Set up bags to catch waste
<b>Maintenance</b>		
Easy & affordable maintenance	Are replacing parts and tools available	Observe, test the repair
Durability and consistency of product	Can it stand multiple tests	Test prototype
<b>Design</b>		
Attractive look	Do people like it?	Ask
Intuitive design	Do people know how to use it?	Let people test the prototype
<b>Value</b>		
Can be used by everyone (women, teens)	Are women comfortable using it	Women testing it, asking

## Final Prototype Cost

---

### Bill of Materials - First Prototype

MONEY (TSh)	DATE	PERSON	USE
12000	23/07/14	ERIC	METAL ROD
3500	23/07/14	JESSE	BICYCLE CHAIN
6500	23/07/14	JESSE	SADDLE
18200	23/07/14	TEAM	BICYCLE PARTS
12000	23/07/14	TEAM	BICYCLE FRAME
3800	23/07/14	JESSE	BICYCLE PARTS
1000	24/07/14	MWANAHARUSI	TRANSPORTATION
1300	25/07/14	HELEN	NAILS
3000	27/07/14	MONA	WELDING
5000	28/07/14	TEAM	PRINTING
<b>TOTAL</b>			<b>66300</b>

We were allowed to use the tools and the infrastructure GCS workshop in Arusha for free. Additional cost for welding and using tools would apply to the total amount of cost.

### Bill of Materials - Final Prototype

MONEY (TSh)	DATE	PERSON	USE
4000	08.02.14	TEAM	BICYCLE PARTS
25000	08.02.14	TEAM	METAL ROD
6000	08.02.14	TEAM	BICYCLE PARTS
6000	08.04.14	HELEN	SPRAY PAINT
200	08.04.14	HELEN	QUARTER PIN
<b>TOTAL</b>			<b>41200</b>

## Final Prototype Test at Nane Nane

The final prototype test had the team on the Nane Nane grounds by 10am on the 8<sup>th</sup> August, 2014. It was a bright day which brought many people around for testing of the prototype. We had a diverse group of testers; old and young, Tanzanian and non-Tanzanian, coffee farmers and others. We also had most importantly three visitors from the Leguruki community; Dora and Christian, both coffee farmers, as well as the mtendaji. One exciting thing about this day was the role our visitors from Leguruki immediately took up; presentation of the final prototype to interested parties! This act showed their interest and acceptance of the device and the willingness to further support the concept. Overall the performance of this prototype was very good:

- The pulping was reduced from 5-10 mins to an average of 2mins for pulping one 10l bucket.
- Everyone could take part in the pulping process; children, women and men.
- This is because the process became much easier and also fun.
- The chain worked smoothly and did not come off while peddling
- The attached collection bags on the pulping machine made catching the beans and the waste easier and more convenient.
- The adjustable height of the saddle catered for everyone's seating preferences.
- It was a form of exercise to many.
- Some suggestions were also made;
- The device could be made safer by creating a sieve over the receiver of the pulping machine.
- The waste produced from pulping could be made useful through recycling to compost or livestock.
- A holder could be attached to the bicycle handle to hold items such as phones, a bottle of water, a radio, to mention a few, since it was observed that other activities could be carried out at the same time.





Coffee Processing in rural Tanzania