DOCUMENTATION

Morama Nut Project

It’s a hard nut to crack

TEAM CGUI

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Cover Illustration by Jamie Noon

Project Abstract

Morama is an indigenous nut of the Kalahari Desert that can be found around D'Kar and nearby settlements. It is a valued and healthy source of food for local families and a good source of income if sold. And can be used for making various products, but needs to be shelled first. However, the traditional method for shelling the nuts by cracking with stones or sticks is time-consuming (20-30mins per kg), laborious, and can cause injuries.
Through the design process (problem statement to idea generation to experimentation and analysis, concept evaluation, Design for x, to detailed design and fabricating, testing and evaluating and getting user feedback and planning for continuity project) two projects were developed: morama nut sheller and morama hot beverage.
This project report discusses the context, design process in detail for the nut sheller and hot beverage to final prototype of technology and hot drink, lessons learned in the process and a continuity plan.

Context

Background

Community description

D'Kar is a settlement in Ghanzi District of Botswana. It is located 40 km to the north east of Ghanzi Township. D'Kar is a private farm which belongs to the D'kar Reformed Church. Trusts work as partners to support the 2000 marginalised, scarcely populated D'Kar inhabitants, and others in the surrounding 15 settlements around Ghanzi as they face the health, economic and political challenges of a minority group in Botswana. The inhabitants are predominantly San sharing a common culture. The spoken language is Naro and the dominant religious affiliation is the Reformed Church.

D'Kar has been demarcated into four wards namely Khotcaase, Dqaraga, Hana, and Dtcoagadxoo. The community has a counselor, chief, clinic, boarding school as well as a small shop and a tuckshop. Livelihood in D'Kar is mainly maintained by the local developmental organization called Kuru Development Trust through provision of employment opportunities. Those who do not find work through the organization tend to find other ways of survival such as jewelry bead making, traditional dancing, ploughing as well as gathering of fruits and other berries in the wild. This is as a result of the residents' possession of considerable Indigenous Knowledge (IK) about plant and genetic resources. They survived with medicine and foods from different plants growing in the veld. Morama nuts have been identified as one of the edible and enjoyable food source that has been exploited by the San which has many different uses. Thus this project focused on the shelling of the nuts because they are considered precious by the community.

"Morama nut plant"

Sara Cao (Qgocgae), Kuru Art Project

Morama Nut

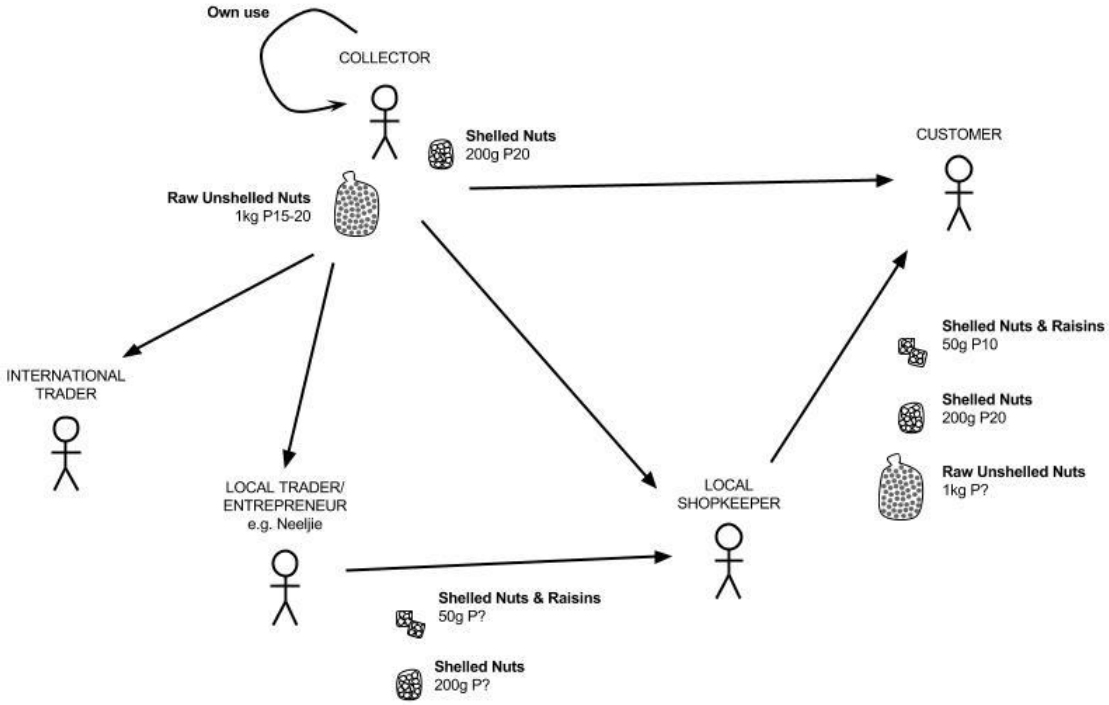
Morama (*Tylosema esculentum*) is a nut native to the Kalahari Desert in Botswana, Namibia and South Africa. It grows across the ground as a trailing creeper with stems of around 3m and a large underground tuber. It grows in dry and low-moisture soils and is extremely tolerant of drought conditions, remaining dormant over winter.

Dried up morama vine/creeper in late June (winter, after the rainy season)
Collection site in Dqae Qare Game Farm, GPS -21.644183, 21.848605

Morama nuts in a pod

Harvest season runs from around March to April/May. It is used by local people and valued for its high nutritional content - high protein, high in mono- and di-unsaturated fatty acids, no cholesterol, a good source of calcium, iron, zinc, phosphate, magnesium, and B vitamins including folate. Yield can vary dramatically from year to year, but the harvested nuts can be stored safely for up to 10 years.

Good sites for collecting morama can vary from season to season and are not always close-by. Modes of transport to reach collection sites: on foot, with a donkey cart, with a vehicle. Often individuals will travel together as groups or as employer and piece-work employees. Local San people have the right to collect morama from land even if owned by others but this is regulated and taken advantage of in an ad hoc manner that relies on good relations.



Existing value chain for local trade in morama
Existing trade for local people is typically in raw unshelled morama nuts or occasionally in shelled nuts. It is apparently hard for local people to get a good price for shelled nuts from shopkeepers.

Morama are very tough nuts, requiring a force of approximately 546.78 Newtons to crack their shells, according to data published by Emesu & Mabuza (we suspect this value was measured using raw nuts) (Emesu & Mabuza, 2014). Further valuable information about the mechanical properties of morama can be found in their paper

Key stakeholders and typical users

KEY STAKEHOLDERS	TYPICAL USER
Collectors and processors	Community
Consumers	Community or Tourists
Government (IKS-Indigenous Knowledge System)	
Entrepreneurs	Community

PATH Statement for morama nut sheller

Morama is an indigenous nut of the Kalahari Desert that can be found around D'Kar. It is a valued and healthy source of food for local families and a good source of income if sold. However, the traditional method for shelling the nuts by cracking with stones or sticks is time-consuming (20-30mins per kg), laborious, and can cause injuries.
The aim of our project is to work with local people to develop two devices which will improve and impact lives in Dkar. Firstly, a simple handheld cracker for households that can shell morama nuts safely at a faster rate (from 12 nuts per minute when shelled by hand to 25 nuts per minute). And secondly, a rotary machine for efficiently cracking larger quantities of nuts to empower local entrepreneurs to make and sell morama products.

PATH Statement for morama nut hot beverage

Morama is an indigenous nut of the Kalahari Desert, valued by local people for its good flavour and high nutritional content. It can be used to make a variety of products, but the potential for entrepreneurship around these has not been tapped due to a variety of challenges. Morama is seasonal and yields vary from year to year. The various processing techniques (shelling, roasting, grinding,etc) required to make different products are often inefficient. And those wishing to start a business around morama are not well supported; for example, local people have difficulty gaining access to markets and start up financing. We will explore the potential for producing a morama based hot drink, "Cgui Tsam" that could be produced locally, with the potential to create new local entrepreneurs.

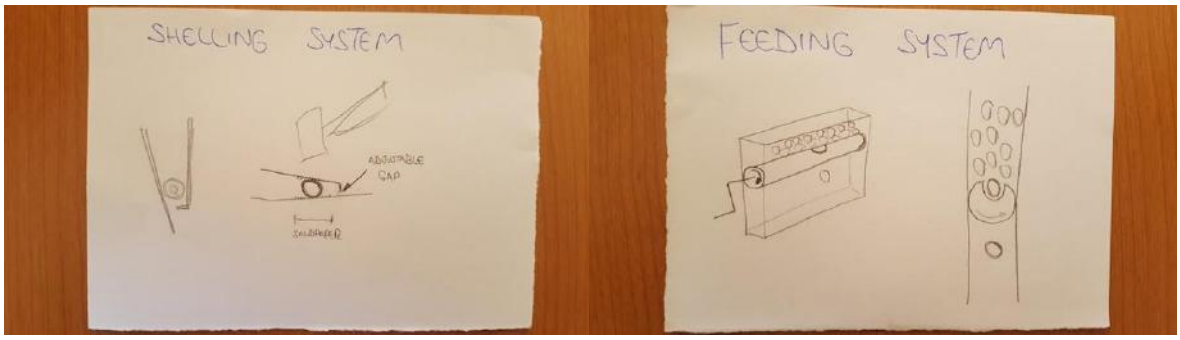
Design Process: Morama Nut Sheller

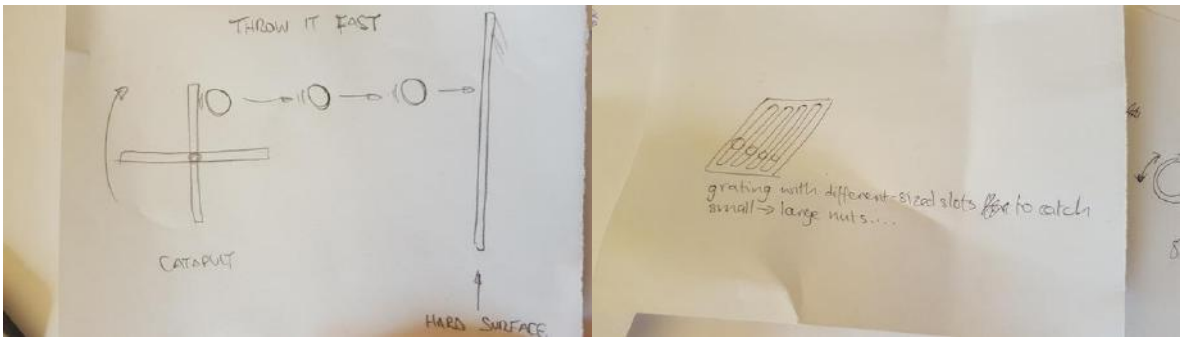
After gathering the user needs, listed in the table below, we started an ideation process, in which each team member gave ideas. All the ideas were based basically in two different approaches to break the shells: pression or impact. Some nut feeding mechanisms were also proposed.

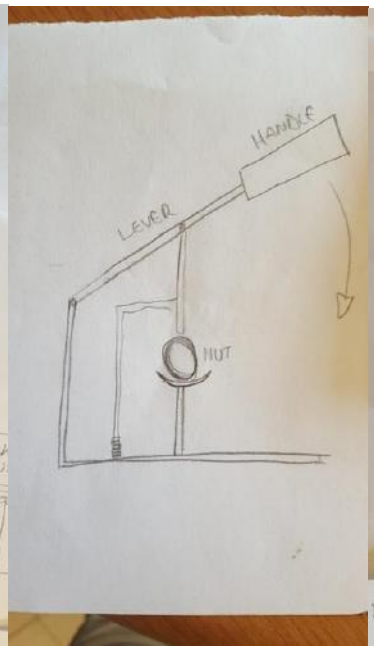
We evolved some of the first drawings into sketch models or functional prototypes before selecting the ideas we would proceed developing. Following we have some pictures and descriptions of the different attempts. The videos attached provide a good complementation to make it easier to understand how each of the different machines work.

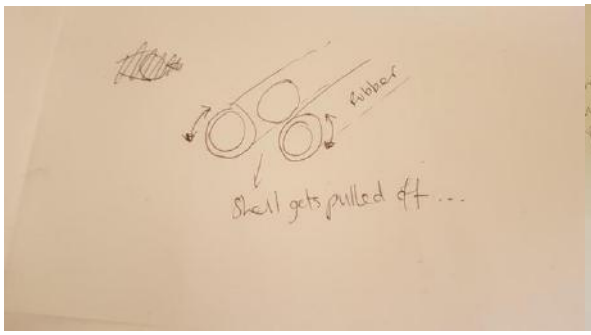
Design requirements:

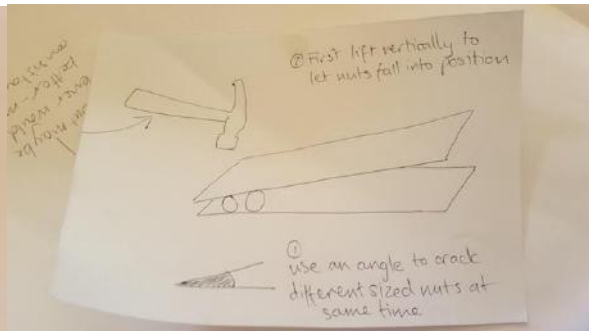
Here we can see some of the first drafts:





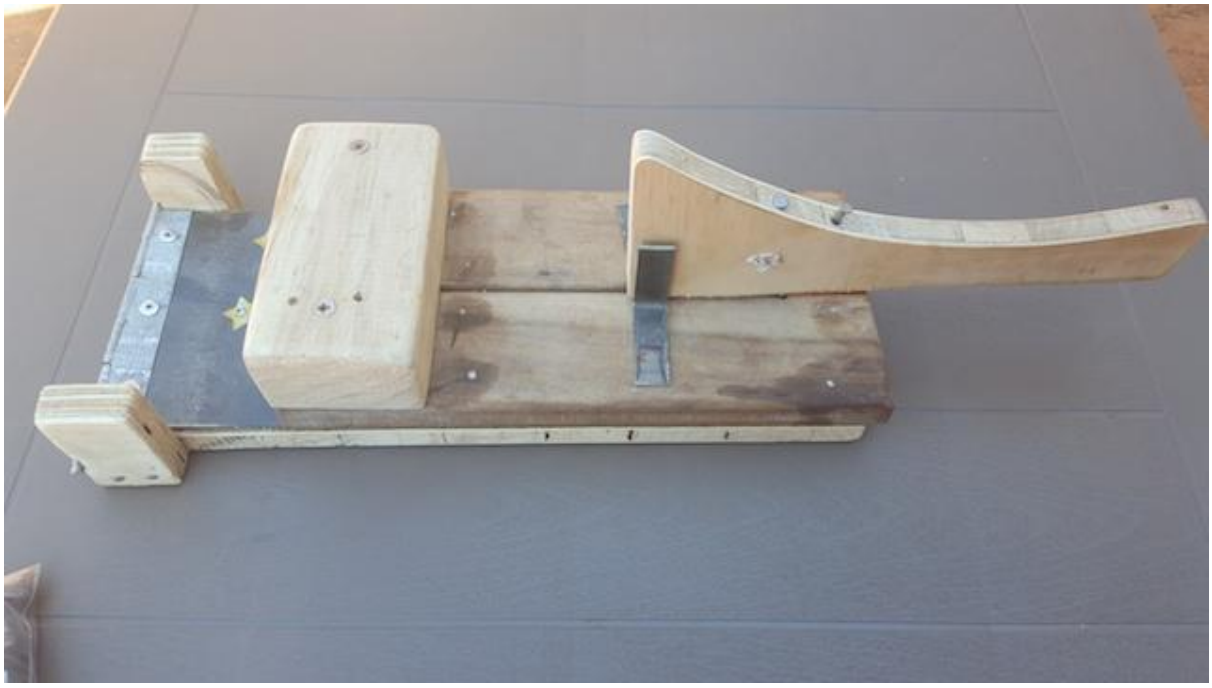


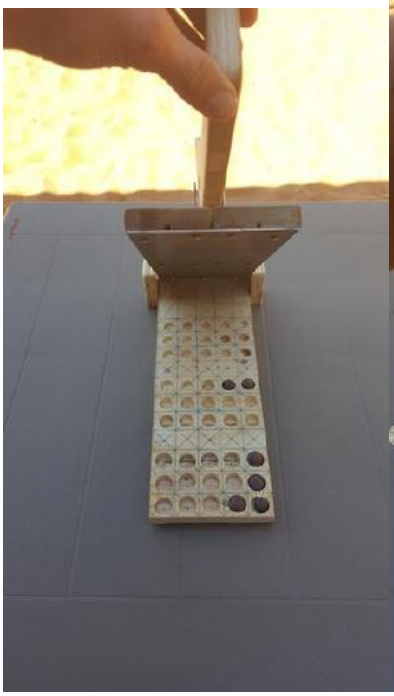




The following photos show one of the prototype we built. The idea here was to break a large number of moramas at the same time. The holes in the base have different diameter and depths, requiring the moramas to be pre-sorted by size before shelling them. The top plate was made with heavy wood covered in the bottom with metal sheet, to make it rigid. It was supposed to work by impact, hitting the top plate against the moramas in the base using the handle.

The problems we faced with this model were two: it takes a long time to put the sorted moramas one by one in the base, and even doing it, the different sizes make some part of the moramas get smashed while other part remains not shelled.





The following model was built after we noticed the traditional shelling method always put the pressure in the direction of the nut's longer-axis. As when we leave the moramas over any surface they stand flat, with the short-axis perpendicular to the base, we tried to make a model in which the pressing force is parallel to the base, allowing the pressure to be put in the long-axis direction. From the pictures it is not possible to notice, but the plywood base is inclined, allowing the moramas to slip into the v-groove between the laterals, stopping naturally where it fits better between the two pieces. There is a screw between the two pieces which is intended to work as a limiter, with a small gap between the screw head and the left lateral. The idea was to limit the shelling movement to about 1 or 2 mm, making the movement break the shell but not the nut. The handle was supposed to feed the machine with one nut when pushed up, and shell one nut when pulled down. There are two small pieces of sandpaper on the laterals, in the shelling area, whose function is to hold the nuts in place. As it was just a sketch model, we used wood for the construction, but in a real prototype we would used metal. This prototype was not further developed due to limitations in the feeding and releasing mechanism.

The following sketch model is a mix of the two previous model, using the v-groove system and the handle-press (not implemented in the model) in the same machine. The gravity was supposed to put the moramas in place, instead of pre-sorting and manual arrangement. We did not further developed this model because it seemed that the press lever would be tricky to apply an evenly distributed force over the moramas.



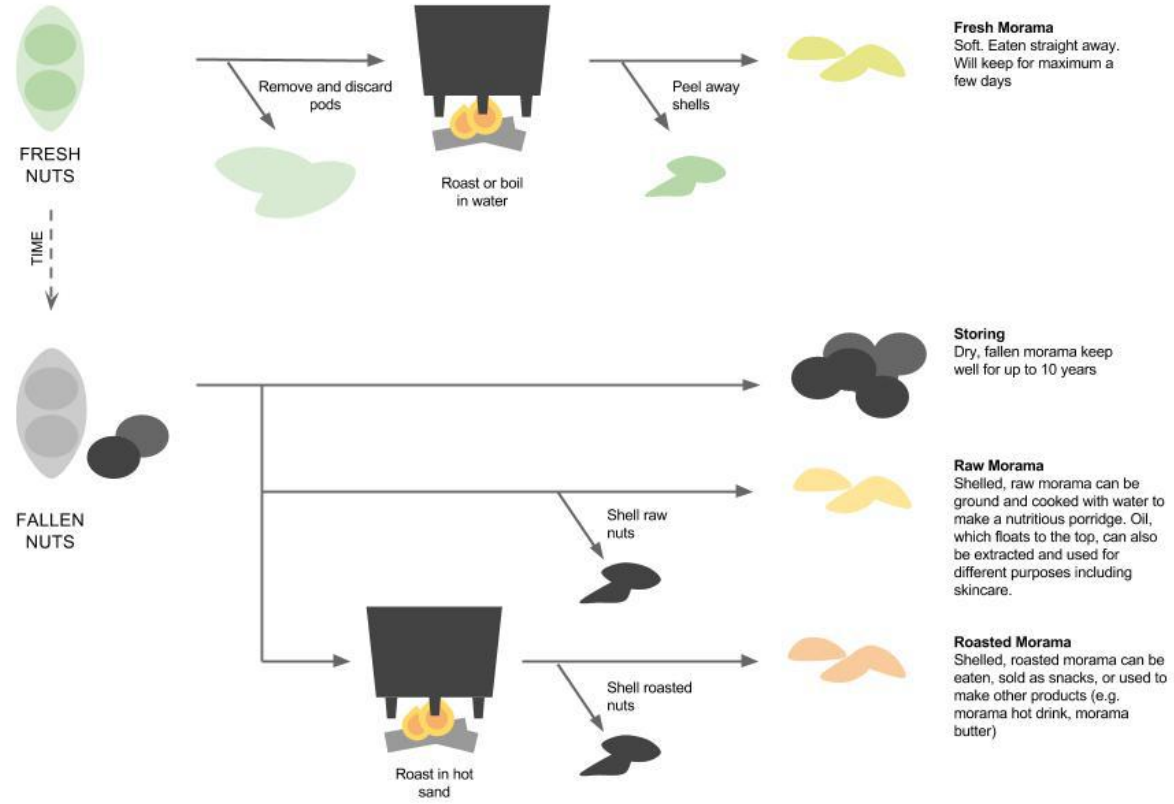

The next model was another lever press attempt, this time breaking the morama against its short-axis. It was equipped with a rotary based feeder mechanism, as it can be seen in the pictures. The user was supposed to use one hand to feed the mechanism with on nut, and the other hand to shell it pulling the lever. There was also a screw in the sheller vertice in order to make an adjustable limiter for the gap. Breaking the nuts against the short-axis were noticed not to be the best approach, as more content was broken with the shell than breaking against the longer axis. Another problem was the feeding and releasing mechanism, too slow for our requirements.




The other models we elected and developed further are described in one of the following sections (Technology/Final Prototype: Morama Nut Sheller).

Design Process: Morama Nut products

With the local members of our team, Komtsha and Setshego, we researched traditional uses of morama nuts in D'kar, of which there are many. Immature morama can be harvested whilst still fresh on the vine and processed for immediate consumption. Fully mature morama that have fallen from the vine, bursting out of their pods are more commonly used as they can be stored very safely for up to 10 years, and processed in small batches as needed. They can be removed from their shells either immediately, or after roasting (this makes the shells more brittle and easier to crack).



Infographic: Processing of Morama nuts
There are a great variety of ways to process morama nuts and different products that can be made. Due to the time of year, we only worked with fallen morama nuts.

We tested production of several morama products and decided to trial morama hot drink and morama butter at the community design review, 1.5 weeks into the summit. We had an overwhelmingly positive response to morama hot drink.

Community Design Review

Testing morama hot drink, morama butter, and whole morama at the product stand. We also made ground raw morama for making porridge, but unfortunately did not have time to prepare it.

Making Morama butter

Roasted shelled nuts are passed through a mincer repeatedly until smooth

Morama butter could still be an interesting product to develop further as morama nuts are so oily, but we found it hard to control the level of bitterness with roasting technique we were using. As such we felt it wasn't as popular as the morama hot drink.
Other suggestions that came out of the community design review included additional traditional morama products (glue, protein powder with multivitamins, body lotion...), and new ideas (morama nut brittle).

Technology/Final Prototype: Morama Nut Sheller

How it works

In this section we will describe the 4 final prototypes we made, including also some performance tests data. As a reference, the traditional shelling method performance data is the following:

PERFORMANCE: traditional shelling method
User: Setshego
Nuts cracked per minute: 12.5 (n=50)
Shells removed per minute: 14 (n=55)
Percentage whole nuts: 38% (n=55)

1- Manual sheller

This model was designed in order to give the occasional morama users an affordable option. It is made by joining two flat metal bars, approx 2.5cm wide, with a simple shopmade hinge. It uses few material and few welding, being appropriate to use in building skills workshops. The morama is put between the two metal bars, standing close to the hinge, and the user put one finger between the bars to be used as a limiter. It is not dangerous as it could seem, with a little practice the user is able to shell the nuts without smashing the content. We thought about putting a mechanical limiter, but the finger has shown itself better, because the sheller is simpler to be built and the finger gives the user the correct sense on the force needed to break and the correct time to stop pressing it in order to avoid breaking the nut.

PERFORMANCE: small hand-held cracker
User: Elivas
Nuts cracked per minute: 14 (n=97)

2- Desktop lever sheller

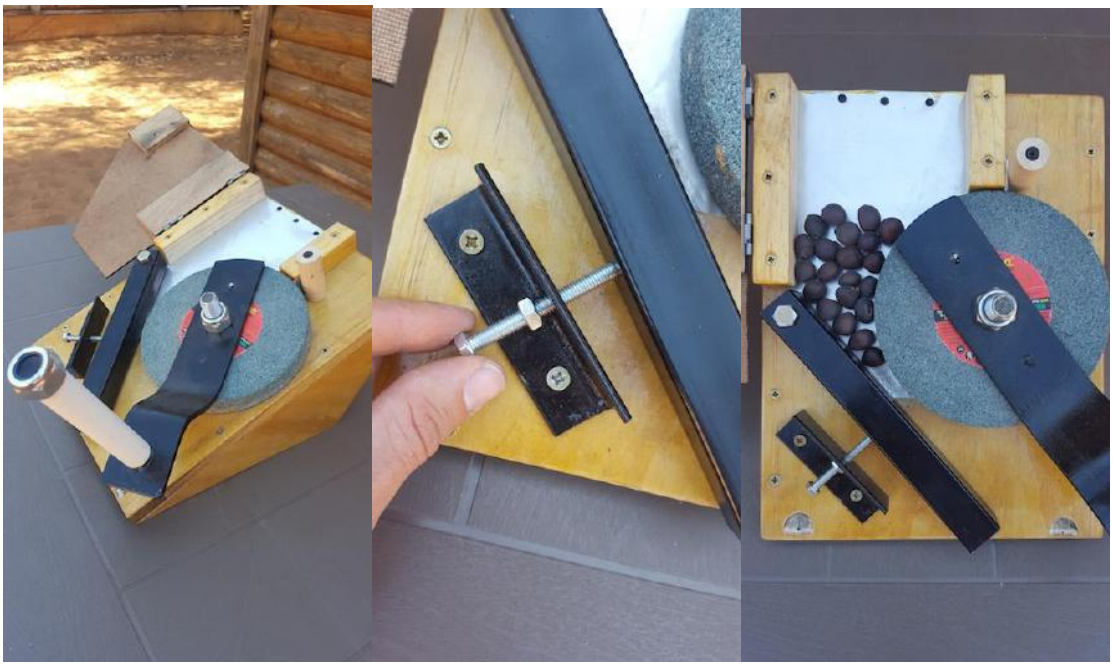
This model is another affordable alternative to shell the morama nuts. It works with a lever which presses the standing morama against the base. The force needed to shell the nuts without breaking the content is easily learned with use. The prototype has only one handle, but it was firstly thought to have two levers, one on each end of the base, allowing a two-persons use, so the people could interact while working on it. It is made with three pieces of metal pipe, being two welded together to make the base plus a third pipe which is used as the the lever press. The base and the lever are united by a shopmade hinge, similar to the manual sheller hinge. This machine is more expensive to be built than the manual sheller, but it can be made cheaper if we use a wooden base instead of the metal pipes, putting a small metal piece just underneath the place where the nut is broken.

PERFORMANCE: desktop lever sheller

Test #1
User: Lucy
Nuts cracked per minute: 14 (n=25)
Percentage whole nuts: 52% (n=25)

Test #2
User: Elivas
Nuts cracked per minute: 15 (n=50)
Percentage whole nuts: 50% (n=50)

3- High-capacity rotary sheller

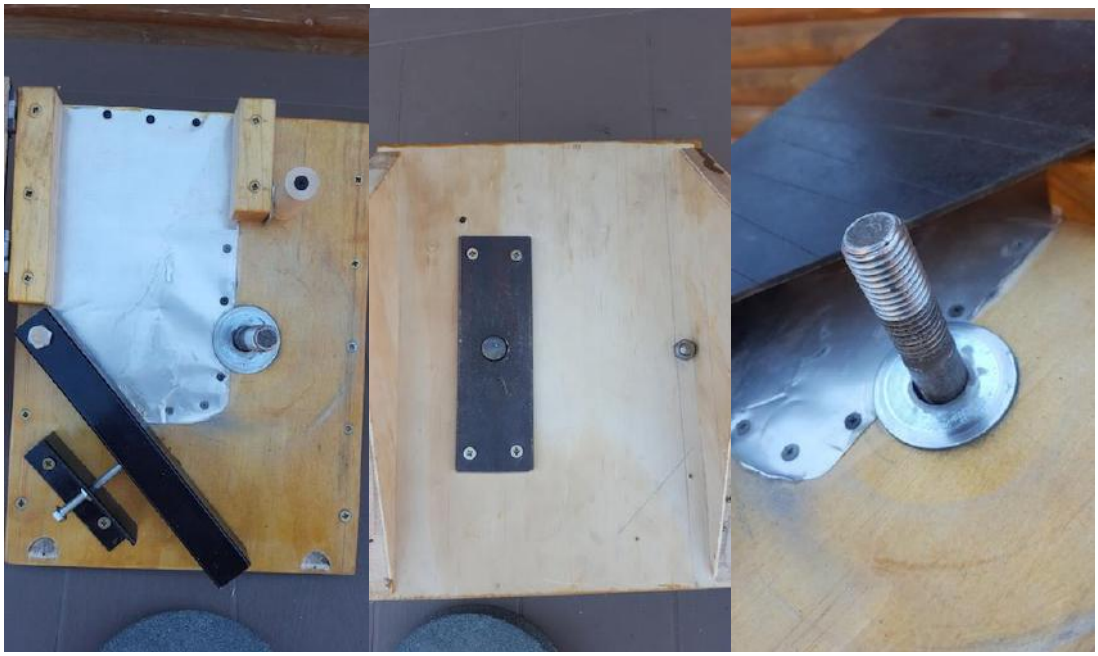








Tork Craft



That is a more expensive, but faster, machine, intended to be used by people who run some kind of business around the morama nuts. It was required not using electrical energy in this machine, given it is not available for all the community, so we opted to use hand power through a handle. Although we called it a "rotary" machine, the handle does not spin through a complete circle, because we discovered that a forward-backward movement is better as it releases the stuck nuts each cycle.
The materials used are plywood, some different metal profiles (square, flat and L-shaped), a 12 mm diameter screw with a pvc pipe for the handle, a circular grinder stone (that type used in electrical bench grinders), another screw with a nut to adjust the gap between the grinder and the counter-break surface (can be seen in the L-shaped metal piece in the pictures, where a threaded hole was tapped), and a piece of aluminum from a soda can to make the surface slippery.
The base of the machine is inclined, about 15 degrees, in order to make the moramas slip on it reaching the shelling area in a way its long-axis is standing between the grinder wheel and the counter metal bar. The gravity allied to the inclined surface makes the morama stand flat on the base. The gap between the grinder and the metal bar is adjusted according to the size of the nuts that are going to be shelled. That would require, as we initially thought, a pre-sorting by size, for which purpose we created a sorting machine which will be described below. But later we discovered that the rotary sheller itself could be used also for the sorting purpose, if we adjust it first for the bigger moramas, and after that we adjust it for a smaller size and pass again the unshelled moramas through the machine. The practice showed us that two or three cycles, corresponding to two or three different morama sizes would be enough for good results.
The gap should be adjusted in order to avoid breaking the content of the nuts when shelling. A gap about 1 mm smaller than the long-axis of the morama seems to be enough for that task.
The small wooden dowel that can be seen on the right superior corner of the first picture is a limiter to avoid a complete spin of the handle/grinder wheel. As mentioned before, the back and forth movement is better than a complete spin because frequently moramas are jammed

in the gap. So, while the forward movement is used to shell the nuts, the backward movement is useful to release the stuck ones.
The black plate with the hinges is put there to avoid flying moramas. It performed well during our tests.
A tricky part when building this machine was making the two holes in the grinding wheel. The concrete drill bits wear out very fast and must be discarded after drilling each hole, making the building costs a bit higher.
As it can be noticed below, the results were satisfying both in speed and quality. After a design review in the end of the process, we received good advices for improvements that are worth to be mentioned here for future improvements.
One is related to the gap adjustment: it would be easier to have some sort of "positive stops" to adjust it instead of the screw, it would be faster and it would avoid a problem we detected which was the screw getting loose after some use. It was suggested some sort of eccentric hexagonal nut put over the base instead of the screw, allowing at least three different gap adjustments.
Another important advice that arose from the usability discussion was that it is better, in terms of force and comfort, to shell the moramas when pushing, not pulling the handle. From that discussion we came up with the idea of mirroring the machine, extending the wheel bar to the opposite side and putting an extra handle on the opposite end, so the user could use two hands to shell. A second squared profile metal bar could also be put on the right side of the wheel, with a second gap, allowing the shelling of nuts on both sides of the grinder instead of shelling it just in the left side.

PERFORMANCE: high-capacity rotary sheller

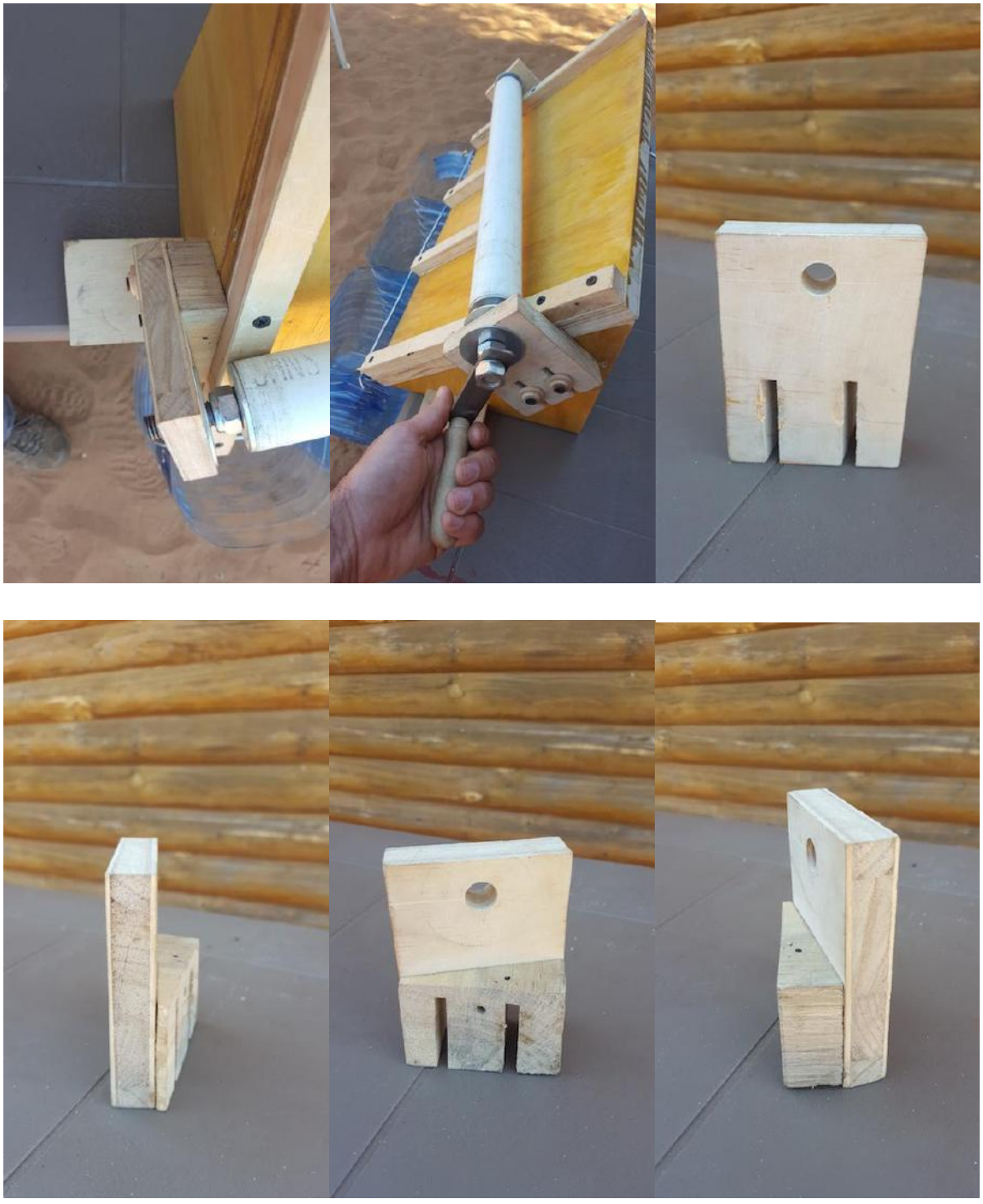
Test #1 - cracking distance >12mm
User: Oda
Nuts through the machine per minute: 74 (n=155)
Percentage nuts actually cracked: 46% (n=155)
Percentage cracked nuts left whole: 56% (n=71)

Test #2 - cracking distance adjusted to 12mm
User: Oda
Nuts through the machine per minute: 63 (n=100)
Percentage nuts actually cracked: 44% (n=100)
Percentage cracked nuts left whole: 75% (n=44)

Test #3 - cracking distance adjusted to 10mm
User: Oda
Nuts through the machine per minute: 58 (n=100)
Percentage nuts actually cracked: 99% (n=100)
Percentage cracked nuts left whole: 55% (n=99)

It is important to register that, although we do not have precise data, after these tests, working together - Setshego feeding the machine and Komtsha shelling, they shelled about 2.5 kg of morama to make coffee in about 15 minutes, which is probably faster than we could perform in the controlled tests.

4- Morama grading machine



As explained before, initially we thought we would need a machine to pre-sort the nuts by size before feeding them into the morama rotary sheller, adjusting its gap according to the different size sorted classes. The machine in the pictures was built with that purpose, allowing the division of the moramas in three classes according to them sizes. It is basically a plywood inclined base and a roll at a compound angle. The first roll angle is the one we see from the front point of view. It is intended to make the moramas roll from the right to the left by the action of gravity. The handle on the right size is made to spin the roll counterclockwise, avoiding morama jams in the way down. The second angle is between the plywood and the roll, so the space between the two pieces is smaller in the right size and bigger in the left size. It can be noticed in the 5th picture, and it is the main feature of the

sorting mechanism: the smaller nuts fall down first, in the right size, in the first bucket, given the gap is smaller there. The medium sized moramas fall in the center of the machine, and the bigger ones in the end, or in the left corner, in the big moramas bucket.

It worked well, but we noticed a lack of grip in the pvc tube surface, even after sanding it with a coarse grit sandpaper. Other material need to be tested.

One tricky part to build in this machine is the pair of the roll supports. Its shape is responsible for the compound angle of the roll, and the variable gap adjustment between the roll and the plywood ramp. Better than words, there are 4 detailed pictures of the piece above. The two smaller screws allow the movement needed to adjust the gap. For our tests, we adjust the right end gap to 8 mm, and the left one to 17 mm. In order to make the adjustment easier, we used two drill bits with that respective diameters as temporary spacers while adjusting. It was not the best setting for the moramas we had, as it can be seen in the data below, most of the moramas fell down into the medium bucket.

The problem with this machine is that, due to the gravity, it sorts the nuts on their short-axis, while the rotary machine shell them in the long-axis. From the first samples of morama we had, we expected a correlation between the two axis, but the second sample we could get was different. The moramas from the second set have a more rounded shaped, the photo below can make it clear. But as we explained in the previous section, it seems that a grading machine can be waived in the process, given we can pass the unshelled nuts again through the rotary machine with a smaller gap each cycle.

Different moramas shapes, showing the lack of correlation between their short (horizontal in the picture) and long (vertical in the picture) axis lengths

The performance test results for this machine are the following:

PERFORMANCE: Grading Machine test
User: Oda
Nuts through the machine per minute: 104 (n=200)
Separation: 7 small, 155 medium, 38 large

In the end we unfortunately did not have much time to optimise the grader and test to see how great an impact it could provide on the efficiency of nut shelling.

5- Separation of nuts from shells

That is a problem we did not have time enough to address. The only test we performed was putting nuts and shells together in water, but both sink.

That is an important process to address in the future, given it takes a long time to separate the nuts from the broken shells manually.

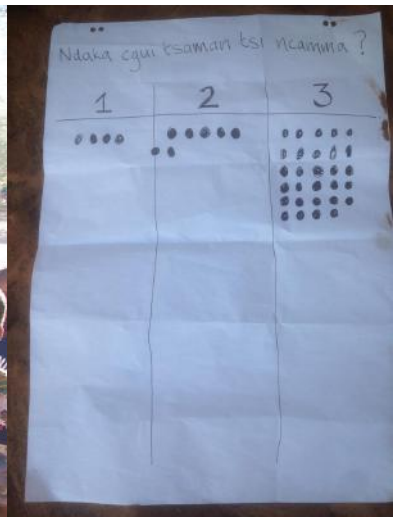
Technology/Final Prototype: Morama Nut Products

User needs and design requirements

User need	**What are you going to measure?**	**How to measure it (units)**	**Good Value**	**Better Value**
Affordability	Cost to buy	Pula		
	Cost to make	Pula		
Quality	Delicious	Rating comparison		
	Healthy	Nutritional value		
	Clean and safe	Presence of contaminants	0	0
	Consistency of grind	Grade of powder	Medium-sized particles	Fine particles
	Shelf life	Weeks, months, years		
	Desirability of packaging	Rating comparison		
convenient to make	Time taken to make	seconds	60	10

As this was a secondary project we weren't able to invest much time into researching user needs - unfortunately this table couldn't be completed. However, during our final presentation we were able to collect some preliminary data about preferred taste for the local community. We tested cgui tsam made with 3 different grades of roasting: 1) light roast, 2) medium roast, and 3) dark roast. There were differences of opinion, but the majority preferred dark roasted cgui tsam.

Grades of roasting
(left to right) Light roast, medium roast, dark roast



Final Presentations - "Which cgui tsam do you like best".
Testing cgui tsam in 3 different grades roasting. Data collected was visualised live as a poster at the Team Cgui stand.

How to make Cgui Tsam

Making cgui tsam is a multi-step process and can involve several family members.

Heat sand in a 3-legged pot

Add nuts and roast, stirring constantly

When ready, tip out and cover with cold sand

1. Roasting

Method: A small amount of sand is first heated in the 3-legged pot over a fire. Once hot (check the temperature by spilling water/spitting on the sand) the morama are added and roasted whilst constantly stirring with a stick to keep as even a heat as possible. The length of time needed to roast the nuts depends on how hot the fire is and the quantity of nuts. First indication that roasting is almost done is the smell of roasted morama. The next step would be to try shelling a few to check. If they are ready, they are tipped out of the pot and covered with cold sand to cool them down quickly. If they are roasted too long the nuts “get angry” and start popping like popcorn - this can be dangerous.
Tools: fire, 3-legged pot, sand, stirring stick
Time: anywhere from 15 to 45 mins depending on how hot the fire and the quantity of nuts (e.g. 45mins for 2kg, 15mins for 200g). Typically 1kg is roasted at a time.
Challenges: The pot has to be stirred continuously to make sure the nuts are evenly roasted. It can be hard to judge when the nuts are ready and they can get burned.

2. Cracking nuts

Method 1: Roasted morama are traditionally cracked by hand, one at a time, by hitting with stones or sticks.
Tools: stones or hard wood sticks
Time: An experienced person averages 12 nuts per minute.
Challenges: This is a time consuming process and can result in injuries to the hands.

Method 2: hand cracker - see page

Method 3: rotary cracker - see page

3. Separating nuts from shells

Method: Shells are removed from the nuts by hand, piece by piece. Children in the family are often involved.
Tools: bowls
Time: Time taken to separate and sort the shells from the nuts varies (we don't have good data for this step).
Challenge: It is much easier to sort nuts from shell pieces if the nuts are not too damaged and remain whole or as large pieces. Occasionally nuts need to be cracked again or broken by hand to free hard-to-remove whole nuts halves. So far we are not aware of a more efficient way to separate nuts from shells - they are similar in density and do not separate in water or in an air current (see ref.).

4. Controlling for grade of roasting (optional second roasting)

As the nuts are unevenly roasted It is possible to sort them by the darkness of roasting to make different types of morama coffee. Initially we thought it was necessary to roast the nuts a second time after shelling to get a dark enough roast for the coffee. However, we found that it is possible and perhaps even better to make the first roast in the shells a little darker and skip the second roasting. This (more even roasting)/more efficient (fewer total steps in

process) if the nuts are roasted in their shells… harder to control the darkness of the roast, but this can be compensated by sorting after (needs to be done anyway).
If a darker grade of roasting is needed, shelled nuts can be roasted for a second time over a fire in a 3-legged pot. However, it is hard to control this process for an even roast - the nuts easily get burnt at the edges.

4. Grinding

Method: Shelled and sorted morama nuts can be ground using a mincer, then shaken to separate out and remove the largest pieces, leaving a fine powder.
Tools: low-cost (around P300) mincer
Time: Actual grinding is fast (200g nuts in around 3mins) but regular time-consuming cleaning is needed
Challenges: It's important to clean the mincer very regularly (perhaps every 2-300g nuts ground) to remove build up of oil and unblock the extrusion holes. This prevents the morama being turned into morama butter in the mincer. This is especially important for more oily varieties of morama - we are not yet entirely sure whether the more oily varieties can actually be used to make coffee effectively.

5. Packaging

We did not test different types of packaging, but found that using small plastic bags (ice-pop bags) and sellotape worked fairly well. We developed a design for the label and did a small test of different colours, settling on a dark brown colour that evoked a rich chocolaty idea with many people.

Lessons Learned

Community engagement

First and foremost, the presence of D'kar locals Komtsha and Setshego in the team was a great asset, taking care of most of our understanding of the value of morama nuts to the community, the traditions of collection and use, and the various challenges involved. In addition, interviews with community members early on in the summit reinforced this understanding and added to our conviction that it would be worthwhile to work on a new technology for shelling morama - many people welcomed the idea as shelling it was laborious for them and they usually hurt their fingers.
Interest in our project at community events (community design review and final presentations) was high, but this was likely influenced by the fact that we were giving out free morama…

User feedback

Other than direct feedback inside the team (we put our prototypes to good use during the development of the product-side of the project), there were 2 opportunities to gather feedback from the community. The prototypes and products that we developed were displayed during a community design review at the launch of the new D'kar Innovation Center, and again at the final presentations towards the end of the summit. However, we found it quite hard to get useful/critical feedback in these situations. All of our demonstrations came with free morama. This made us very popular, especially with children, but it was very hard to control the interactions with community members and get genuine feedback when energy levels and excitement were so high. The most successful strategy was to offer a comparison, as we did in both cases with morama products, and ask the stand visitors which they preferred.
Further user-testing in different settings, perhaps longer term at-home user-testing where community members are given 2 or more similar but different shellers, would likely be more informative.

Troubleshooting

One major problem that we ran into was in switching to a different source of morama nuts (bought from Farnie, a local farmer). These nuts were rather different from those we had been initially using - they were perhaps rather bigger and proved to have a much higher oil content. When we tried to use them to make cgui tsam it seemed almost impossible to grind them without them turning into morama butter. As a team we lost quite a lot of our limited supply of morama to this problem before we realised what was going on. One attempt was made to rescue clumpy, oily product by boiling it in water before removing the oil that floats to the top, then drying it in the sun. This returned the product to something that looked very

much like high quality cgui tsam, but it is not yet clear whether quality was otherwise affected. We think it extremely likely that flavour and nutritional content would have been lost in the process. The best solution we had for the problem of oily product was to avoid this type of morama nuts.
Secondly, we had been very concerned through the design process of the sheller that the cracking width of the rotary cracker be adjusted to the size of the nuts to be cracked. We developed the morama grader to address this concern. However, at the final testing at the very end of the summit whilst making a batch of cgui tsam to gift to all those who helped and supported our project, we realised that it might not be such a major concern. If the rotary cracker

Next Steps/Project Future

Reflection on project viability and other design opportunities

The reflection on project viability and design opportunities for the entire project has been divided in two parts:

Technology

Hand Crackers

- **Viability**: Two hand crackers were built with different mechanism of press and one with lever. The hand cracker with press system is viable rather than the lever system because it is portable whereas, the one with lever mechanism is not portable. The hand cracker is targeted to be used by individual households and still need to go through design iterations to make the existing prototype more user friendly and to find substitute materials to make the product cheap if possible.
- **Opportunity**: Once the cost is reduced, the local champions in the community can manufacture and create a business around selling the hand crackers to the locals. (Technical Concerns are explained in the next section)

Rotary Cracker & Sorter

- **Viability**: The product developed is viable after few changes are made: a gap adjustment and ergonomics is considered (explained above in section Design Process)
- **Opportunity**: The opportunity around this cracker can be made by providing a service based model to the local communities who want to sell large quantities or process large quantities to be able to make various products with morama nut.

Value Added Product – Viability and Opportunity

Cgui Tsam

- **Viability**: The product can be targeted to be sold to the local communities to first test the market and then build a market strategy to be able to sell it to tourists/tourist spot
- **Opportunity**: To be able to sell the products in local, national and international market. There is also opportunity around exploring ways of efficiently roasting morama nut.

Other plants that can be used to make a hot beverage

i. Ncone (in Naro), Boscia Albitrunca (Scientific name), Shephards tree (English name)
ii. Tcaatcee (in Naro), Bauhinia petersiana (Scientific name), also known as Kalahari White Bauhinia

Continuity/dissemination model

The continuity/dissemination model for the entire project has been divided in two parts:

Technology

Hand Crackers

The local community champions who were part of the Team Cgui will be taking forward the project. The hand crackers will be sold by them to the community members. The approach taken would be the community champions become members at the Innovation Centre and make small number (5-10) and sell. After the community knows they are the local sellers they will make and sell based on orders. The local champions also feel people will pay approximately 150P for lever system and 60P for press system hand cracker. But to be able to sell the product, there is need to iterate on design to make it cheap and more user friendly. Post that, basic business training in book keeping, cost analysis and basic use of computers will be required to be given to the local champions. (More detailed plan for continuity is given in Gantt Chart).

Rotary Cracker & Sorter

The local community champions who were part of the Team Cgui will be taking forward the project. The local champions will make the product in the innovation centre and sell as per order. And a business model around renting the machine for service for a fee needs to be designed. But to be able to sell the product, there is need to iterate on design. Post that, basic business training in book keeping, cost analysis and basic use of computers will be required to be given to the local champions. (More detailed plan for continuity is given in Gantt Chart).

Value Added Product

Cgui Tsam

The local community who were part of the Team Cgui will be taking forward the project. The local champions will take the product forward by testing within the community and finalising on the product. Then packaging, market linkage and supply chain and costing has to be done.

Other Plants

Needs to be explored to be able to have steady supply of hot drink.

The project will be taken forward by the community champions of D'Kar village itself. The team members Sets and Komtsha will be our entrepreneurs who will be making the hand cracker and selling to the local communities and will be designing a rental service fee for the rotary machine. And for the coffee, they would be selling it to the local communities to start with and then to tourists.
The existing team would be able to provide support in following ways:

Thabang	Research and connections in Botswana
Oda and Lucy	Design support
Palak	Business development

The tools they require to make are available in the Innovation Centre:

Morama nut
Metal Profile
Wood ply
Metal pipes
Grinder stone
Nuts/Bolts/Screw
PVC pipe
Varnish, sandpaper, paint

- Funding

Needs to be applied with a business plan – mentorship is required to develop a business proposal

- Skills/Knowledge
- Business knowledge - mentor
- ecology of morama –consultant
- ergonomics-consultant

- Mentoring/Technical Assistance
- Business mentor – once product is clearer
- Coffee – training in advance (2 weeks), mentorship through harvest season
- Machine – 1 session per month

Action items for the next few weeks, months; action items for the next few months (including who is responsible for completing them)

Task	Implementation Period	
	2015	2016

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Funds and Material to be arranged												
Iterate (based on suggestions)												
User Test												
Business model (Service model)												

Task	Implementation Period											
	2015					2016						
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Coffee												
Testing taste												
Recipe												
Business strategy												

Anticipated Risks and Challenges

Risk Type	Risk Description
Social	Monopoly as local entrepreneurs
Environmental	
Operational/Managerial	To be able to form social netorks
Technical	To

	develop products with new poducts
Financial	Raising funds
Policy	For Bushmen to be able to collect Morama Nuts with permits

Anticipated needs for mentors and partners

- To design prototypes with feedback
- To develop business strategies around nut sheller and hot beverage

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Additional Information

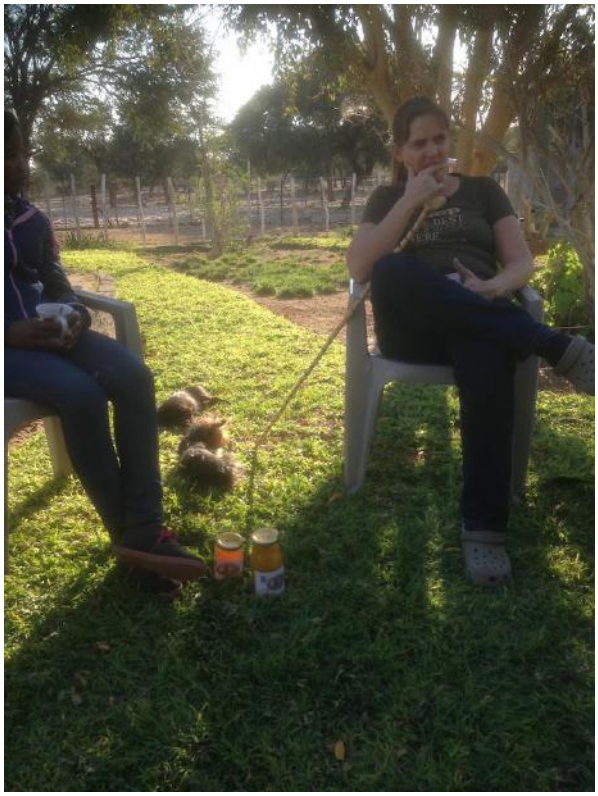
Other Veldfood product ideas

From Neeljie Bower:

-21.611543, 21.974882

Tsama (summer) melon jam

very easy to make.



Neelijie, her dogs, and 2 jars of Tsama melon jam

Coffee beans (Tcaatcee)

Mixed with a tuber to make an appetite-increasing coffee drink. P5 for one heaped teaspoon.

Perfumed plants

Essential oils could be extracted from several nice-smelling plants/bushes

From Xgaiga

Shepherds tree

(tree bark coffee)