A Low-Cost Peanut Sheller for Use in Developing Nations

Final Application for IDEAS

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SUMMARY

In places like Haiti and many West African countries, peanuts are a major crop. Most peanut farmers shell their peanuts by hand, an inefficient and labor-intensive process. Our goal is to build a low-cost, easy to manufacture peanut sheller targeted at individuals and small cooperatives that will increase the productivity of the peanut farmers. Furthermore, this peanut sheller would be manufacturable with materials that are readily available in the target communities.

1.0 Background

Our aim is to serve technologically underdeveloped parts of the world where peanuts are grown, processed, and marketed. We hope to increase peanut sector productivity and raise the technological bar by creating a simple, low-cost peanut sheller for use by households and small cooperatives.

We take inspiration from previous work on agricultural technologies in developing nations, some of which we will review later. But especially, we give credit to Eric Schumacher's advocacy of "intermediate technologies" as a way to help develop technologically underprivileged parts of the world.

In a general sense, the communities we wish to serve are in rural areas in West African nations that rely heavily on peanut production as a local condiment or for export. Much of the world peanut production comes from major industrialized regions such as the southern United States and China. Among the less developed regions, West Africa, and several other countries, are prime regions for injecting technological innovation. There are about 14 peanut-producing nations of West Africa, making it the leading peanut producing region in the developing world. Furthermore, there has been over 53% growth in the West African peanut market in the last 25 years. Haiti is also a prime location for pilot testing since our team has established contacts in Haiti that are affiliated with a peanut processing cooperative.

Our potential customers include individual households, women's cooperatives, and subsistence farmers. This presents a huge group of communities that could be served. Like much of the work that is done in the agricultural sector in the developing world, women and children generally do the peanut shelling manually. Innovation in this process could significantly reduce the time require for shelling, as well as spur technological growth by introducing simple, novel intermediate technologies.

1.1 Prior Art

In the US, hand powered or electric powered machines perform peanut shelling commercially. Pearman Corporation (Chula, GA) is one manufacturer of such machines. Their machines shell peanuts by striking them with rods until the shells split open. The shelled kernels then fall through a grating where they are collected. Their hand powered machine can process 68 kg of peanuts per hour and costs $275. The electric powered version can handle 250 kg/hr and costs $1250.

The Thai Rubber-Tyre Peanut Sheller uses a rubber tire to rub peanuts against a metal housing. It was presented at the Post Harvest Technology Conference Nov 19-20, 1981. Bangkok 21p. It is assembled using a full sized automobile tire, and many formed sheet metal components. See:

www.idrc.ca/library/document/060359/chap5_e.html#chap5.1 and www.idrc.ca/library/document/060359/.

The cost of such a hand-cranked machine is $130. It can process peanuts at roughly 60kg/hour. Other technologies from the same workshop include a wooden paddle sheller (70kg/hr) and a revolving stone sheller (70kg/hr).

The Malian Peanut Sheller is an example of a low cost, small scale sheller. Its design is available for free. The materials needed for this sheller design cost less than $10. It is constructed out of two pieces of molded concrete, and a few basic pieces of metal used to reinforce the concrete reinforcements and to make the axle and crank mechanisms. The Malian Peanut Sheller can process 50kg/hr (www.peanutsheller.org).

2.0 Innovation

Our design improves on the prior art because it is inexpensive, small scale, and does not need outside help to build. The materials and tools are readily available and do not require communication with external parties to be built.

Big commercial systems are simply too expensive for our target market. Even the hand cranked machines cost upwards from $130. Electric powered machines are impractical because electricity is expensive and hard to find in rural areas in Africa and Haiti. Our solution is small and inexpensive; it fits well into the household peanut industry.

The Malian peanut sheller is also a good low cost alternative, but it requires the builder to have molds to make the concrete components. If the builder has access to fiberglass materials to make molds out of, it is easy for him to build the device. If he does not have access to such technologies, he must contact the designers and buy the molds at through the United States, which may be very expensive. We aim to eliminate the need for molds and the need for outside parties. Our machine requires no foreign assistance at all. It can be built using local materials by the local craftsmen. There is no need for builders to communicate and interact with foreign parties.

Our approach to solving the peanut shelling problem is to use the concept of the rubber tire design but make it affordable and easy to build with locally accessible materials. The machine itself is very easy to build, and requires few skills besides basic carpentry. Our concept does away with costs and complexity of fiberglass molds yet maintains a very low cost. Repair is simple; extruded steel and other common components are easy to find. The concept is simple and the design is modular, so it can be expanded if higher throughput is desired. Locally accessible materials may differ in different regions, so our design can be adapted to use different materials.

The second component of our system is a device that separates the shelled kernels from the shells. Prior designs for separation equipment use forced air to carry the shells away from the kernels. Since forced air requires complex fan units and extra power, we designed a separation machine that does not depend on air currents. Our design uses the round property of the kernels to separate them from the husks. The round kernels roll in contrast to the shell fragments, which are flat and may have fibers sticking out at the broken edges. Our separator places the combined kernels and shells onto an inclined plane where the round kernels roll down the plane, and the shell fragments stick on the sloped surface.

3.0 Implementation

Our implementation plan is focused on iterative prototype designs, each one enhanced by new knowledge gained from lab testing, field testing, and research on cost and material availability. The nature of the task creates a complex optimization problem. Factors that must all be considered are cost, safety, throughput, ease of use, probability of adoption, cost of repair, component lifetime, modularity, frequency of repair needed, among others.

For this reason our implementation strategy can be broken down into three phases. The first is functional development, which focuses on developing knowledge about what factor influence the functionality of our device, and how to optimize those factors. The second focuses on simplification and optimization of cost and manufacturability. In this phase we will take the working prototype and find ways to retain the basic functionality but use simpler, cheaper components and find creative ways to further reduce complexity. The final phase will focus on looking at the sheller from a manufacturing standpoint. We will optimize the final design for construction in the target community with materials that are locally available. This will include making plans for the devices we design, but also for jigs, etc. that will aid in construction.

3.1 Work To Date

We are currently in phase 1 of the implementation. The first prototype was built and tested during the 2.009 demo period. This prototype was optimized for quick construction, using many pre-fabricated parts such as a bike wheel with a tire, and the bearings and axle from a bicycle. This was not a particularly practical design for the final product, because the bike wheel/tire are unnecessarily complex for the purpose. However, it did serve to prove that the concept was a good one.

After much consideration of prior art and what simplifications we could make, we have completed the design for the second prototype peanut sheller. In the new design we have eliminated some of the unnecessary complexity from the first prototype, but we have added features that are suitable for a prototype in this phase. (See Figure 1 on next page) The new design is more modular and allows us to easily change such factors as wheel height and angle of channel. These features are necessary because this prototype is meant to be used for extensive functionality tests, and the range of tests this flexibility allows is crucial to developing the best peanut sheller possible. The simplification comes mostly from the wheel, which is made from one solid piece of high-density particleboard rather than a complex and expensive bike wheel.

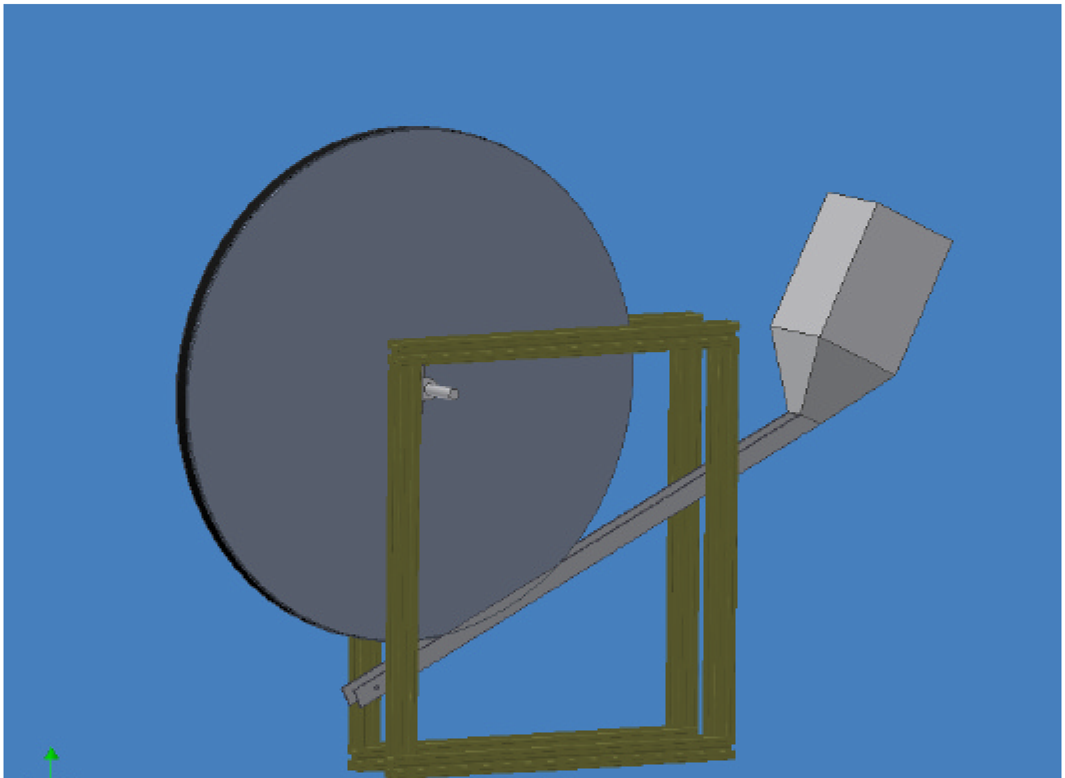


Figure 1 – 3D model of peanut sheller prototype

As is evident from Figure 1, we have a complete 3D model of each part of the new prototype, designed in Autodesk Inventor, and we have also ordered all the parts for construction. So we will have version 2.0 of the peanut sheller working within the week.

The peanut-shell separator is still in the design phase. We are focusing on the sheller right now, and once we have a working model of that we will begin final development of the separator prototype.

3.2 Implementation Plan

Our general implementation plan was described above. Between successive iterations of prototypes, we will do extensive testing of the current prototype version. The first version will be tested in lab using sun-dried peanuts brought back from Haiti by the members of the Haiti Class who traveled there during IAP. Once the functionality is verified we hope to build a set of new models and take them to Haiti for field testing and validation. This period will be a time to investigate both the functionality and the cultural acceptance of our device. We have multiple contacts in Haiti – both Peace Crops volunteers and local members of peanut-growing cooperatives, so we have already found a suitable group of people who are willing to work with us.

The field tests will be followed up by detailed analysis of our findings and a through design review of our device based on what we have learned. As we go we will move through the many phases of the implementation plan, optimizing for all the many important factors that we have to keep in mind.

3.3 Challenges

The big challenges will be the limitations of our target community – monetary, technological, and cultural. We will have to work within strict cost requirements in order to make our product worthwhile for the farmers. Furthermore, we will have to accomplish the task using materials and manufacturing practices that are available in even the poorest and most rural communities. One such issue is the problem of finding bearings or some kind of bearing surface to use at the point where the wheel axle contacts the frame. It will require some creativity to develop a cost-effective, robust, and simple solution to this problem. Finally, there may be cultural barriers to overcome in the target communities. We will have to make sure we are aware of the context in which we are working and work with the people we are trying to help so that we develop a product that they will want to have.

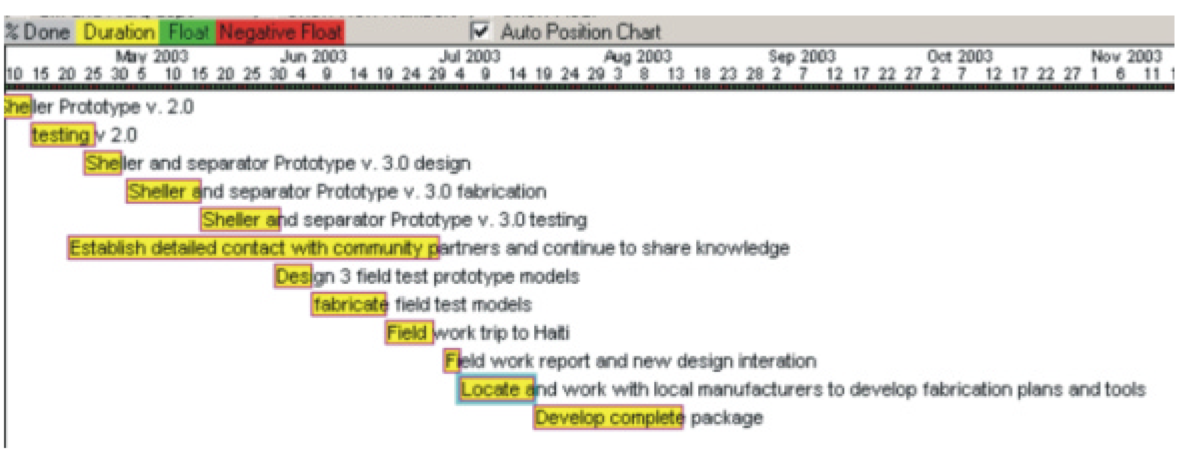
3.4 Support Network

Our primary on-site point of contact will be Peace Corps workers in the field. Due to our prior experience in Haiti we have developed contacts that would enable us to reach villages to set up introductory testing of several of the peanut shellers.

Name	Email	Position	Experience
Donna Perry	donna.perry@yale.edu	Fellow in Agrarian Studies at Yale University	Experience working with peanut farmers in Senegal (5 years of field experience as a Peace Corps volunteer and anthropologist in West Africa).
Dan Broockmann	broockmann@yahoo.com	Peace Corps volunteer in Mayisad, Haiti	Extensive Peace Corps contacts in Haiti
Jessica Hsu	kjesshsu@yahoo.com	Peace Corps volunteer in Haiti	Affiliated with an organic peanut butter cooperative in Haiti
John M. Staatz	staatz@msu.edu	Professor of Agricultural Economics	Expertise on agricultural policy in West Africa

Table 2. Our primary community and advisory contacts.

3.5 Timeline



3.6 Scope

The ultimate goal is to enable mass manufacturing of the peanut sheller in Haiti. We have visited an atelier (workshop-mass assembly plant) in Haiti and have established relations with several engineers at the plant. Similar work could also be pursued near field locations in West Africa.

We will eventually create plans for manufacturing both the devices themselves, and manufacturing aids for assisting in the fabrication of the end product. These aids are things such as welding jigs that can be fabricated in the more advanced regions of the country and will allow local craftsmen to then fabricate the end products much more successfully. Once they have the manufacturing aids, it will be a simple process of cutting stock steel parts, welding them inside jigs, etc. This is a very necessary part of the development, because if we do not facilitate the manufacturing process, our device will not proliferate beyond the short range of highly skilled manufacturing environments with complex tools and advanced training.

4.0 Community Impact

The peanut sheller would initially be tested in several pilot projects with various households. The immediate impact of the peanut sheller would be as a technological novelty. The peanut sheller would spur the minds of young engineers and would stimulate basic technological innovation in the rural community. We believe this is one of the benefits of the development of intermediate technologies.

One salient case of the success of basic peanut processing technologies can be found in the case of women's cooperative in the village of Dan Issa, Niger. An African Development Foundation grant and technical assistance enabled the cooperative to purchase peanut shelling, oil pressing, and grilling equipment. During a 10 week period in 1999, the women's cooperative was able to process three tons of peanuts into $2000 worth of peanut oil.

The peanut sheller, with sufficient market penetration, would offer a substantial increase in shelling efficiency. Most shelling is done by hand in peanut-producing regions of the developing world. Women or children usually do this type of task. Savings in time could be translated to increased time for other agricultural tasks, but also for schooling or small business development. One potential drawback is that there may be initial cultural barriers to usage of the machine

The low-cost peanut sheller is a classic case of an intermediate technology. Ultimately, it could significantly reduce peanut processing time for rural women and children, opening up time for other tasks. It presents an opportunity for entrepreneurs to develop and innovate the peanut sheller for business purposes. And it is another step in technological progress and agricultural innovation for many parts of developing world.

5.0 References

ThinkCycle site: http://www.thinkcycle.org/tc-space/tspace?tspace_id=41963

"World Peanut Market: An Overview of the Past 30 Years" by C.L. Revoredo and S. M. Fletcher, University of Georgia Research Bulletin, Number 437, May 2002.

Video of working prototype:
http://web.mit.edu/2.009/www/project_results/sketch_models/GreenA/GreenA1.html

Prior Art photographs
http://web.mit.edu/yipal/Public/peanut

Dan Issa women's' cooperative
http://www.adf.gov/danissa.html

6.0 Appendices