A Low-Cost, Human-Powered Teff Thresher

Bringing agricultural prosperity to Ethiopia

by W.E. Do Good

and

in connection with

SDSU Zahn Innovation Center

W.E. DO GOOD™

(a.k.a. World Entrepreneurs Do Good )
Overview

Engineering and business students at San Diego State University have implemented a low-cost, human-powered Teff Thresher with a sustainable, scalable, for-profit business model that can dramatically improve agronomic practices and impact poverty in Ethiopia. The Teff Thresher transforms the arduous, unsanitary, and inefficient harvesting of teff and is differentiated by its extreme affordability in both capital and operational costs. The product is in the second prototype stage and will soon be field tested in the village of Simbo, Ethiopia.

The Teff Thresher is the first product from World Entrepreneurs Do Good (W.E. Do Good), an organization that creates opportunities for business and engineering students to solve the economic and social problems of the global poor.

Product Innovation

The Problem

In Ethiopia, traditional methods of threshing grains such as teff (separating the grain head from the straw and separating the kernel from the head) include beating the plant on the ground or animals walking on it. The process is arduous, time intensive, and often keeps children out of school during harvest. Also, grain is mixed with dirt, stones, and animal feces, making it unsanitary and unhealthy, and much grain is left on the stalk. Ethiopian farmers lack the capital required to purchase traditional, automated threshers and are not able to pay for the fuel or electricity needed to operate them.

The Solution

The Low-Cost, Human-Powered Teff Thresher

The Teff Thresher is a grain processing machine that overcomes the entry barriers of previous threshing machines. The Teff Thresher is:

- Affordable for small farmers in Ethiopia
- Human powered, requiring no fuel or electricity
- Easy to use under a variety of field conditions
- Locally manufactured and repaired with local off-the-shelf components
- Durable and portable from farm to farm, creating micro business opportunities

Engineering Innovations

The Teff Thresher has been designed to maximize threshing productivity. A simple, yet durable design with six flat steel bars removes significantly more teff than traditional methods. Grain separation is also vital. To this end, we have designed a custom-built sieve with an inclined wall that minimizes loss of teff and...
reduces winnowing labor (the energy required to blow away chaff). Both mechanisms are driven by multi-gear bicycle sprockets, making the unit human powered and enabling performance to be adjusted. Common components like bike sprockets increase the likelihood of availability to the villages and their ease of repair. A pictorial guide and a repair kit will also be included with the product.

Prototype 1 Winnowing Mechanism

Social Impact Mantra
The Teff Thresher’s social impact is three pronged, creating more prosperous communities, more education opportunities, and healthier grain production. Firstly, the Teff Thresher boosts teff production, increasing agricultural prosperity and self-sustainability and reducing poverty. The product will also spur the formation of local micro businesses that sell the machines or provide services for other farmers. Secondly, the Teff Thresher will prevent children from being removed from school during the harvest. Finally, the Teff Thresher will produce a safer, more hygienic grain, improving the health of a majority of the population in Ethiopia.

Environment
Teff represents a significant market in Ethiopia:

- Teff is Ethiopia’s most significant crop by area planted and value of production and the second largest cash crop (after coffee), generating almost 500 million USD income per year for local farmers (CSA, 2012).
- Teff alone is grown by 6.2 million farmers in Ethiopia (FAO, 2013).
- Teff has the lowest yield among cereal crops due to inefficient agronomic practices.
- In Ethiopia, seventy percent of the workforce relies on small-scale agriculture.
- Grains are the chief field crop and the foundation of the diet of most Ethiopians.
Resources

The Village of Simbo, Ethiopia
In 2011 San Diego State University students and faculty engaged with the village of Simbo (population 400) in Southwest Ethiopia to provide solar-powered reading lights so that children can study at night (http://www.dlightdesign.com). The project also included building a new school facility for the local children. The relationship and subsequent trust that has been built with the village is vital to the success of the Teff Thresher project. We are able to communicate with the village through Gamechu Abraham, a 2011 graduate of the College of Business at San Diego State University. This open communication has formed the basis of designing a product that meets the needs of the farmers we are targeting. We have been able to gauge how effective our thresher is compared to the farmers’ current methods, as well as the specifications they are seeking. The next step is to send the prototype to Simbo for field testing. Once the Teff Thresher is successful in Simbo, we will scale sales across Ethiopia.

Villagers in partner town of Simbo, Ethiopia

SDSU Zahn Innovation Center
The SDSU Zahn Center has been another invaluable resource, providing us with guidance in making sure that our product is aligned with a scalable business model. The Zahn Center also connected us with Project Concern International, a global non-profit with local expertise in Ethiopia. Within the SDSU College of Engineering, the Zahn Innovation Center is a commercial and social incubator that supports students, faculty, and staff from any major or department as they transform their ideas into companies.
Project Concern International (PCI)
PCI has expressed an interest in assisting the production, marketing, and sales of the Teff Thresher on a large scale to many agrarian-based villages in developing countries. PCI’s mission is to prevent disease, improve community health, and promote sustainable development worldwide. The Teff Thresher is synergistic with PCI’s programs that provide hunger relief and food security.

Additional SDSU Campus Resources
The building and testing of our prototype has occurred on the SDSU campus, where we have access to a complete machine shop that includes CNC machines, 3D printers, and a large-scale water-jet. We also locally grow approximately 4,000 square feet of teff for on-campus testing, which is a major advantage that the climate of San Diego affords.

Donors and Investors
The Teff Thresher project placed 1st at the 2013 Zahn Social Innovation Challenge, earning $7,000 dollars for project development. We also have a potential grant opportunity through the U.S. Agency for International Development, which would provide funding to subsidize the sale of the thresher to farmers.

Social Impact Baselines and Milestones
- Production rates for our current prototype – a yield of 7.5 lbs of grain in 14 hours using 2 people – are dramatically greater than the current village rate of 2 lbs in 14 hours using 5 to 7 people plus livestock.
- Faster, more efficient production will increase income for the farmers, allowing them to expand operations and better support their villages.
- Attendance rates at schools will be less affected by the harvest, for which children are currently asked to skip school to help harvest.
- In implementing the microloan program, W.E. Do Good will be tracking the farmers on a monthly basis. The farmers will pay back the loans through the sale of teff at local markets.
Assumptions and Givens

Assumptions
- An increase in yield will result in an increase in income for the farmers, i.e. there is a demand for teff beyond the current production capability curve.
- The demands of farmers in Simbo will accurately reflect the demands of farmers elsewhere in Ethiopia.
- Farmers’ incomes will expand by an amount that will allow them to repay the microloan in an acceptable period of time (3 years).
- The farmers will realize the product we are shortly sending over is a prototype and not a finished product.
- The farmers will be motivated to test the prototype and give honest feedback.
- The teff that we are growing in San Diego to test the product is not radically different from the teff grown in Ethiopia.

Givens
- Simbo villagers have expressed a need for this product and we are able to supply a working prototype.
- Teff is one of the most important cereal crops and is integral in providing a source of food and preserving a culture.
- Approximately 2.8 million hectares are used to grow teff in Ethiopia which equates to 27 percent of their land.
- Teff Production in Ethiopia experienced an average growth of 11.28% per year between 2004 and 2011 and shows no sign of slowing.
- The price of teff tripled in 5 years to 855.8 birr per quintal in 2010.

Project Operating Model

The Teff Thresher’s product implementation is at the midpoint, while its business model is in the early stages. W.E. Do Good is structured as a privately owned, for-profit entity with a social mission (B-corporation). The Zahn Innovation Center is currently determining whether the Teff Thresher can be patented. Licensing the technology will also be explored as a scalability option. PCI, who has expertise working throughout Ethiopia, will be a valuable partner in determining the manufacturing and distribution requirements.

Product Implementation
The program is being implemented in three phases: 1) Requirements identification, 2) Design and prototyping, and 3) Building of local business. Currently, we are in the design and prototyping stage, which will last through October 2014.
**Phase 1: Requirements identification (12 months)**

- Map out economics and value chain. Determine pricing and performance. Map out feasible business models based on cost scenarios.
- Determine size and characteristics of crop, including harvesting methods, seasonality, and threshing batch work requirements.
- Characterize current methods in terms of efficiency.
- Establish relationship with social corporate entrepreneurship or similar organization of large firm that builds combine harvesters.
- Understand threshing requirements for local species of teff.
- Refine power engineering calculations to investigate opportunities for solar-powered units.
- Map out local manufacturing capabilities, resource requirements, and opportunities.
- Ascertained other relevant local requirements.
- Research materials and commercial off-the-shelf (COTS) components and local replacement/maintenance parts availability.

**Phase 2: Design and prototyping (12 months)**

- Integration and prototyping
- Lab testing
- Engineering refinements and revised prototype testing

**Phase 3: Building of local business (12 months)**

- Develop business plan.
- Promote opportunity to social venture firms to raise funding for manufacturing and distribution.
- Establish relationships with micro-financing firms.
- Build local business organization.
- Ferret out export requirements.

**Innovator Capacity and Readiness**

The Teff Thresher team is composed of a faculty advisor and upper-division students who have demonstrated excellence in their respective majors and areas of specialization. Business students have training in social entrepreneurship and innovation, and mechanical engineering students have experience in machine design and value engineering. In addition, all team members take the plight of the global poor seriously and are passionate about the opportunity to improve the lives of millions of people in rural villages in Ethiopia. Team members from both disciplines meet weekly to update each other on progress, brainstorm solutions to challenges, set goals, and coordinate efforts. All team members are investing at least ten hours per week over the course of one or more semesters.
Project Team and Core Expertise

Michael Sloan, Social Entrepreneur in Residence, integrates the program into his Social Entrepreneurship class at San Diego State University, provides support to developing a feasible business model, ferrets out the local operating environment in Ethiopia, and coordinates efforts between the business and engineering schools to ensure the efforts are interdisciplinary.

Gamechu Abraham, a 2011 graduate of the College of Business at SDSU is a collaborator with Michael Sloan in developing the project in Ethiopia. He is very familiar with the local operating environment and opportunities as his ancestry is Ethiopian. Mr. Abraham is available to assist with bringing this project to fruition.

Alex Nogle and Darla Rossi, form the current business team. These senior students are developing the business model canvas, communicating goals, requirements, and tasks to the various members, and preparing marketing and grant proposal materials as needed. Both students will be graduating in May 2014 from the SDSU College of Business.

Ezequiel Galindo, Ryan Medina, Robert Schneider, and Kevin Semo form the current mechanical engineering team tasked with design and fabrication of a second prototype, as well as testing and preparing the first prototype for shipment. This team will be graduating at the end of Fall 2014 from the SDSU College of Engineering.

Partners and Collaborators
- Project Concern International
- Zahn Innovation Center
- SDSU College of Engineering
- SDSU College of Business Administration