Bamboo Lota Findings Report
Malawi 2013

Executive Summary

From May 2, 2013 to June 30, 2013 the Bamboo Lota team traveled to Zomba, Malawi to meet with our partners on the ground, locally source and build a charcoal kiln and briquette press, and teach villagers how to create bamboo charcoal. It was a successful trip that allowed us to develop partnerships and pilot test the technology and product in the field. This report summarizes our activities and details the next steps for the Bamboo Lota team.

Materials

Rather than bring supplies from the United States, we decided to source the materials needed to build a kiln and carefully track costs (in both US dollars and Malawian kwacha) to gather additional data points needed to evaluate the feasibility of organic growth through purchases made by local Malawians.

Kiln

Oil drum		$30.61	K12000
Welding services		$11.48	K4500
Total		**$42.09**	**K16500**

Briquette Press

Metal sheet		$3.83	K1500
Large screw		$0.77	K300
Metal cylinder		$3.80	K1500
Welding services		$5.10	K2000
Total		**$13.52**	**K5300**

**USD calculated based on 392 Malawian Kwacha to 1 US Dollar exchange rate (5/9/13)*

Charcoal Trials

Test 1: Pyrolysis of bamboo into charcoal using halved bamboo culms and 50 L oil drum

One bucket of bamboo leaves and branches were used as kindling to fill the 5 holes on the underside of the oil drum. Additionally, a layer of kindling was lined along the inside bottom of the oil drum. The oil drum was elevated on three bricks placed in a triangle on the ground. A bamboo culm was put in the middle of the drum to save space for an air draft column in the middle. Halved bamboo pieces were placed with the open/exposed inside of the culm face down. Our assumption for exposing the inside part of the bamboo culm was that it would ignite more easily than the exterior. No particular pattern for layering the bamboo was used. Bamboo pieces were stacked in a spiral around the inside of the oil drum up to the top of the oil drum. Once fully stacked, additional leaves and sticks for kindling were inserted into the middle portion of the oil drum.

Our ability to ignite and sustain a fire at the five different holes was affected by the wind and limited kindling. The bamboo leaves, if not bunched close together, burned out quickly. Tight bunches of the kindling were necessary to keep a decent fire ignited underneath the entire oil drum. First efforts to ignite all five holes simultaneously were unsuccessful. To fully light a fire, more kindling needed to be inserted into the holes and directly underneath the oil drum. The second attempt to ignite the bottom was successful due to the new amounts of kindling surrounding the holes underneath.

Once the fire traveled up into the holes and into the bottom layer of the kindling, the team fanned the top and bottom of the oil drum. Smoke started to come out of the opening at the top of the oil drum. However, after a few minutes the smoke stopped. More kindling was added to the middle of the oil drum and roughly 1/2 cup of gasoline was poured on the materials to keep it ignited. The middle kindling was lit from the top and a fire was started. Flames continued for a few minutes as the team fanned underneath the oil drum. At 23:00 min, the smoke began billowing out of oil drum to heights of 15-20 ft. After six minutes of fanning, the team stopped to let the fire burn on its own. At 31:00 min, the smoke dwindled to a low cloudiness and the team took out the bricks from underneath and placed the oil drum onto the ground. Wet dirt was shoveled around the bottom edges of the oil drum to prevent air from entering or leaking out. The lid was also put over the opening at the top and wet dirt was placed along the edges of the lid to prevent smoke from escaping the oil drum. At 35:00 min the oil drum was completely sealed and left to cool down overnight.

The bamboo was taken out of the oil drum by hand to examine the final state. Sorting took place and the team separated the small pieces of the bamboo charcoal from the other contents of the oil drum - a lengthy and tedious process. The bamboo culms had reduced down to 0.75 kg of carbonized bamboo. The rest of the bamboo was only partially or slightly carbonized. By estimates, 25% of the bamboo was fully carbonized into usable charcoal. The leaves and sticks kindling were fully carbonized.

The non carbonized bamboo went through another cycle of pyrolysis in the oil drum to finish carbonizing into charcoal. Igniting the fire and having it reach the inside of the oil drum took 2 minutes with smoke immediately leaving the oil drum. After 10 minutes the smoke died down to clearer gases and emissions. The bricks were then removed and the oil drum was sealed.

Insights: Removing and sorting the bamboo charcoal took a significant amount of time that villagers may not be willing to spend. This process can be altered to be more efficient in the future. Additionally, precautions need to be taken when extracting the charcoal as the edges of the opening at the top of the oil drum, if not smoothed out, are sharp and may be a hazard.

Test 2: Pyrolysis of bamboo into charcoal using whole bamboo culms and 50 L oil drum

The methodology for Test 2 was consistent with Test 1 save for a few changes.

Available dried leaves and sticks were used as kindling for bottom of the oil drum. Additional kindling was placed underneath the oil drum to light the bottom area. The team started a large fire underneath the oil drum in the beginning stage to allow for faster ignition of the kindling through the five holes in the bottom and for initial heat to be applied to the bamboo inside to start pyrolysis. Alternative layers of bamboo culms and kindling were stacked up to 80% of the drum height. The team added extra layers of kindling which allowed the higher portions of the drum to ignite more quickly and carbonize faster.

Insights: Overburning can occur at the bottom of the drum if all the biomass isn't ignited evenly.

Briquette Trials

Test 1: Raw cassava binder

Two fresh unpeeled cassava were diced up and placed into 100 mL of water. The starch mixture never took a thick consistency, as the cassava pieces did not break down enough. The outer layer of the root needed to be strained before mixing with the charcoal. This cassava binder mix was not strong and led to weak briquettes that easily crumbled under light pressure.

Test 2: Dried and powdered cassava binder

One cup of dried, powdered cassava was mixed with 1.5 cups of water. The opaque solution was heated and stirred until the mixture became porridge-like after ~2 minutes of high heat. The consistency was paste-like. This binder provided enough "stickiness" to hold briquettes together effectively. Briquettes did not crumble under light pressure when squeezed.

Using the briquette press:

Making briquettes using the handheld briquette press was time-intensive. From start to finish, the methodology took ~20-25 seconds to make one briquette.

We started by placing the bottom compressor piston into the handheld briquette press. The inside of the briquette press was made wet with water. This kept the briquette from sticking to the walls of the press when being extracted. After the press was thoroughly lined with water, we scooped the bamboo charcoal mixture into the press and pushed out all air pockets and gaps in the center of the briquette. We continued to fill the briquette cup until it filled to the top. Using the top compressor of the briquette press, we smoothed out the top of the bamboo charcoal briquette and pressed it firmly to shape the briquette. We twisted the bottom compressor piston to loosen the bottom of the briquette and pushed the briquette out of the press. We carefully removed it off the compressor piston and placed it in the sun to dry for 2-3 days--drying speed varied depending on the weather.

Cooking Test

Test: Cooking traditional lunch with bamboo charcoal briquettes
Meal cooked: Nsima (maize), ndiwo (greens), and nkuku (chicken)
Cooking items: Bamboo charcoal briquettes, ceramic stove

Rota was a cook employed at Emmanuel International's headquarters. She volunteered to test out the bamboo charcoal briquettes

Although Rota found the bamboo charcoal briquettes "good quality" because of its ability to easily light and give off little smoke, she also used firewood and dry bamboo for addition heating as it allowed her to cook the meal faster. The briquettes' cylindrical shape did not fit into the ceramic stove efficiently and created gaps where energy was lost. In turn, the heat from the stove was not concentrated enough and had to be supplemented with additional wood biomass. The bamboo charcoal briquettes' heat density was not enough to fully cook certain dishes in the meal (nsima and chicken) so it was used to keep certain foods (ndiwo) warm as other parts of the meal were cooked. Rota did not find the smoke from the firewood to be very off-putting and she also had her grandchildren huddled close to the cooking area where smoke could easily be inhaled. As smoke from the fire is a normal part of the daily cooking experience, education on the benefits of reduced smoke or smoke-free cooking environment will need to be made available to the charcoal consumers and end-users.

Meetings

Welton Phalira, Program Manager of LEAD, May 13, 2013

LEAD (Leadership for Environment and Development) designs and implements programs related to climate change, natural resource management, and capacity building. During

our trip we met with Welton Phalira, Program Manager of the Lake Chilwa Basin Climate Change Adaptation Program.

Welton shared his experiences working on a bamboo cultivation project in the center region of Malawi (Touma Forest Reserve, Salima), to enhance the local basket weaving business. LEAD had a few charcoal briquette initiatives in the past that had lost steam along the way and was interested to learn more about Bamboo Lota's methods. He also shared contacts within the Department of Physics at Chancellor College (for emissions testing), the Energy Department, and the Forestry Department. Going forward, Welton and LEAD will serve as a vital source of knowledge as well as potential partner for future programs.

Dennis Kayambazinthu, Director of the Malawi Department of Forestry, May 13, 2013

Dennis Kayambazinthu provided the Bamboo Lota team with an extensive overview of current charcoal production in Malawi and what steps would need to be taken to legally produce charcoal. He also shared the challenges of regulating the industry from a governmental standpoint and expressed his desire for a more sustainable solution.

The Malawian government is actively pursuing bamboo as a resource, not simply for fuel, but for the amazing array of products that it can produce (clothing, fencing, flooring, etc.). The government has applied for INBAR (International Network for Bamboo and Rattan) membership and is eager to support projects that work with bamboo.

The certification process to legally sell charcoal in Malawi entails:

1. Assemble village natural resource management committee (VNRMC, lowermost institution of structure that is recognized legally by government) in village
2. VNRMC must create a management plan and bylaws that dictate how the village will share the responsibilities and assets
3. The government then is invited to write an agreement with the community (if they are producing the charcoal via forest reserves)

Centre for Development Management
Bright Sibale, John Ngalande

CDM is a research and monitoring & evaluation (M&E) focused organization. They have experience designing systems for viable development programs and link up at the policy level to make recommendations. Other organizations implement the projects.

CDM was involved with an EU-funded project on community co-management of bamboo

in Dedza. The final product was raw and unprocessed bamboo. They also did a value chain analysis on tree crops in relation to climate change. Projects like these informed their thoughts on Bamboo Lota's project.

Recommendations include:
-A good starting point would be to analyze the demand for energy (Ex: In just two years, a bag of charcoal in Lilongwe went from K500 to K4,000)
-Factors to consider in starting the project: site for implementation (Thuma, Mulanje, Palombe), model for scaling up (private vs. government)

Opportunity: In drafting proposals for implementation of the project, CDM could be included in the proposal to provide M&E and research services.

Total LandCare
Richard Bunderson, Haig Sawasawa

Total LandCare is an organization that provides opportunities to smallholder farmers to increase agricultural productivity, food security and incomes, while ensuring sound natural resource management.

Within the two or three years, TLC will be growing and testing bamboo propagation on a small area of land allocated to them by the government. They need to satisfy government mandates to grow pine and blue gum on the land, but are looking to allocate a portion for bamboo. Currently, they have 1000 hectares in total with 860 hectares allocated for pine and blue gum.

Recommendations include:
-Look into large scale gasification with bamboo as a feedstock (US Power Plant model)
-Larger production operations may help drive the cost of bamboo charcoal production down and provide larger amounts to meet growing energy needs

Opportunity: Access to TLC's land for piloting bamboo plantation