Charcoal Briquette Enterprise Development
March 5, 2014

Speakers:

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- Jean Kim Chaix, **The Charcoal Project**
- Sylvia Herzog, **The Charcoal Project**
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Q1: Entrepreneurship capacities are not mentioned as one of the main challenges. Why?

A1: When choosing partners, HFI pays special attention to the organization's leadership, its management team, and the company's overall experience in running a new business. Most of these enterprises do face some degree of management challenges, whether they be in financial training, lack of engineering background or limited marketing experience. However, one of our objectives is to provide business guidance to help fill in the gaps, and help these enterprises see where they need to add management skills.

Q2: Do you know of any experiences with charcoal briquetting at the household level (very small scale)?

A2: The D-Lab hand press and kiln are very inexpensive and could be purchased and used for a household or group of households. As long as the user was comfortable with the carbonizing process (if they have made charcoal before, they would be), and has sufficient space so that the smoke does not bother neighbors, then they could easily make enough briquettes for their household. To see how to make the presses and kilns, visit the "How To" section of the HFI website: http://www.harvestfuel.org/resources/

Q3: Given the obvious better characteristics/behavior of char briquettes, are users ready to pay higher price than traditional wood charcoal?

A3: Though we have not yet done a thorough study of consumer willingness to pay, anecdotal evidence suggests that users are not ready to pay more for briquettes than wood charcoal at this time. Since use of the briquettes require some change of cooking habits, and the characteristics are a bit different than

wood charcoal, users still need to be enticed to try them. However, middle class consumers have been very receptive to the briquettes and they may present an opportunity for higher margins as they would value more highly any potential health and cleanliness aspects of the briquettes.

Q4: How do you make high-quality char-briquette production economically profitable in local domestic markets given the low price of "traditional" charcoal? [Related] How can char briquettes be competitive when you take into account efficient carbonization, strong quality control, social & environmental improvements, a robust marketing campaign, business development considerations, and regular government taxes?

A4: If low cost wood and charcoal are readily available, it is unlikely that agricultural waste briquettes can be competitive on a price basis. However, the price of traditional charcoal is rising given the increasing scarcity of wood in some parts of the developing countries. This includes parts of East Africa where HFI is active. In these locations, there is opportunity to develop alternatives as people search for other sources of fuel. Another reason charcoal prices may increase is the rise of fuel costs to transport the charcoal to market, especially in areas where distances between production and markets are significant.

Also, while in the short term government policies do not treat wood and biomass briquettes consistently, The Charcoal Project is working to highlight these differences so that energy ministers can see the benefit of recognizing and regulating the charcoal market. In the long term this will help level the playing field for biomass briquettes.

Q5: What would the motivation be for an entrepreneur to sell high quality char briquettes on the domestic market instead of the international market which pays a much higher price for them?

A5: Most of our entrepreneurs do not have the connections or resources to connect with international markets. While prices may be higher on international markets, transporting the goods to the nearest port would be prohibitive, especially for partners in landlocked countries such as Uganda. Also most of the people entering these businesses have a social mission to provide environmentally friendly fuel to their communities.

Q6: Could you describe the cash flow for some of the char-briquette producers? Range in revenue? Are sales steady or do they come in cycles? Feedstock purchases made in big batches, or small and steady? Overall, have cash flow issues arisen?

A6: Our entrepreneurs were specifically chosen in a range of revenue potential, so we could test the viability of different models. Not surprisingly, the largest scale producers have the biggest cash flow issues because of investments in equipment and higher working capital requirements.

Keeping in mind that all of these businesses are less than three years old, they have done pretty well financially. Revenue ranges for 2013, for just fuel briquettes, spanned from just over $3,000 to near $75,000. Two of the businesses were operating profitably by the end of the year, one was at break-even, and one was still struggling with production issues that kept volumes low, requiring cash infusions. All of them also experienced good cookstove sales, in some cases surpassing the briquette sales.

Sales for all of them have been somewhat steady as long as they have been able to maintain stable production volumes. They do tend to experience higher demand during rainy season, when the price of

alternatives rises. For the larger producers, feedstock purchases are fairly steady, but for the smaller producers, batch purchases are more common to conserve on transportation costs.

Though some of the enterprises are producing profitably, they are not yet at high enough sales volumes to be generating sufficient cash flow for large capital purchases or substantial marketing expenditures. So for the short term, they will still be getting some funding support.

Q7: Are there proven relations between cookstove producers/distributers and briquetting value chains? Are there any studies or research on this?

A7: As far as we know, there is little data available to support the relationships you describe. This is an area we hope to explore further.

Q8: Because of the issues mentioned in the consumer research presentation (briquettes being light, loose, not compact enough, etc.), how can they compete with local charcoal?

A8: The briquettes compete on different characteristics. Overall, carbonized briquettes are longer lasting, require less fuel, are cleaner to touch and environmentally friendlier, and potentially cleaner burning, although more testing is needed to confirm when and if this is actually the case. Consumers need less fuel (which saves money), have cleaner hands and kitchens, and can feel good about reduced forest degradation. Thus, the producers are able to market their products with these characteristics that the customers value.

Q9: Which advantages and disadvantages do you consider when comparing carbonized and uncarbonized briquettes?

A9: We have mostly focused on carbonized briquettes because of health concerns related to uncarbonized briquettes. Testing of emissions comparison of carbonized and uncarbonized briquettes in unimproved cook stoves showed significantly higher amounts of CO and especially particulate produced with the uncarbonized fuel (Banzaert 2013).

In addition to health considerations, when deciding between the two, you would compare the additional cost of carbonizing and binder to the additional equipment costs for uncarbonized briquettes which often require higher compaction pressure. The stoves that will be used in conjunction with the briquettes also play an important role, since uncarbonized briquettes are best burned in high quality wood/gasifier stoves and carbonized briquettes are usually used in charcoal stoves. Finally, consider what type of institutional clients you might have. A bakery may need high heat and prefer uncarbonized briquettes and a chicken farmer may need longer lasting carbonized briquettes, that don't burn as hot.

Q10: What experience have you gained concerning the informality (e.g., access to feedstock, taxation, user rights, enterprise investment into infrastructure set-up) of the biomass energy sector?

A10: The biggest impact of this lack of formal structure has been in the area of value added taxes. If the briquette maker runs a legitimate business, they may be subject to certain value-added taxes that are not applied evenly to less legitimate competitors (e.g., illegal charcoal makers and transporters). Also, while investment in other energy saving technologies may attract government subsidies, biomass briquettes have not yet been recognized by many governments as an environmentally friendly fuel that should be supported in any way.

Q11: What is the composition of the production of the briquettes?

A11: The briquettes are made from carbonized agricultural residues, water and a binder. The carbonized waste is either agricultural waste that the entrepreneurs have carbonized in a kiln, or charcoal fines that they have collected from waste points. The binder is generally made from cassava flour, but maize flour or other starches can also be used.

Q12: What health challenges are associated with briquette production activities?

A12: Health challenges include: smoke inhalation at the carbonization site, possible burns from handling hot kilns and burning material (workers should wear gloves, safety glasses and boots), dust inhalation during production of briquettes (masks should be worn), exhaust inhalation if an engine/generator is used in production (proper exhaust piping and ventilation needed), and auditory damage for those using hand presses (ear plugs should be worn).

Q13: Are business plans developed for each of these companies? Are they for-profit or non-profit?

A13: Yes, each enterprise develops a business plan that is reviewed and vetted by HFI. We have a mix of for profit and non-profit organizations, but they all have the goal of making their solid biomass fuel businesses financially sustainable within two years.

Q14: You mentioned that a stable environment is important, but are there any thoughts on how to present wood alternatives to unstable areas with high wood fuel demands such as Haiti and Somalia?

A14: From the standpoint of choosing HFI partners, we look for stable political environments because we need to ensure that the staff and students sent to these locations are safe. However, we would never want to discourage entrepreneurs from developing these businesses where there is great need, and would do what we could to support these entrepreneurs remotely. There are many countries that are more challenging, but not impossible to work in. Carbon Roots International is developing a fuel briquette business in Haiti, for example, and there is one in the DRC, not far from the conflict near the Virunga National Park.

Since HFI is keen to nurture social enterprises, much of the success of a business will ultimately depend on the local market demand for such solutions. Ultimately, success will depend on the market demand for alternative solid biomass fuel solutions.

Q15: Was HFI's decision to invest in small businesses in Uganda and Tanzania influenced by the national and/or local policy environment in those countries?

A15: HFI approached the regional market selection with an open mind, which included the possibility of investing in potential partners in Asia. Ultimately, however, greater weight was given to logistics and market potential as opposed to local/national policy environment.

Q16: Can you provide specific test results for emissions from uncarbonized briquettes?

A16: The PhD dissertation of Amy Banzaert (MIT, 2013) provides emissions measurements from uncarbonized briquettes produced from different industrial waste feedstocks (paper, textiles). More

information can be found at http://gear.mit.edu/Publications/Charcoal/Banzaert - Cooking Fuel Emissions - PhD Thesis.pdf.

Q17: Is char-briquette production influenced by seasons (e.g., rainy season) and how is this challenge tackled?

A17: Yes, rainy season conditions affect all stages of the briquette production process. The most prudent solutions in preparing for rainy season include forecasting product demand, increasing production and building up a store of briquette product leading up the rainy season to supplement reduced output during the rainy season. Sufficient carbonization requires that the feedstock is relatively dry (<10% moisture content). To dry and shelter feedstock and save on storage space, air-ventilated silos can be used. HFI enterprises have found that limited char production can be achieved during lulls in rainfall. Briquette air drying times during rainy conditions are significantly longer (up to one week) than during dry, sunny conditions. Sheltered tunnel drying with forced air draft or heat input can be effective methods for fast briquette drying in any weather condition.

Q18: How do emissions during the charcoal production phase differ between agricultural waste charcoal and wood charcoal?

A18: To our knowledge, no emissions data is available from carbonization of agricultural residues. D-Lab intends to perform these tests using existing small-scale kiln technology during 2014. Using unimproved methods, there is likely little difference in production phase emissions from agri-residues and wood charcoal.

Q19: How can I effectively carbonize sawdust using a drum kiln, when the sawdust seems to pile up together and some sections do not carbonize?

A19: Creating a "rocket-style" void through the center of the kiln can help to improve heat transfer through the kiln. This can be done by standing a piece of wood/timber (8-12 cm diameter) upright through the center when loading the kiln with biomass. Careful removal of the timber leaves a continuous void through the kiln. A similar effect can be achieved for fine materials by standing a wire mesh tube along the center of the kiln which prevents fine material from falling into the chimney void. Another method is layering lightweight, fibrous material (grasses, reeds, twigs) in between layers of sawdust. This material will burn more easily and generate heat to drive local carbonization in "hard to reach" parts of the kiln. Lastly, mechanical agitation and mixing during carbonization, possibly with internal mixing tines attached to a handle outside the kiln that, when rotated, mix hot pieces of biomass with cool pieces to improve carbonization uniformity.

Q20: Could you comment on the impact---if any---of different types of feedstock on briquette quality.

A20: This is an area that we are only just starting to receive feedback and collect data. In general, high ash-containing feedstocks (e.g., rice husks, leaves & grasses) result in briquettes with high ash content and reduced calorific value. The most common negative feedback relates to large ash quantities from these briquettes. Shifting the briquette recipe toward lower ash materials (e.g., charcoal dust, coconut shell charcoal) content has remedied this problem for some producers. Finer feedstocks are also more susceptible to difficulty in carbonization due to heat transfer limitations, especially in natural draft, fixed bed kilns without agitation. HFI welcomes input from producers with regards to feedstock impacts on quality (www.harvestfuel.org/forum).

Q21: What are the average costs of production to produce 100kgs (for example)?

A21: We don't have an average cost figure for you that makes sense, because the businesses are all very different and are growing rapidly. However, if you look at our medium size producer, TEWDI, they can produce 83kg of char per day per kiln, which would be converted into 67kg of briquettes. So in just two days with one kiln and one modified meat grinder extruder, you could make over 100kg of briquettes. The cost of the kiln is approximately USD $60, and the extruder is approximately USD $400.

Q22: You mentioned that in order to improve the quality of the briquettes, there's a need to mix the feedstock in certain amounts. What would be the best combination of feedstock in order to have a char briquette that can compete (easier to light, dense, etc.) with wood charcoal?

A22: There is not currently a comprehensive set of data to compare combustion characteristics of briquettes produced from various feedstocks. Unsurprisingly, briquettes made with high wood charcoal dust content generally have lower ash and higher heat output. Therefore maintaining high wood charcoal dust content (>50 mass%) is favorable. Addition of carbonized residues tends to reduce the heat output of the briquette but extend the burn time, which might actually be favorable for some types of cooking or other applications (e.g., poultry farming).

Q23: What is the best charcoal press to use?

A23: It depends on the desired output, availability of capital and willingness to import equipment. For larger-scale production, a number of roller press and extruder options are available, though we have heard of a number of cases of durability problems with extruders. For small- to medium-scale production (0.5-5 tons per day), many enterprises are using extruders which have common durability problems. HFI has identified this is a key area for technology development.

Q24: Does the density of the briquette affect the overall quality of the briquette?

A24: From our experience, yes. Consumers generally value a denser briquette, similar to the wood charcoal that they are accustomed to. In general, dense briquettes sustain a longer burn time, and depending on the ash content, higher heat output than low density briquettes. Although I have come across some low-density briquettes that performed very well in terms of time to boil in a Water Boiling Test (WBT).

Q25: Briquettes sometimes crumble. How do you prevent this?

A25: Grind the char fine, mix the binder and char well, and pack the briquettes dense. The first two are especially important in our experience. Boiling the binder in water first will also increase its bonding ability.

Q26: Has there been third party testing of the briquettes with respect to cooking or boiling time, whether they are longer burning, and if there is less need to add charcoal, etc.?

A26: D-Lab has just finished a field test campaign where we performed WBTs using several different carbonized and uncarbonized briquette materials, measuring time to boil, fuel consumption and emissions. Results from these tests will be published later in 2014. Amy Banzaert, a former D-Lab PhD,

wrote her dissertation on testing and measurement of emissions from wood charcoal and various briquettes ("Viability of Waste-Based Cooking Fuels for Developing Countries: Combustion Emissions and Field Feasibility", MIT 2013).

Q27: What's the calorific value of drum kiln char-briquettes vs. the local charcoal?

A27: Carbonized agri-residue briquettes contain approximately 70-90% of the energy of wood charcoal (30-35 MJ/kg), depending on the feedstock, production method and binder quantity used.

Q28: What are the most appropriate binders used to help hold the feedstock together and help make the briquettes water proof without interfering with the combustion rate?

A28: Common starch binders (e.g. cassava, yucca) are hygroscopic, so they adsorb water in high-humidity environments. Biomass tar or oil produced during pyrolysis has been applied as a non-hygroscopic binder, although tar is difficult to obtain in large quantities and requires distillation to remove water in its raw form. While we have not tested this, some producers have found that short term exposure of fresh briquettes to high-temperatures gives the briquettes a "case-hardened" quality which prevents moisture adsorption (but might also inhibit drying).

Q29: Can water hyacinths be used as feedstock and what treatment should be done to them to ensure efficiency?

A29: I am not aware of an application using water hyacinth as charcoal feedstock. It contains relatively high ash content (20 mass %) which would likely limit its application in production of quality household fuel briquettes. Another key concern would be the ability to sufficiently dry the feedstock prior to carbonizing.

Q30: What is the best way to carbonize very light materials, like leaves, to help reduce smoke during combustion?

A30: Some of the HFI enterprises have reported success carbonizing leaves and low-density grasses using ARTI-style drum kilns, maintaining a chimney void through the center of the kiln (see answer 19).

Q31: Do you have any consumer research or technological information about briquettes from roller presses? Beyond capital costs, what are the downsides to this kind of technology?

A31: At this time, we do not have any consumer research about briquettes from roller presses. With regards to technical feedback, HFI enterprises have found the durability of the roller pressed briquettes is good, and the heat output is high for pillow shaped briquettes. We don't have performance or emissions data for roller pressed briquettes at this time.

Q32: Did any users in the consumer survey mention less sparks during ignition?

A32: No, the consumers did not report any sparks during ignition.

Q33: One slide from your presentation on consumer research notes that charcoal briquettes produce less ash but another slide notes that the users would like to see less ash or use of ash. Can you please explain the difference between these slides?

A33: Yes. The data that you are referencing refers to briquettes from two different enterprises. One of the enterprises makes briquettes that produce more ash than wood charcoal. Thus, the consumers indicated that they would like HFI to work on reducing or reusing the ash from these briquettes. The briquettes produced by the other enterprise typically produce less ash than wood charcoal according to the consumers. Thus, the users did not have any recommendations to change the ash content of these briquettes.

Q34: Which of the various benefits mentioned by consumers in the consumer research study were most highly valued? Will the results of this consumer study be incorporated into product-specific marketing strategies?

A34: The benefits that were most highly valued by consumers were that the briquettes lasted longer, the users were able to save on fuel and fuel expenditures, their kitchens were cleaner, and there was less smoke in the kitchen.

Yes, the results of the consumer study will be incorporated into the product-specific marketing strategies. The team communicated the findings to the enterprises and they are using this some of this data to create a brand and marketing strategy. The enterprises are also working with MIT business school students to do further market research.

Q35: During your consumer research, did you find that households surveyed were exclusively (or primarily) using the new stoves and briquettes, or were they using them in combination with traditional stoves and fuels?

A35: In nearly all cases, households were not exclusively using briquettes. Consumers using the briquettes were often using wood charcoal and sometimes wood. In addition, in most cases, consumers were not exclusively using the new stoves, with the exception of some of the institutional clients.