

Fuel from the Fields

Written by Amy Smith & Shawn Frayne



In January of 2003, a team of MIT students traveled to Haiti as part of the first D-Lab class. In Haiti, wood charcoal is the staple cooking fuel, but its heavy usage contributes to the deforestation and erosion of a country that is already 98% deforested. In rural areas of Haiti, using an alternate source of biomass to produce the charcoal could lessen further environmental degradation. The MIT team quickly discovered this need for alternative cooking fuels and determined that a possible solution would be to make charcoal from bagasse, a waste product of sugarcane processing. While it was later discovered that this general concept was not completely new, previous research efforts had never been designed with Haiti's available skills and raw materials in mind.

Lab Testing

Initial tests at MIT were promising, although only small scale trials could be performed in a New England, urban environment. Sugarcane does not grow anywhere close to Cambridge, Massachusetts, so bagasse had to be shipped to the lab from a sugarcane cooperative in Florida. Only small batches of bagasse could be procured and therefore only a limited number of briquettes could be made for testing. Despite the paucity of available resources, using a simple oil drum kiln and a binder made from cassava flour, within months the MIT team had developed a process by which bagasse could be transformed into charcoal briquettes. Tests of these briquettes showed that the new "sugarcane charcoal" did not produce smoke and could pass the critical water-boiling test. So with growing confidence in their new process, Amy Smith, the D-Lab instructor, and researcher Shawn Frayne decided it was time to go back to Haiti for field testing of the process.



Haiti:

Population 7,656,166
Area: 27,560 sq. kilometers
Life Expectancy: 52 years
Average Per Capita Income: US\$500
Environment: Haiti is 98% deforested



Biomass: Any plant material or animal waste that is used as a fuel source. Includes wood, charcoal, raw or processed agricultural waste materials, and dung.



What is charcoal?

Charcoal is the product of incomplete combustion of organic matter. This occurs when the organic matter is heated in a low-oxygen environment, which causes the organic matter to be carbonized instead of burning away.

Fuel from the Fields

A Case Study of Sugarcane Charcoal Technology

Connections

Due to the political instability in Haiti, the Peace Corps had evacuated all staff, so the original partner in the project, a volunteer in the village of Mayisad, was no longer at the initial field site. There was however a local connection with a community in Haiti—Gerthy Lahens. She was the mother of one of the students in the first D-Lab class who also happened to be the founder of a program called “The Friends of Petite Anse”. Working with one of the local churches, the Friends of Petite Anse had set up a school and a clinic in collaboration with a local fishing cooperative. Gerthy was eager to introduce a project that might provide a new economic opportunity for the members of the cooperative.

Petite Anse

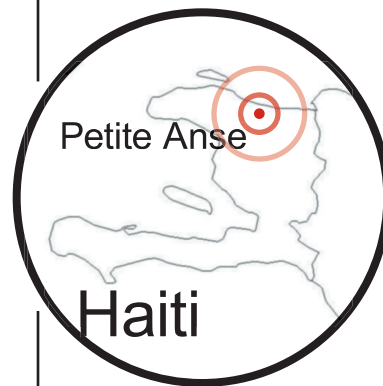
Petite Anse, a small fishing village in northern Haiti, is poor, even by Haitian standards. Government services are largely unavailable—most programs are provided through local churches. Unfortunately, the churches do not have the resources to meet the needs of the entire community, and the majority of the population lives in extreme poverty. The village is crowded and few people have access to safe water, adequate sanitation or even rudimentary health services. In response to these needs, the Friends of Petite Anse raised the funding to run a school and a clinic in one of the church buildings. The lunch provided by the school is the only decent meal that some of the children get each day. The programs sponsored by the Friends of Petite Anse are greatly appreciated by the local community, and the Friends of Petite Anse has a commitment to improve these services and expand them to provide more opportunities to the members of the community.



Some of the afflictions linked to the inhalation of smoke from solid fuels:

- Acute lower respiratory infection (ALRI)
- Chronic obstructive pulmonary disease (COPD)
- Pulmonary tuberculosis
- Cataracts

source: 1, pp. 10-12



Fuel from the Fields

A Case Study of Sugarcane Charcoal Technology

Because of the long-standing collaboration between D-Lab and the Friends of Petite Anse, Amy Smith had formed strong ties with Gerthy Lahens, and consequently local resources could be mobilized for the sugarcane charcoal project with moderate ease. The MIT team, made up of Amy, Shawn Frayne, a former D-Lab student and head researcher on the charcoal project, and Linda Plano, an MIT alumna with a background in business development, arrived in Petite Anse to find that the church was well-prepared for their visit. Pere Valcimond, the priest of the church, had arranged to have a truckload of bagasse delivered to the rectory. The supply of bagasse was plentiful, a sack of cassava root, known locally as manioka, had been purchased at the market, and the only thing missing was an oil drum kiln. Due to a misunderstanding, the oil drum they had obtained was plastic, which would not stand up to the elevated temperatures of a charcoal burn.

Eager to get started as quickly as possible, they took stock of the available resources. There was a small pit in the back of the rectory that could be enlarged to burn the bagasse until arrangements could be made for a metal kiln. Members of the community were eager to help—sorting and drying the bagasse, peeling and grating the manioka, and digging out the pit. Within a few hours, the first charcoal burn was underway.

The next morning, the air of anticipation was palpable as the team opened up the pit to examine the results of the first burn. A crowd had assembled—in addition to members of the cooperative who had helped on the first day, other members of the community had come to watch, including Antonio Etienne, a local businessman who had gone to school in the United States. The results were promising, and the members of the community seemed encouraged by the sight of the charred bagasse and were eager to move on to the next phase—forming the briquettes.



A village in Petite Anse



Cassava Root

Cassava flour is made from the tropical root crop cassava (also known as manioka) which historically served as a basic foodstuff for rural inhabitants of Latin America and surrounding tropical regions such as Haiti. It is a very robust crop, as it can be relatively easily grown in infertile soil, and can withstand drought and other climatic changes.

source: 3

Fuel from the Fields

A Case Study of Sugarcane Charcoal Technology

As Amy cooked the cassava porridge, Antonio voiced his excitement for the project, but he also raised concerns regarding the use of a food crop as part of the process. He explained that there might be local, non-edible plants that could act as a binder, such as the cactus that grew around the edge of the rectory yard. He went on to say that he could see a day when a larger, higher capacity briquette factory churned out hundreds of thousands of sugarcane briquettes for the masses. Linda explained that the goal of the current incarnation of the project was maximizing job creation, hence the small scale, to which Antonio countered that a great factory producing briquettes would create far more jobs than a decentralized approach in rural Haiti. As the future directions for the project were debated, the first batch of over a hundred briquettes dried in the sun.

Although the results of the first burn were heartening, there was a fair amount of bagasse that had not completely carbonized. And so, on the following day the team split into two so that they could more quickly design improvements to the process. One group stayed at the rectory to make improvements to the charcoal pit while the other went to Cap Haitien, a nearby city, to find an oil drum that could function as a kiln. While at the rectory, Shawn, Gerthy and Antonio made ventilation channels in the bottom of the pit, thereby creating better airflow throughout the makeshift pit-kiln. This modification would hopefully allow the fire to burn hotter and thus create the conditions necessary for more complete carbonization of the bagasse. Linda and Amy went into Cap Haitien to find the oil drum and to have a local metal worker convert it into a kiln. Both groups achieved their tasks, and by the end of the afternoon, two new batches of bagasse were burning—one in the improved pit, and the other in the oil drum kiln.

The (simplified) MIT Process



Making the kiln:

Ventilation holes were cut in an empty 55 gallon oil drum. These holes allow air to flow through the kiln as the fire is getting started, and then can be sealed off to provide to the low-oxygen environment necessary for carbonization.



Carbonizing the bagasse:

The drum was filled with dried bagasse and ignited. When the proper temperature was reached, which is indicated by a change in the color and quantity of smoke produced, the ventilation holes were sealed off.

After several hours, the bagasse was converted into charcoal.



Forming the briquette:

The carbonized bagasse was moistened and then crushed into a powder. A binder was made by boiling grated cassava root to form a sticky porridge. The binder was mixed with the charcoal dust, and then hand-formed into briquettes



The results:

After drying in the sun for about a week, the briquettes harden considerably and are ready for use.

Fuel from the Fields

A Case Study of Sugarcane Charcoal Technology

The next morning revealed even better yields and quality of carbonized bagasse, with the best results to date coming from the oil drum kiln. However, later that day, Gerthy met with the MIT team; she was frustrated with the lack of interest in the project by the leadership of the church. Pere Valcimond did not see why people should go to the trouble of making charcoal for themselves, when they could just buy it in the market. Gerthy went on to say that she often had problems working with Pere Valcimond, as she felt that he did not appreciate the dire conditions in which most of his parishioners lived, and that he cared more for their spiritual life than for their daily life. At fifty Haitian dollars per bag, buying charcoal was a drain on the meager resources of many of the villagers.

There continued to be significant outside interest in the project, however. The archbishop of the region came for a tour of the project, as did members of a local health organization. A doctor who was visiting from Citadel, a neighboring district, was so taken with the project that he arranged to send some representatives from his village to come and learn what they could about the process.

On the last day at Petite Anse, the MIT team ran a training session, the “Ecole de Charbon”, which was attended by several youth in the neighborhood and the representatives from the Citadel region. In the morning, the team explained the fundamentals of the process and walked through the details of production techniques. In the afternoon, the students did a charcoal burn on their own, with minimal intervention from the MIT team. It turns out that this was the most successful burn to date. After the class, the students thanked the MIT team for teaching them about the charcoal process. As one student said, “I used to look at the piles of bagasse and only see waste, but now, I see that it can become something useful...” Another student, Rosemond, was particularly interested in the wider implementation of the project and talked about the possibility of setting up a youth corps to take the technology to the more rural areas and train farmers in the methodology.



“You can reduce the total burden of respiratory illness by a factor of 2 by switching from biomass to charcoal”

-Professor Dan Kammen,
University of California at
Berkeley

source: 2, pp. 3



Students of the “Ecole de Charbon”

Fuel from the Fields

A Case Study of Sugarcane Charcoal Technology

Tests showed that the sugarcane charcoal was able to compete with wood charcoal on an energy density basis, and a rough economic analysis showed that it could be produced for about a third of the cost of the wood charcoal available in the local market. However it was not as tough as regular charcoal, which could be a problem during transportation or on rainy market days. In addition, significantly more ash was produced during burning. Both of these issues could be addressed by increasing the pressure applied during the forming of the briquettes, a modification that would require a small manual press. This represented a departure for the original philosophy of the project, in which only readily available resources were required for the production process. However, in order enable the sugarcane charcoal to compete with wood charcoal in the market, it was deemed necessary to improve its durability.

The trip to Petite Anse was certainly a success in terms of research and advancing the project, however there was still much work to be done before the project could be successfully implemented. The fieldwork showed that there were several technical obstacles that needed to be overcome (e.g. the design of a simple briquette press, the identification of alternative binders, and the construction of an improved oil drum kiln). But more importantly, once the technical challenges had been solved, a strategy for disseminating the process would have to be devised. As a first step towards determining an appropriate strategy, use the attached worksheets to perform a stakeholder analysis for the charcoal project in Petite Anse.



2.4 billion people burn biomass for cooking and heating. When coal is included, a total of 3 billion people, close to half the world's population, cooks with some form of solid fuel.

source: 1, pp. vi

Fuel from the Fields

A Case Study of Sugarcane Charcoal Technology

References

1. Warwick, Hugh and Alison Doig. "Smoke – the Killer in the Kitchen". ITDG Publishing, London, 2004.
2. Betts, Kellyn S. "How Charcoal Fires Heat the World". Environmental Science and Technology Online. ACS Online. Article Published April 3, 2003. Accessed September 9, 2004. <http://pubs.acs.org/subscribe/journals/esthag-w/2003/apr/tech/kb_kenya.html>.
3. D. Dufour, ed. "Cassava Flour and Starch: Progress in Research and Development". CIAT Publication No. 271, December 1996, Printed in Columbia, 1996. ISBN 958-9439-88-8. Accessed via internet at<http://www.ciat.cgiar.org/agroempresas/pdf/cassava_%20flour_session%201.pdf>on September 9, 2004.

First issued on September 15, 2004