Seeding Biochar in Costa Rica: Profile of an Integrated Development Program

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Introduction

At the earliest stages, commercial adoption of biochar as a soil amendment will rely upon robust plant yield data from field trials and reliable cost information from producers. Philanthropic-funded, NGO-managed programs offer a viable path for generating such cost/benefit scenarios. Integrating biochar production and field trials into a single program offers the prospect of interaction and optimization of outcomes. But implementation of such programs may not be easy or obvious, and if not carefully managed, things can go astray. Ours is a cautionary tale.

Costa Rica is an ideal setting for biochar development. In addition to its reputation for environmental stewardship—aspiring to be the world's first carbon neutral nation—Costa Rica hosts strong institutions in sustainable agriculture and renewable energy. Its tropical climate and varied geography support diverse, productive agricultural and agroforestry enterprises. The Osa Peninsula, project focus area, has acidic nutrient-poor soils on sites degraded from timber extraction and pasturing; the sort of setting where biochar's benefits can be most profound. The Osa distinguishes itself by being one of the most biodiverse places on the planet, affording a unique opportunity to assess biochar's potential for habitat restoration as well.

While first season results from agronomic studies were compromised by delays and quality issues, the strongest plant yield results were from "biochar mineral complex" (BMC), a heat-reacted blend of wood biochar, clay, chicken litter, and mineral nutrients. Wood biochar activated with phosphoric acid and amended with calcium carbonate also performed well. Straight biochar did little better than controls in the first year.

Results and Discussions

The Costa Rica Biochar Project was conceived in three broad phases: 1) implement biochar production equipment; 2) conduct plant field trials; and 3) develop economic analyses. Targeted feedstocks were the heaps of mill scrap from area *Gmelina arborea* plantations, and the growing mounds of waste from local African oil palm processing. A "dream team" was assembled involving Costa Rica institutions: the *Clean Production Center* (CPC, part of an international network of such centers supported by the United Nations Environment Program) and *Centro Agronómico Tropical de Investigación y Enseñaza* (CATIE—regional leaders in sustainable agriculture); to be guided by consultants from IBI, administered by the forest conservation NGO *Forest Trends*.

Given the qualifications of participants and the expertise of project consultants, it was widely assumed that the first task, developing biochar production equipment, would be relatively routine. Sadly, this was not to be the case. The question of liability insurance for the kiln's designers arose, resulting in several weeks delay and a level of remove between the CPC and IBI consultants. And the CPC proved to be less a technical resource than a stable of consultants and subcontractors. The resulting disconnect between design, engineering, fabrication, authority and responsibility led to delays and ultimately fabrication of a defective kiln.

High prevailing moisture content in the *Gmelina* scrap was another complicating factor; equilibrium moisture percentage of seasoned wood in the humid tropics during the rainy season hangs in mid to high 20's—high enough to compromise kiln performance Overcoming this would require a pre-drying oven, which could be powered by waste heat from the kiln exhaust stack. The oil palm waste, a fibrous low-density material, also proved challenging to pyrolyze in the retort kiln design, and so a separate kiln design would be needed for this unique material.

In August of 2009 IBI consultant Dr. Stephen Joseph came to Costa Rica to advise on the project and assist in the commissioning of the kiln. Although some biochar was produced, defects were such that its further operation would result in rapid deterioration and mechanical failure. The CPC and their subcontractors were given a fix-it list to bring the kiln up to snuff. The promise of repairs dragged on for the months, but none were implemented.

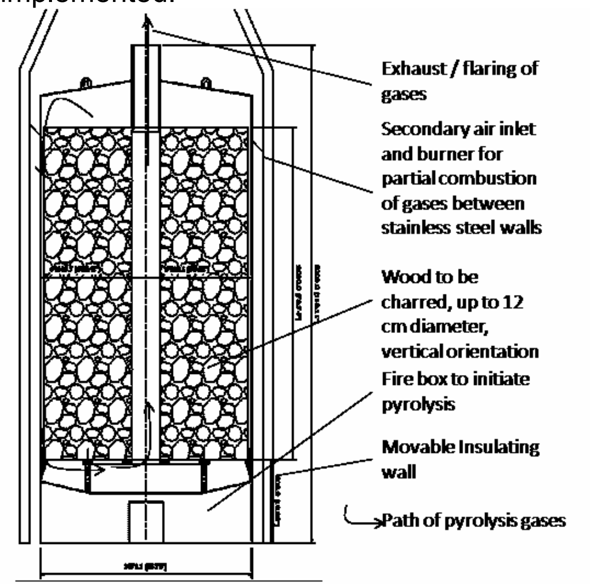

Figure 1. Retort kiln design by Nikolaus Foidl.

Meanwhile, Joseph advised aspiring Osa biochar start-up BCR on building a simple biochar mineral complex (BMC) reactor, wherein a slurry of biochar, clay, chicken litter, and mineral nutrients are continuously blended while being heated to torrifaction temperatures (~220C). CATIE investigators were somewhat belatedly provided with a selection of biochar products for scaled back field trials, including *Gmelina* biochar, acid-activated biochar, and BMC.

When the project was renewed for the 2010 season, BCR was awarded the contract to complete kiln development, including a TLUD sawdust gasifier to prime the main kiln (Figure 1), and a drying oven for feedstock; all under the guidance of IBI consultant/biomass engineer Nikolaus Foidl.

The new project team overcame the legacy of delays and defects from the prior season, and various other technical challenges, to achieve clean, controlled kiln performance with the new and refurbished hardware. Pending approval of bridge funding, the retort kiln, TLUD, a new and improved BMC reactor, and an oil palm waste pyrolyzing kiln will all be assembled under one roof by end of the year—an unprecedented collection of biochar hardware assets for pilot-scale production of a spectrum of biochar based soil amendments in this part of the world; enabling expanded and comprehensive field trials.

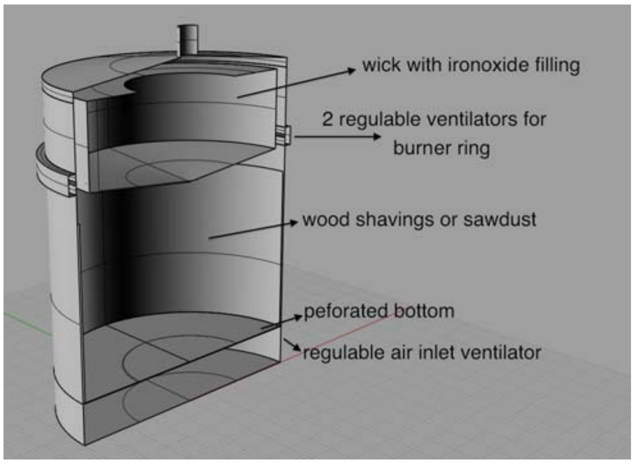

Figure 2. TLUD to prime the main kiln; at 1M dia. and 200kW+ output, maybe the world's biggest.)

Conclusions

Perhaps the most important conclusion from our work is that developing biochar production hardware—of sufficient capacity to serve for meaningful field trials; capable of producing a controlled uniform product; while generating only minimal emissions; and safe to operate by unskilled labor—is not a trivial undertaking.

The stage is now set for a complete collection of biochar hardware assets under one roof, enabling production of a spectrum of biochar products and derivatives, facilitating comprehensive field trials.

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