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Special Report: Inspired by Ancient Amazonians, a Plan to Convert Trash into Environmental Treasure

New bill in U.S. Senate will advocate adoption of "agrichar" method that could lessen our dependence on fossil fuel and help avert global warming

By Anne Casselman

SIDEBAR: The Companies and Organizations Poised to Turn Garbage into Fuel, Fertilizer and a Means of Carbon Sequestration

When Desmond Radlein heard about Richard Branson and Al Gore's Virgin Earth Challenge, a contest in which the first person who can sequester one billion tons of carbon dioxide a year wins $25 million, he got out his pencil and began figuring whether or not his company was up to the task.

Radlein is on the board of directors at Dynamotive Energy Systems, an energy solutions provider based in Vancouver, British Columbia, that is one of several companies pioneering the use of pyrolysis, a process in which biomass is burned at a high temperature in the absence of oxygen. The process yields both a charcoal by-product that can be used as a fertilizer, and bio-oil, which is a mix of oxygenated hydrocarbons that can be used to generate heat or electricity.

Because the charcoal by-product, or "agrichar," does not readily break down, it could sequester for thousands of years nearly all the carbon it contains, rather than releasing it into the atmosphere as the greenhouse gas carbon dioxide. Along the way, it would boost agricultural productivity through its ability to retain nutrients and moisture.

"I developed this rough back-of-the-envelope calculation of what it would require if one were to [attempt the Virgin Earth Challenge] with the agrichar concept," Radlein explains. "One would need about 7,000 plants each processing 500 tons of biomass per day, which is a large number, but it's not outside the bounds of possibility." Such facilities would produce four parts bio-oil to one part carbon sequestered, so it would rake in money as well as carbon.

An International Movement

Radlein is not alone in his belief in this technology—last week in Terrigal, New South Wales, Australia, the newly formed International Agrichar Initiative held its first ever conference, which included 135 attendees from every corner of the globe. According to Debbie Reed, an environmental policy expert who organized the

conference, keynote speaker Mike Mason of the carbon offset company Climate Care urged attendees to unify in an effort to apply for the Virgin Earth Challenge. He also encouraged them to submit their method to the United Nations's Clean Development Mechanism program, which is designed to transfer clean technology from the developed to the developing world.

Although no officials from the U.S. government attended the conference, there is a nascent stateside movement pushing for adoption of agrichar. "[Democratic Senator] Ken Salazar of Colorado is drafting a stand-alone bill on this, and he may also promote it as part of the Farm Bill," notes Reed. The Farm Bill, whose terms are decided every year, determines what agricultural initiatives can be funded by the U.S. government. Inclusion in the Farm Bill would virtually guarantee subsidies for research and application of the agrichar process.

A Technology with a (Potentially) Huge Upside

In 2100, if pyrolysis met the entire projected demand for renewable fuels, the process would sequester enough carbon (9.5 billion tons a year) to offset current fossil fuel emissions, which stand at 5.4 billion tons a year, and then some. "Even if only a third of the bioenergy in 2100 uses pyrolysis, we still would make a huge splash with this technology," remarks Johannes Lehmann, a soil biogeochemist at Cornell University and one of the organizers of the agrichar conference.

There are other perks: Increasing production of bio-oil could decrease a country's dependence on foreign oil. In the tropics, boosting soil productivity increases the number of growing seasons per year, which could help alleviate the pressure to deforest biodiversity hot spots. The new markets for agricultural crops, which would in effect become sources of fuel, could boost rural economies worldwide, just as the demand for ethanol has bolstered the price of corn.

One calculation by Robert Brown, director of the Office of Biorenewables Programs at Iowa State University, revealed that if

the U.S. adopted a cap and trade program in CO_2 emissions like the one already in place in the European Union, farmers in the Midwest could almost double their income by using corn stover—the leaves, stalks and cobs that remain after harvest—to fuel pyrolysis.

The use of char also promises to combat marine dead zones, like that in the Gulf of Mexico caused by nitrogen- and phosphorus-rich agricultural runoff. Char reduces the need for man-made fertilizers by helping the soil retain nutrients. In addition, it can be made out of the very same manure and sewage that would otherwise pollute the oceans.

Amazonian Origins

Agrichar is not a recent invention. Rather, it is a modern-day attempt to re-create the *terra preta,* or dark soils that cover some areas of the Brazilian Amazon. These soils were created over thousands of years by pre-Columbian Indians, who covered their fields with the charred remains of domestic and agricultural trash. This practice boosted the carbon content of the soils from a meager 0.5 percent to 9 percent.

"This is actually slash-and-char agriculture," Brown notes, contrasting it with the modern day slash-and-burn variety. "Instead of biomass being burnt down to a fine ash, charcoal remains, just like after a campfire." In addition to retaining nutrients, the porous charcoal helps microorganisms colonize and build up the soil. Charcoal is known for remaining stable over long periods of time, and alternating rainy and dry seasons preserve it even more. "You basically are drying out a steak," explains Danny Day, president of Eprida, a renewable energy development company based in Athens, Ga. "So you get beef jerky, which will last you for years." Even today, the Amazonian dark earths are so fertile that farmers continue to till them.

"What we're looking at is producing those kinds of charcoals in a modern pyrolysis reactor," notes Brown, who received a $1.8 million grant from the U.S. Department of Agriculture (USDA) to attempt to recreate *terra preta* using corn stalks. He plans to have enough char generated by this spring to run field trials this year. By his calculations each square mile of corn farm that uses this "fiber to fertilizer" pyrolysis process can offset the emissions of 330 automobiles.

But is it Viable?

As with all new technologies, many questions about the ultimate utility of agrichar have yet to be answered. "As of now agrichar is not a uniform product," explains John Kimble, a retired USDA soil scientist. "And there's no easy way for farmers to apply it with existing equipment. They also need to know there is a large enough source of the material. Farmers are driven by profit, as is everyone, and they need to be shown that it will improve their

bottom line."

Complicating debates about the costs of agrichar is the paucity of data on the subject. "No one is sure what types of biomass should be used as raw material," Kimble notes, "or exactly what production methods work best, so calculating the costs is really an exercise in speculation."

In addition, scientists are finding it hard to replicate the original *terra preta* soils. "The secret of the *terra preta* is not only applying charcoal and chicken manure—there must be something else," says Bruno Glaser, a soil scientist at Bayreuth University in Germany. Field trials in Amazonia using charcoal with compost or chicken manure find that crop yields decline after the third or fourth harvest. "If you use *terra preta* you have sustaining yields more or less constantly year after year," he says.

"I'm skeptical about adding just a pure carbon source," says Stanley Buol, a professor emeritus from the Department of Soil Science at North Carolina State University's College of Agriculture and Life Sciences who spent 35 years studying Amazonian soils. "It will be black and look good," but will it contain enough inorganic ions, such as phosphorus and nitrogen, essential to plant growth?"

Many of the interactions between the char, the soil and the microorganisms that develop with time and lend the soil its richness and stability are still poorly understood. Glaser believes that the key to making agrichar behave like *terra preta* lies in the biological behavior of the original Amazonian dark earths—a difference he attributes to their age. "You would need 50 or 100 years to get a similar combination between the stable charcoal and the ingredients," he cautions.

"I think [research into the biological behavior of *terra preta*] is where the new frontier will be," Lehmann counters. If he is right, and scientists can perfect a modern-day recipe for agrichar, then its fans will not need Richard Branson's $25 million to jump-start their initiative—the annual demand for fertilizers exceeds 150 million tons worldwide.

Additional reporting by Coco Ballantyne and Christopher Mims