Birth of a New Wedge

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Terrigal, New South Wales, Australia - As delegates met in Bangkok this week to debate climate change solutions contained in the IPCC's latest report, one technology not mentioned in the draft report was being closely examined at a conference in Australia in the beach town of Terrigal, just north of Sydney.

The first meeting of the International Agrichar Initiative convened about 100 scientists, policymakers, farmers and investors with the goal of birthing an entire new industry to produce a biofuel that goes beyond carbon neutral and is actually carbon negative. The industry could provide a "wedge" of carbon reduction amounting to a minimum of ten percent of world emissions and possibly much more.

Agrichar is the term not for the biomass fuel, but for what is left over after the energy is removed: a charcoal-based soil amendment. In simple terms, the agrichar process takes dry biomass of any kind and bakes it in a kiln to produce charcoal. The process is called pyrolysis. Various gases and bio-oils are driven off the material and collected to use in heat or power generation. The charcoal is buried in the ground, sequestering the carbon that the growing plants had pulled out of the atmosphere. The end result is increased soil fertility and an energy source with negative carbon emissions.

Prominent Australian scientist Tim Flannery, who has written a book on global warming called "The Weather Makers," was on hand to give encouragement to the conferees. "I am deeply committed to your solution," he told the group. In a keynote address, Flannery provided an update on the acceleration of global warming, from the rapidly melting Greenland ice sheet to the unprecedented drought that has gripped Australia.

Because the pace of global warming already exceeds projections, Flannery is convinced that the world must do more than just reduce emissions; we must find ways to rapidly remove CO2 from the atmosphere. According to many researchers at the conference, agrichar has the potential to store billions of tons of carbon safely away in soils.

The attendees were clearly excited by this potential, and, unlike other meetings concerned with climate change, an electric buzz of optimism was in the air. Joe Herbertson, director of a consulting company called Crucible Carbon, said, "When I heard about this technology, the hairs went up on the back of my neck. This is the best news on climate change I've ever heard."

One reason for the excitement is agrichar's potential to address a range of problems from poor soil fertility to waste disposal to rural development. About half the world's population relies on charcoal for cooking fuel, and the production of charcoal drives deforestation in Africa and other places. Smoky, inefficient charcoal kilns pollute the air with noxious gases that harm health and heat the planet.

An effort to replace these kilns with modern, efficient pyrolysis units would relieve the pressure on forests by reducing waste and adding the ability to use any source of biomass, including agricultural waste products such as rice hulls. The ultimate objective is to produce enough charcoal to have some left over to bury and increase soil fertility, leading to a bootstrapping effect where increased yields provide both more food and more biomass for energy.

Projects discussed at the agrichar meeting ranged from a household-size pyrolyzing stove that produces both cooking gas and charcoal, to industrial- scale units capable of processing large waste streams from sugar mills, pulp mills, poultry farms and even municipalities.

Some participants suggested that energy, rather than agriculture, would be the key driver for adopting biomass pyrolysis. There is a tradeoff between producing energy or charcoal, as the process can be optimized for either one. Desmond Radlein of Dynamotive Energy Systems said, "It is wishful thinking that people will switch to renewable fuels unless it is cheaper. All of this is tied to the price of oil; as it goes up, many more things are possible." Because it costs money for transport and the labor to put agrichar into soil, Radlein feels that the path forward lies with biomass energy plantations fertilized by agrichar, which will become a self-sustaining loop pumping carbon into soils, paid for by the energy yield.

Robert Flanagan, an entrepreneur working in China, had a different view. There are 700 million farmers in China, he pointed out. China could quickly deploy a small, village-level pyrolysis unit he is

developing, and because labor is cheap, spreading the agrichar on fields would be affordable even without a large energy harvest.

Others at the conference felt that an expanding market for carbon credits under the Kyoto protocol would be the force that drives the adoption of agrichar. Mike Mason, director of the UK biomass company, Biojoule, said the impact of agrichar on nitrous oxide emissions alone would be enough incentive to fund the needed projects.

Nitrous oxide is 270 times more potent than CO2 as a greenhouse gas and it lasts for 150 years in the atmosphere. Use of nitrogen fertilizers is a major source of the gas, and a difficult one to mitigate. But agrichar applied to fields seems to have a significant damping effect on nitrous oxide emissions. Lukas Van Zwieten, a researcher at the New South Wales Department of Primary Industries, looking at preliminary results of his field trials measuring nitrous oxide emissions from agrichar amended soils, said "the more I look into this, the more excited I get."

Several farmers attending the conference were primarily interested in the increased yields possible with agrichar. Australia has some of the poorest soils in the world - 75 percent of Australia's soils have less than one percent carbon.

The exceptional properties of charcoal in soil were first noticed in the Amazon where there are large areas of what is called "terra preta" or Amazonian dark earths. These dark earths can be several feet deep and contain up to nine percent carbon, as compared with nearby soils that have only about half of one percent. In one of the most fascinating aspects of this story, the terra preta soils turn out to have been deliberately created by a lost Amazonian civilization. Some of the areas have been dated going back to more than 7,000 years, and they are still highly fertile.

Field trials and experiments in pots show impressive yield gains in charcoal-amended soils, but so far researchers don't completely understand why. One question is whether the effect is primarily chemical and physical or primarily biological. Charcoal is a highly porous material that is very good at holding nutrients like nitrogen and phosphorus and making them available to plant roots. It also aerates soil and helps it retain water.

Charcoal's pores also make excellent habitat for a variety of soil microorganisms and fungi. Think of a coral reef that provides structure and habitat for a bewildering variety of marine species.

Charcoal is like a reef on a micro-scale.

One of the research papers presented at the conference documented an increased diversity of beneficial microbes in terra preta soils as compared with unamended soils, but there are still no answers about whether the fertility increase is due to physical or biological factors. The best answer may be that it is both.

One very evident tension at the conference was between the scientists who are trying to better understand how agrichar works, and the farmers and investors who want to apply the technology as soon as possible. But one obstacle to deploying agrichar is the ability to quantify its effects in order to create both a reliable product for farmers and a solid guarantee of agrichar's carbon-fixing capacity for the carbon-trading market.

To that end, one of the most important research questions is how long the charcoal stays fixed in the soil. It's important to distinguish char, or black carbon, from soil organic carbon that comes from adding compost, manure or crop residues. According to John Gaunt of Cornell University, this kind of fresh organic matter does not stay in the soil but is almost all released back into the atmosphere as CO2 within ten years. For this reason, soil organic carbon has not qualified as a carbon emissions reduction that would be tradable under the Kyoto protocol.

Johannes Lehman, also of Cornell, is attempting to determine what percentage of the char stays fixed in the soil. Some of it does oxidize, he says, but it's difficult to say how much. He believes that agrichar- amended soils will see an initial period of weathering, after which they will be stable for long periods.

Certainly the existence of the terra preta soils in the Amazon is testimony to the long-term carbon-fixing ability of agrichar, and several conference participants felt that it would be best to settle on a conservative amount of guaranteed carbon fixation and move as quickly as possible to get policy in place to qualify agrichar as a tradable form of emissions reduction.

The feeling in Terrigal was universal that there is no time to waste in deploying the agrichar wedge as a global warming solution.

However, there were some additional cautions sounded about the potential for abuse, especially the pitfall of all biomass schemes - the danger that too much of the planet's land will be appropriated

for human needs and not enough left for other species. Mark Glover of Renewed Fuel said that the source of biomass must be carefully determined and that it would not do to repeat the mistakes of the palm oil industry, which is rapidly deforesting the habitat of orangutans in Indonesia, or the American corn ethanol industry, which has ended up pricing tortillas out of the reach of Mexico's poor.

Mike Mason of Biojoule expressed concern over the quantities of biomass needed, but he said that if properly phased in, agrichar can be the solution we are all looking for. First, he said, we must take the four billion tons of agricultural waste products produced every year and turn as much of that as possible into char and bury it in soils to increase soil fertility. After a few years, as the productivity of our fields rises, we can begin optimizing biomass pyrolysis for energy production to help replace coal and fossil fuels. Eventually, as our energy supply becomes decarbonized and we move more and more to rely on solar, wind and ocean power, we can shift biomass utilization back to char again and keep sequestering more carbon to get atmospheric levels back to pre-industrial levels.

In addition to directing Biojoule, Mason is also the founder of Climate Care, a highly successful voluntary carbon-offset program that supports renewable energy projects in the developing world, so he is one of those visionary people who also knows how to make things happen.

By the end of the conference, after the participants had considered the political and economic obstacles to the vision, there was a bit of sobering up, but not much. Robert Flanagan set up one of his pyrolyzing wood cookstoves out on the beach and the scientists and entrepreneurs quaffed beer and roasted marshmallows over the smokeless glowing coals. Occasionally the stove would belch a sudden puff of foul smoke and Flanagan would rush to adjust the downdraft control.

After an hour or so, Flanagan opened the stove and dumped a few chunks of charcoal out onto the sand. Those small morsels of black lying on the white expanse of sand might symbolize the embryonic state of their movement, but for most of the conference participants, agrichar was still the best news they had ever heard.