The Economist

The virtues of biochar

A new growth industry?

Biochar could enrich soils and cut greenhouse gases as well

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CHARCOAL has rather gone out of fashion. Before the industrial revolution, whole forests disappeared into the charcoal-burners' maw to provide the carbon that ironmakers need to reduce their ore to metal. Then, an English ironmaker called Abraham Darby discovered how to do the job with coke. From that point onward, the charcoal-burners' days were numbered. The rise of coal, from which coke is produced, began, and so did the modern rise of carbon dioxide in the atmosphere.

It is a sweet irony, therefore, that the latest fashion for dealing with global warming is to bring back charcoal. It has to be rebranded for modern consumers, of course, so it is now referred to as "biochar". But there are those who think biochar may give humanity a new tool to attack the problem of global warming, by providing a convenient way of extracting CO_2 from the atmosphere, burying it and improving the quality of the soil on the way.

Many of those people got together recently at the University of Colorado, to discuss the matter at the North American Biochar Conference. They looked at various ways of making biochar, the virtues of different raw materials and how big the benefits really would be.

The first inkling that putting charcoal in the ground might improve soil quality came over a century ago, when an explorer named Herbert Smith noticed that there were patches of unusually rich soils in the Amazon rainforest in Brazil. Most of the forest's soil is heavily weathered and of poor quality. But the so-called “terra preta”, or “black earth”, is much more fertile.

This soil is found at the sites of ancient settlements, but it does not appear to be an accidental consequence of settlement. Rather, it looks as though the remains of burned plants have been mixed into it deliberately. And recently, some modern farmers—inspired by Wim Sombroek, a Dutch soil researcher who died in 2003—have begun to do likewise.

Char grilled

The results are impressive. According to Julie Major, of the International Biochar Initiative, a lobby group based in Maine, infusing savannah in Colombia with biochar made from corn stover (the waste left over when maize is harvested) caused crops there to tower over their char-less peers. Christoph Steiner, of the University of Georgia, reported that biochar produced from chicken litter could do the same in the sandy soil of Tifton in that state. And David Laird, of America's Department of Agriculture, showed that biochar even helped the rich soil of America's Midwest by reducing the leaching from it of a number of nutrients, including nitrate, phosphate and potassium.

All of which is interesting. But it is the idea of using biochar to remove carbon dioxide from the atmosphere on a semi-permanent basis that has caused people outside the field of agriculture to take notice of the stuff. Sombroek wrote about the possibility in 1992, but only now is it being taken seriously.

In the natural carbon cycle, plants absorb CO_2 as they grow. When they die and decompose, this returns to the atmosphere. If, however, they are subjected instead to pyrolysis—a process of controlled burning in a low-oxygen atmosphere—the result is charcoal, a substance that is mostly elemental carbon. Although life is, in essence, a complicated form of carbon chemistry, living creatures cannot process carbon in its elemental form. Charcoal, therefore, does not decay very fast. Bury it in the soil, and it will stay there. Some of the terra preta is thousands of years old.

Moreover, soil containing biochar releases less methane and less nitrous oxide than its untreated counterparts, probably because the charcoal acts as a catalyst for the destruction of these gases. Since both of these chemicals are more potent greenhouse gases than carbon dioxide, this effect, too, should help combat global warming. And the process of making biochar also creates beneficial by-products. These include heat from the partial combustion, a gaseous mixture called syngas that can be burned as fuel, and a heavy oil.

Taking all these things together—the burial of the charcoal and the substitution for fossil fuels of the heat, gas and oil produced by its manufacture—Johannes Lehmann of Cornell

University and Jim Amonette of the Pacific Northwest National Laboratory in Washington state suggest that a reduction of between one and two gigatonnes of carbon-emission a year might be achievable. That compares with current annual emissions of some 9.7 gigatonnes. But the truth is that the computer modelling involved in making these estimates is a work in progress, as researchers do not know a lot of pertinent things accurately enough: how much material is available for conversion, for example; how much land is available for biochar to be ploughed into; how much char that land could handle. Dr Amonette's estimate is that 50 tonnes per hectare—a figure larger than that used in most of the experiments conducted so far—could go into soils without harming productivity. Some soils could take even more.

The claims for biochar are not supported by all, however. Biofuels Watch, a British lobby group, worries that a craze for the stuff could see virgin land tilled specifically to grow crops such as switchgrass, whose only purpose was to be pyrolised and buried. That tillage would release carbon dioxide and methane. But the alternative, growing those crops on existing farmland, would encourage the clearance of more land to grow the food crops that had been displaced. Indeed, Kelli Roberts, another researcher at Cornell, told the meeting that, taking all factors into account, growing switchgrass for biochar may do more harm than good. Corn stover, garden waste such as grass clippings, and offcuts from forestry and timber production are better bets, she reckons.

And if sequestration by biochar is deemed sensible, there remains the question of how, exactly, to go about it. Making the charcoal is not a problem. Pyrolising stoves are easy to construct and available models range from the portable to industrial-scale machines costing tens of thousands of dollars. Moreover, Jock Gill of Pellet Futures, a company based in Vermont that makes grass and wood pellets for use as fuel, told the meeting that a teenage protégé of his has invented a stove that can be fed continuously, rather than processing batches of raw material. If that proves successful, it would be a breakthrough of the sort that has enabled other industries (not least ironmaking) to take off in the past.

The benefits of improving their soil should be enough to persuade some farmers to make and bury biochar. Others, though, may need more incentives—probably in the form of carbon "offsets" that compensate for emissions elsewhere. In the rich world, Europe already caps carbon-dioxide emissions, and trades permission to emit the gas. America may soon do so too. CO_2-emitting industries could pay farmers to buy stoves to char and sequester farm waste. That would mean working out how much of what kind of biochar counts as a tonne of CO_2 sequestered, and would also need a lot of policing.

A charcoal sketch

If the details can be nailed down, though, farmers in poor countries could get in on the act too, through the Clean Development Mechanism, a United Nations' programme that allows rich-world emitters to buy offsets in the poor world. And Lakshman Guruswamy, of the University of Colorado, told the meeting of another advantage if poor-world farmers can be brought in. Many of them burn wood, waste and dung indoors for heating and cooking. The soot released into the air as a consequence is also a climate-changer because, being dark, it absorbs heat. Much worse, though, about 1.6m people are killed each year by inhaling it. But pyrolytic stoves produce almost no soot—the carbon is all locked into the biochar. Worldstove, a firm based in Italy, seeks to provide small and simple pyrolising stoves to poor countries.

It is all, then, an intriguing idea. It certainly will not solve the carbon-dioxide problem, but it could be what Robert Socolow of Princeton University refers to as a wedge—one of a series of slices that, added together, do solve it. And there would be a nice historical justice in the substance that was displaced by coal playing an important role in cleaning up the mess that coal has left behind.

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