Reversing climate change: Is charcoal the answer?

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PhD candidate Carolyn Winsborough examines maple seedlings she has grown with and without biochar added to the soil.

It's black, it's gritty, it's essential for barbecues -- and it just might save the world from global warming.

Biochar, a kind of charcoal that is rich in carbon, traps CO_2 from the atmosphere and can store it in soils for hundreds to thousands of years,

says Professor Nathan Basiliko, a soil scientist at U of T Mississauga's Department of Geography. Now, Basiliko and colleagues in the Faculty of Forestry are poised to demonstrate that wood waste from Ontario's forest industry could be used to produce energy and biochar, making the wood a truly carbon-negative biofuel.

"I had been following the buzz about biochar bioenergy for a while when the owner of Haliburton Forest, Peter Schleifenbaum, emailed me out of the blue," says Basiliko. Schleifenbaum is Basiliko's industrial research partner, and was interested in producing energy with wood waste from his new mill. He wondered if, instead of burning all the wood, he should make biochar.

Biochar is produced by pyrolysis, a process where organic matter such as wood smoulders at moderate temperatures with very little oxygen. Part of the wood burns, yielding heat and gases that can be captured and used as biofuel. But roughly half the carbon remains behind as charcoal that is very resistant to degradation. In fact, pre-Columbian Indians in the Amazon fertilized their fields with biochar that has persisted for thousands of years.

"Pyrolysis and biochar production has certain advantages over conventional combustion," Basiliko says. Although yielding more energy, fully combusting wood is at best carbon-neutral-the amount of carbon released during combustion equals the amount of carbon taken up as new trees replace the original wood. Pyrolysis is potentially carbon-negative because a significant percentage of the carbon in the smouldered wood is locked into biochar, which can be incorporated into soil and stored for hundreds of years.

If the expected benefits of producing biochar pan out, the net effect will decrease atmospheric concentrations of CO_2. This is where rescuing the world comes into play. Basiliko says that even if we stopped using fossil

fuels today, the CO2 that humans have already pumped into the atmosphere will remain for hundreds of years. But burying biochar in the soil, while allowing new tree growth to replace the amount of wood harvested for pyrolysis, would draw down CO_2 levels and help reverse climate change.

The benefits don't stop there. Biochar soaks up nutrients such as calcium and magnesium, preventing them from leaching out of soil, and thereby boosts soil fertility. "The best case scenario is that it sustains or increases forest productivity while some portion of the biochar stays stable in soils over hundreds of years," Basiliko says.

Schleifenbaum is planning to invest millions of dollars in a bioenergy facility and has invited Basiliko and his colleagues to carry out their research on his forest. "An enormous amount of work needs to be done before we can utilize biochar on an industrial scale," Basiliko says. For one thing, most of the research on biochar has been done in the tropics and in agricultural systems, so no one can say for sure how it will behave in Canadian forest soils.

One key question is how long biochar can reside in the soils of Haliburton Forest before microbes consume it. Basiliko will also analyze the effect of biochar on soil nutrients, microbial biodiversity and the emission of greenhouse gases from microbes.

The $13,500 seed grant that Basiliko and his colleagues received from the Ontario Centres of Excellence will help launch the biochar project. Other bioenergy research already underway at Haliburton Forest is examining what happens to ecosystem health when additional slash is removed for bioenergy. Slash is the downed wood, leaves and small branches left behind on the ground after logging. Slash provides habitat for animals and plants and is an important source of nutrients for the next generation of trees. The researchers are determining how much

slash can be removed for energy production without harming carbon storage and ecosystem function.

The scientists have also secured funds from NSERC, MITACS, Haliburton Forest and Ontario Power Generation, and are partnering with researchers at the Ontario Ministry of Natural Resources and other sources to make sustainable bioenergy in the forestry sector a reality in Ontario.

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