Carbon Sequestration

During their lives, plants absorb massive amounts of carbon, which is then naturally released as CO_2 (carbon dioxide) into the atmosphere as plants decay. When plant matter is pyrolyzed and converted to biochar, some of the carbon is released instantly in the pyrolysis process, but the rest becomes more stable.

It has been suggested that biochar initially loses 50% of its carbon as CO_2 (carbon dioxide) during pyrolysis, but locks up the other 50% for hundreds or maybe thousands of years (Figures A & B). However, recent studies have shown that biochar may not lock up the carbon for as long as previously thought, due to physical degradation processes when it is applied to soil. Researchers at ISTC (Illinois Sustainable Technology Center) have done a number of studies on biochar to try to improve its ability to sequester carbon long-term.

An initial study by Wei Zheng, senior research scientist at ISTC (Illinois Sustainable Technology Center), and Ling Zhao, visiting scholar from Shanghai Jiao Tong University – China, tested two biomass feedstocks (sawdust and switchgrass) with six chemical additives – triple superphosphate (TSP), phosphate rock tailing (PRT), bonemeal (BM), clay, phosphoric acid (H_3PO_4), and boric acid (H_3BO_3). The chemical additives were added to the biomass before pyrolysis. All the chemical additives increased the carbon content of biochar from between 53% and 55% to between 58% and 74% except for BM (bonemeal). Of the six additives, TSP (triple superphosphate) presented the highest tendency to increase the remaining carbon in the biochar. The project results were published in the Chemical Engineering Journal "**Distribution and evolution of organic matter phases during biochar formation and their importance in carbon loss and pore structure**" and the initial project was funded by the Illinois Hazardous Waste Research Fund.

Further funding provided by the Russell and Helen Dilworth Memorial Fund allowed this research to continue with a focus on (1) optimizing production conditions of designer biochars using chemical modification methods to strengthen carbon retention and stability and (2) investigating biochar's effects on carbon sequestration and crop yields when it is applied in agricultural fields. The chemical additive TSP (triple superphosphate) was chosen for this study because it is a common low-cost phosphorus-based fertilizer and because, as shown in a previous study, TSP (triple superphosphate) added to biomass produced the highest percent of remaining carbon in the biochar. Their research, "**Copyrolysis of Biomass with Phosphate Fertilizers To Improve Biochar Carbon Retention, Slow Nutrient Release, and Stabilize Heavy Metals in Soil**" was published in the ACS Sustainable Chemistry and Engineering journal.

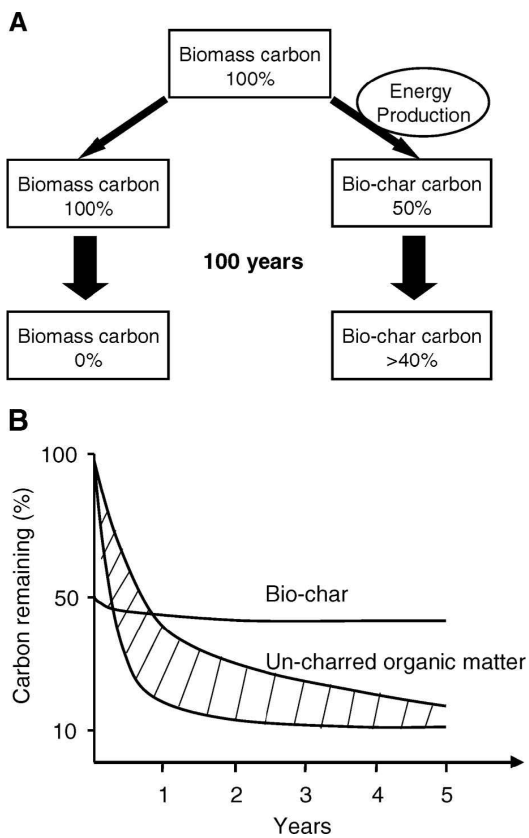

Figure A: *Carbon (C) remaining from biomass decomposition after 100 years for biochar vs. non-pyrolyzed biomass.*
Figure B:*Percent of carbon remaining during decomposition of biomass (bottom lines - different plants have different breakdown and carbon release rates so a range is created) vs. biochar; ISTC (Illinois Sustainable Technology Center) researchers theorize that with TSP (triple superphosphate) the biochar decomposition will retain more carbon than the unmodified biochar (red dashed line - an estimate of carbon retention in TSP (triple superphosphate)-modified biochar).* (Figures adapted from **Lehmann et al., 2006**)

Energy

Pollutants

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  - **Carbon Sequestration**
  - **Carbon Black Replacement**
  - **Biochar Use in Sensors**
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- **Distribution and evolution of organic matter phases during biochar formation and their importance in carbon loss and** pore structure

- **Copyrolysis of Biomass with Phosphate Fertilizers To Improve Biochar Carbon Retention, Slow Nutrient Release, and Stabilize Heavy Metals in Soil**

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