Biochars for Soil Remediation

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Outline

- Introduction
  - Biochars and their potential benefits and barriers
- Study objectives
  - Lab phase
  - Field pilot
  - Field demonstration
- Path forward

Biochars – What are they?

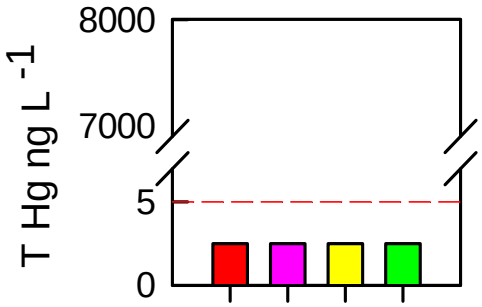
- Pyrolysis
  - Stable, carbon-rich charcoal produced by thermal decomposition of organic material under low/no oxygen at relatively low temperatures (300 - 700 °C)
- Hydrothermal Carbonization (HTC)
  - Stable carbon from heating biomass in a weak acid at temperatures between 180 - 300 °C) and elevated pressure (<20 Bar).

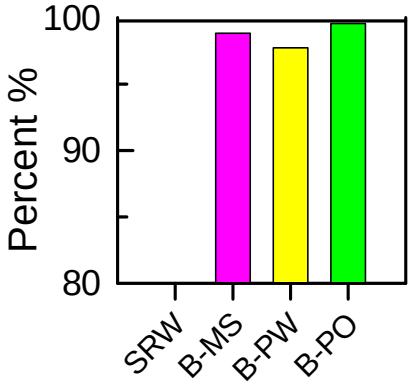
Potential/Alleged Benefits

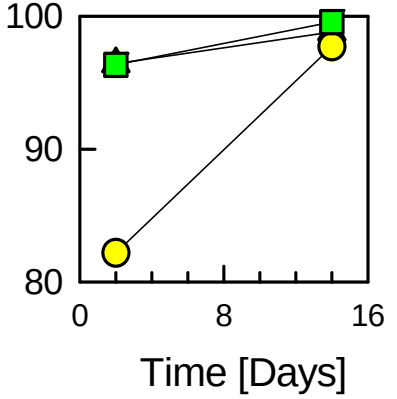
- Tool for environmental management
  - **Sequester contaminants, reducing the bioavailability of metals, pesticides, PCBs, dioxins, furans, etc.**
  - Improve soil health and fertility, soil structure, nutrient availability, and soil-water retention capacity
  - High affinity of nutrients/pesticides can address soil degradation, food production, and water pollution.
  - Biomass waste management
- Generate renewable energy
- Address climate change/GHG through long-term C sequestration

Biochar Batch Test Experiments

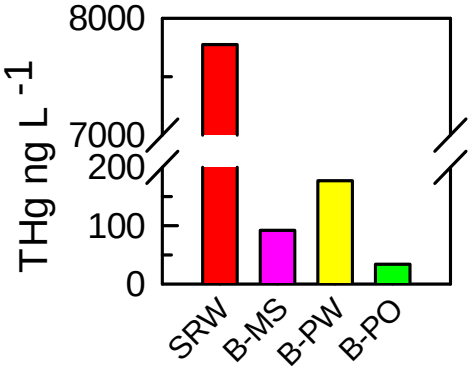
Control Experiments







Hg Spiked Experiments



Total Hg Removal %

Time	MS (%)	PW (%)	PO (%)
48 hrs	96.43	82.19	96.34
2 wks	98.81	97.72	99.56

Not a silver bullet – uncertainties and barriers

- Technical barriers
  - Production technology
  - Biochar in soil applications
    - Studies needed to understand long-term effectiveness and mechanisms
    - Site-specific conditions affect benefits; BMP being developed
    - Biochars are not all the same; how best to evaluate?
      - International Biochar Initiative (IBI) guidance document
- Economic barriers
  - Market value uncertainty of biochar products and services
- Policy barriers
  - Something “new”

Developing a list of FAQ’s

Biochars for terrestrial ecosystems

Three Study Components

1. Lab / greenhouse
2. Field pilot
3. Field demonstration

Primary Objectives

- Assess the value of biochars to reduce the bioavailability of mercury in the terrestrial and surface water ecosystems by reducing the amount of methyl mercury (MHg) in the biosphere.
  - Evaluate biochar types, application rates and methods of incorporation, timing of application, and other parameters to significant reduce mercury bioavailability (sequestration) alone or in combination with other soil amendments in laboratory, field pilot, and / or field demonstrations.
- Do no harm

Secondary Objectives

- Partner with experts and stakeholders to evaluate biochars to:
  - Reduce inorganic nutrient, bacteria, and pesticide loadings into surface and ground waters
  - Improve soil productivity for plant growth
  - Manage animal manures and other biomass from local sources, especially those being applied to floodplain soils to recycle nutrients and carbon and as a waste disposal option.
  - Sequester carbon in soils.
  - Determine sequestration mechanisms by characterizing biochars using appropriate methods.
  - Determine the longevity of biochar treatments.

Lab phase I - Ongoing

- Soil containing 40 µg Hg/g.
  - Characterize using soil testing methods
- Screen biochars
  - Assess biochars properties based on IBI guidance
    - Cat. A: pH, TOC, H:TOC, TN, EC, particle size, moisture, ash, carbonate
    - Cat. B: earthworm avoidance, germination assay, *dioxane/furan, PAH, PCB, trace elements (14)*
    - *Cat C: NH_4-N, NO_3-N, P&K, Surface area*
  - Assess biochars to reduce soil Hg bioavailability to soil organisms (i.e., earthworms, predatory mite, collembolans, enchytraeid worms).

Lab phase II / Field Pilot Studies 2013-2018*

- Studies of longer duration using results of Lab phase I
  - Hg sequestration
    - Soil organisms, including earthworms
  - Soil productivity (plant production)
  - Treatment longevity
  - Sequestration mechanisms
- Develop agronomic knowledge base
  - Examine treatments in small field plots
  - Use BMP provided by Virginia Tech to help fill knowledge gaps

*Tentative

Field pilot study 2013-2018*

- Three to five-year field experiment to assess the effect of biochars in sequestering soil Hg, enhancing soil productivity, improving the management of nutrients and locally-produced biomass, and sequestering carbon in soil.
- A field pilot study is oulined in the following steps:
  - Select a continuous half-hectare area that can be devoted to the pilot study.
  - Biochar selection and application rates and methods based on results from lab studies, char characterization data, and BMP for agronomic crop production.

*Tentative

Field demonstration 2015*->

- Farm-scale implementation
- Availability/quantities/qualities of local materials to char
- Charring facilities
- Acceptance
- Barriers to and difficulties in implementation

*Tentative

Field study/demonstration endpoints

- THg and MHg in soil and biota
  - Invertebrates and plants
- Soil chemical and physical characteristics as needed
- Agronomic considerations
- Microbial community structure
- Water quality (Hg, pH, TOC/DOC, plant nutrients, pesticides, etc.) in run-off and deep percolation
- Carbon sequestration and treatment longevity.
- Life Cycle Assessment.
- Other . . .

Path Forward – off to a good start

- ✓ Select / produce chars
- ✓ Identify field site(s)
- ✓ Collect soil(s)
- ✓ Char characterization and initiate studies
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Develop Hg-specific FAQs on carbon amendments, esp. chars
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Identify partners
  - To provide guidance on the production, characterization, evaluation, use, and acceptance of biochars in soil remediation
    - Universities, NGOs, USDA, US EPA, VA DEQ
  - To provide chars
  - To provide soils and sites for studies

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