

# Life–Cycle Assessment of Biochar in Agricultural and Forest Ecosystems: Effects on Production, Soil Fertility, and Economic Impact



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# Project Overview

- ▶ The objective is to test the effectiveness of biochar in diverse managed ecosystems with respect to:
  - soil fertility,
  - plant productivity, and
  - carbon sequestration.
- ▶ The 3 year project will study approaches to biochar application that are both ecological and economically sustainable in small and mid-size managed ecosystems.



# Project Team

- ▶ **Marcella Windmuller–Campione, PhD:** Assistant Professor, Department of Forest Resources, University of Minnesota
  - ▶ **Rob Slesak, PhD:** Site–level Program Manager, Minnesota Forest Resources Council and Adjunct Assistant Professor, Department of Forest Resources, University of Minnesota
  - ▶ **Jeb Barrett, PhD:** Professor, Department of Biological Sciences, Virginia Tech
  - ▶ **Harry Groot:** Dovetail Partners, Inc.; MN
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# Crops

Crop	State
Three Sisters (corn, squash, beans)	NM
Produce	NM
Native Grassland	NM
Pecans	NM
Hemp	NM
Organic Soybeans, Corn, and Alfalfa	MN
Softwoods	MN
Apples	MN
Mixed grass pasture	VA
Cowpeas and Flowers	VA
Switchgrass	VA
Wine Grapes	VA



# Grower's Plots





# Grower's Protocol (for ag crops)

- ▶ Each test plot consists of four 20m<sup>2</sup> cells, under the same crop and management:
  - Cell 1: control<sub>1</sub> – no treatment
  - Cell 2: control<sub>2</sub>—with bloodmeal only
  - Cell 3: 40% rate of biochar, activated with bloodmeal
  - Cell 4: 100% rate of biochar, activated with bloodmeal
- ▶ All biochars locally sourced and tested at common lab
- ▶ Productivity will be assessed
- ▶ Soils will be analyzed pre and post application and annually



# Common Garden Research

- ▶ 40–4m<sup>2</sup> cells in an established Switchgrass field at the Catawba (VA) Sustainability Center:

- 5 negative control
- 5 positive control
- 5 raw hardwood biochar
- 5 activated hardwood biochar
- 5 raw softwood biochar
- 5 activated softwood biochar
- 5 raw switchgrass biochar
- 5 activated switchgrass biochar



- ▶ Stable Isotope Pulse Chase Experiments:

- To track C and N plant uptake in each plot, we will conduct <sup>15</sup>N and <sup>13</sup>C pulse–chase experiments following the biochar applications.

# Focus on Forestry

- ▶ Unique aspects:
  - Long rotation crop
  - Char application typically only feasible on surface





# Forestry Protocol

1. In-hole application of biochar with planted seedlings
  2. Area-wide application of biochar with both planted and naturally seeded regrowth
    - Surface only
    - Disturbed soil
- ▶ Comparison of:
- Survival rates
  - Growth rates



# Common Garden Forestry Research Plots

- ▶ 3 replicates of growers' plots at the University of Minnesota Cloquet Forestry Center:
  - 3 negative control
  - 3 positive control
  - 3 activated biochar at 40% rate
  - 3 activated biochar at 100% rate
- ▶ Stable Isotope Pulse Chase Experiments:
  - To track N plant uptake in each plot, we will conduct an  $^{15}\text{N}$  pulse-chase experiment following the biochar application.

# Challenges

- ▶ Need to understand effect of biochar on soil flora and their effect on nutrient uptake
- ▶ Reduction in fines
- ▶ Sourcing quality biochar
- ▶ Difficulty collecting comparable productivity data across various crops and times
- ▶ Bigger Picture:
  - Reconciling the variables affecting biochar's value proposition in both ag and forestry settings
  - Defining biochar's carbon footprint



# Project Highlights

- ▶ Three growing seasons
- ▶ Crop productivity assessment as well as ongoing soil chemistry analysis
- ▶ Common biochar analysis of regionally-produced chars
- ▶ Holistic assessment of economic and ecological outcomes



# About Dovetail Partners, Inc.:

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*To provide authoritative information about the impacts and trade-offs of environmental decisions, including consumption choices, land use, and policy alternatives.*

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