



# The Use of Biochar in Agroforestry to Promote Soil Microbial Health, Tree Productivity, and Carbon Sequestration

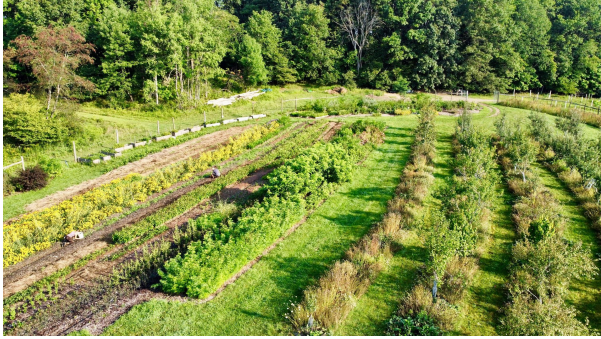
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Farmer Working Group  
Inaugural Workshop

Arthur's Point Farm, Ghent, New York

March 31, 2022

# Welcome to Arthur's Point Farm



# Agenda

10:00 - 10:15	Welcome, Intros & Agenda
10:15 - 10:30	Team Member Roles & Responsibilities
10:30 - 11:00	Research Goals, Experimental Design & Hypotheses
11:15 - Noon	Farm Walk
Noon - 1:00	Lunch (Provided)
1:00 - 1:30	Biochar Overview & Research Context
1:30 - 2:00	Project Deliverables, Timeline & Farmer Treatment Overview
2:00 - 2:15	Hand-Out Materials and Goodbyes



# Team Member Roles & Responsibilities

- Arthur's Point Farm - project management, research & farmer engagement
- Wood's End Laboratories - sampling analysis and scientific reporting
- Juan Alvez, UVM - report drafting, review of product materials
- Project Advisory Committee
- Farmer Working Group - importance of Farmer Participation





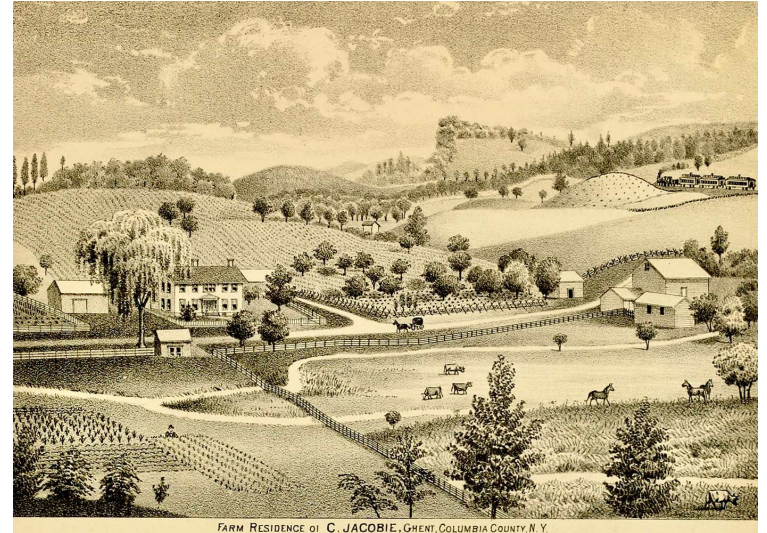
# Research Question & Goals

- *Question* - How does biochar in various combinations with compost and a mix of microbes and minerals affect the health and productivity of soil and chestnut trees?
- *Goals:*
  - Assess efficacy of biochar in agroforestry
  - Generate knowledge to assist farmer decision making
  - Provide resources and networking for farmers
  - Identify barriers and opportunities for broader farmer adoption



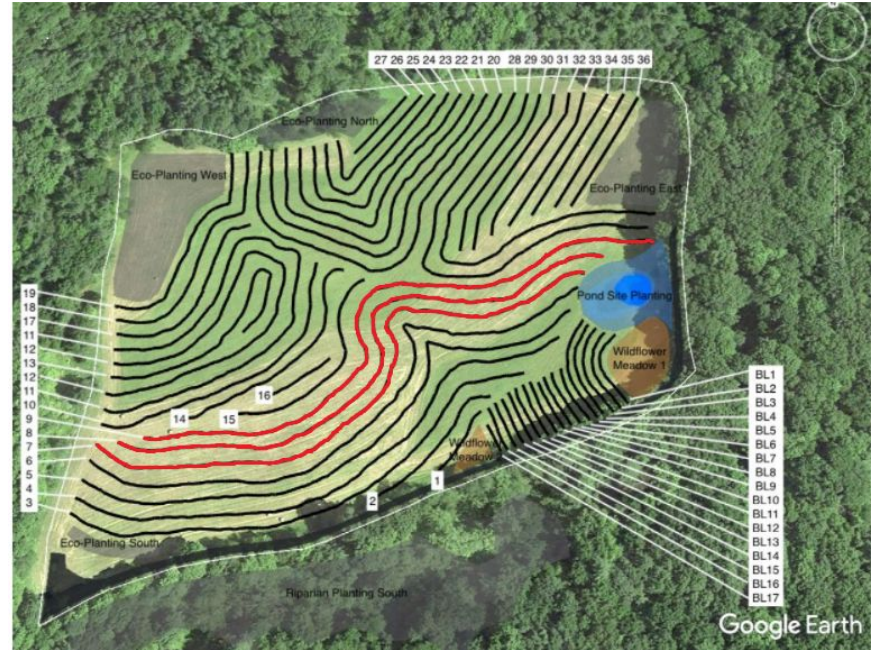
# Land-Use History

- Stockbridge-Munsee Band of Mohicans
- Colonial farming since late 18th century
- Oats, barley, rye, hay, apples & pasture
- Continuous use for ~250 years
- Soil - thin, rocky, typically wooded



# Experimental Design

- Three 800 ft rows
- Chestnut and black locust (10 ft spacing)
- Establishment: March '22
- Growing Seasons: '22, '23, '24
- Final Results in early '25



# Research Treatments

**T1 (Control)** - Native soil

**T2** - Raw biochar

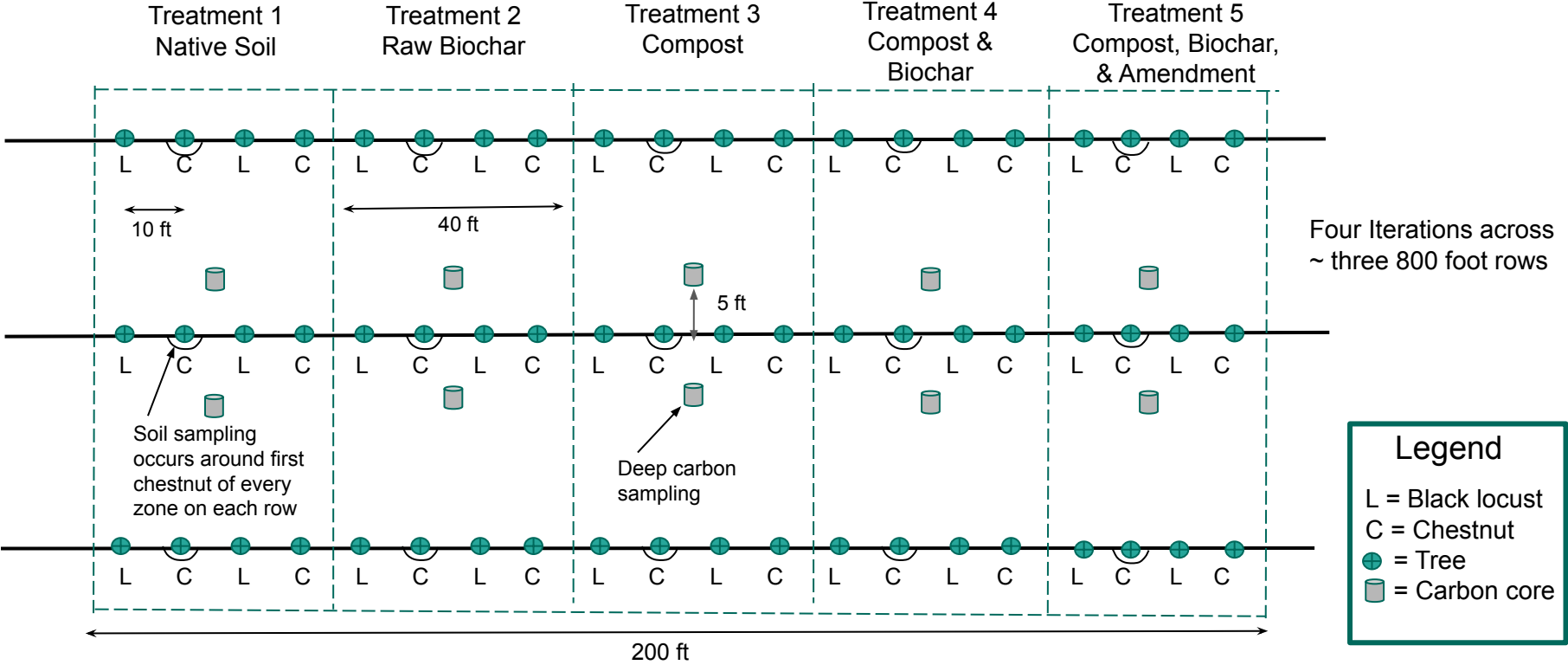
**T3** - Compost, top-dressed annually with compost

**T4** - Biochar + compost, top-dressed annually w/  
biochar-compost

**T5** - Biochar + compost + microbial amendment,  
top-dressed annually w/ biochar-compost



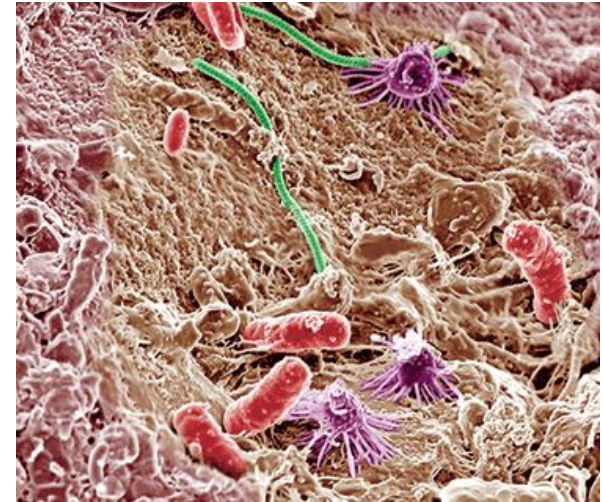
# Experimental Design





# Assessment Metrics - Soil Health/Microbe Abundance

- Quantitation - 17 soil microbial groups & 16 relationship indices
- Correlation between soil chemistry and microbial group
- K, Na, Ca, Mg, storage P, Solvita CO<sub>2</sub>, Solvita SLAN and VAST (aggregate stability), nitrate, soil organic matter, pH, C:N ratio, soil bulk density



# Assessment Metrics - Nutrient Bioavailability

- Leaf tissue analysis with 30 mature leaves from all chestnuts within treatment block
- Nitrogen, phosphorus, potassium, magnesium, calcium, sodium, sulfur, boron, zinc, manganese, iron, copper, and aluminum
- Compare with presence in soil



# Assessment Metrics - Carbon (Soil & Core Tests)

- 1 meter carbon sampling, years 1 & 3
- Additional sampling around trees
- Water soluble carbon & total organic carbon
- Biochar additions will be measured



# Assessment Metrics - Tree Health & Vigor

- USFS protocol from Forest Ecosystem Monitoring Coop (Duncan, Chojnacky)
- Above ground biomass
- Live crown ratio
- Vigor (overall tree health)
- Dieback (response to recent stress)
- Foliage transparency (foliage size and density)
- Defoliation
- Foliage discoloration



# Research Hypotheses

- **Hypothesis 1:** Biochar + compost + amendment = ↑ soil microorganism abundance, ↑ nutrient bioavailability, ↑ tree health/vigor, ↑ carbon sequestration
- **Hypothesis 2:** Planting chestnuts only in native soil = ↓ vs. compost and biochar treatments across assessment metrics
- **Hypothesis 3:** Straight biochar w/o compost or amendment = ↓ nutrient bioavailability, ↓ inhibit tree health/vigor vs. compost and biochar treatments across assessment metrics





# Farm Walk





# Biochar Overview

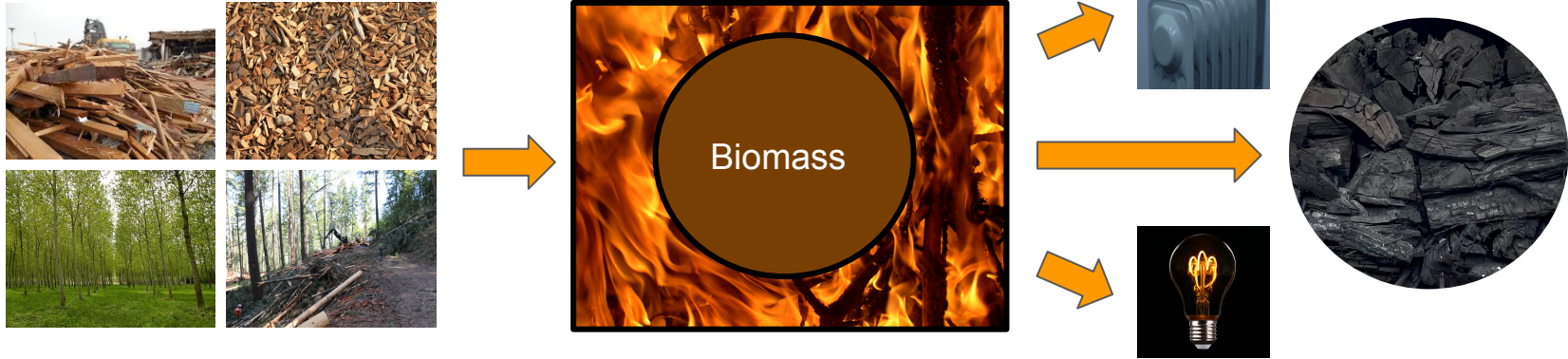


# Feedstock

- Any biomass, including solid waste
- Construction debris
- Mill scraps
- Biocarbon crops (fast growing, easy to grow; e.g., willow, poplar)
- Forestry debris
- Carbon footprint - waste streams, locally-sourced, and minimal inputs to produce



# Production Process



Feedstock

No O<sub>2</sub> + Heat (400-900°C)

Biochar  
Heat  
Power

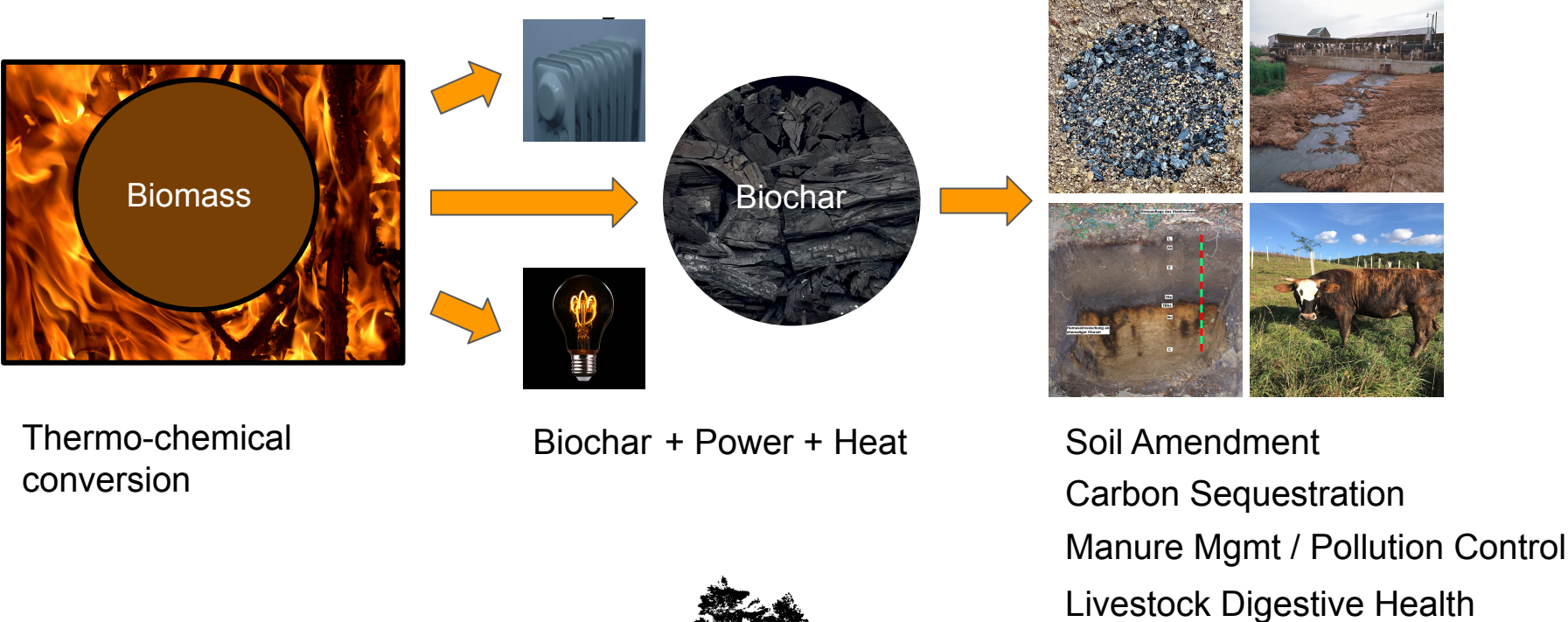








# Benefits & Ecosystem Services



Thermo-chemical conversion

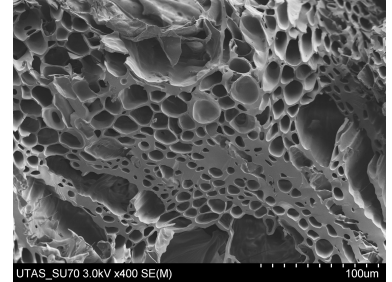
Biochar + Power + Heat

Soil Amendment  
Carbon Sequestration  
Manure Mgmt / Pollution Control  
Livestock Digestive Health



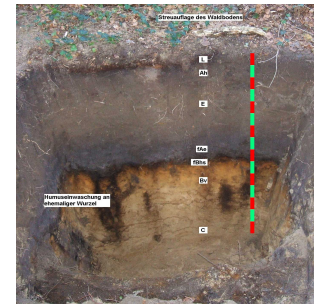
# Soil Health & Productivity

- Porous structure, large surface area, adsorptive/absorptive
- Water, micronutrients & microbial habitat
- Mycorrhizae and certain bacteria help plant nutrient availability
- Useful in depleted or sandy soils with low soil organic matter
- 18-28% productivity gains reported (but only annuals)
- Research needed given variability in biochars and uses
- Research needed for tree crops and other perennials



# Climate Mitigation - Natural Carbon Sequestration

- Carbon capture and storage + reduction in fossil energy use
- Turning biomass into stable carbon for thousands of years
- Reduce nitrous oxide ( $N_2O$ ) & methane ( $CH_4$ ) from tillage, fertilizers & livestock
- $N_2O$  &  $CH_4$  = 300 and 25 times potency of  $CO_2$
- U.S. agriculture = 80% of  $N_2O$  and 40% of  $CH_4$  emissions
- Biochar carbon credits being sold - scaling to small, medium farms a challenge





# Manure Management & Pollution Control

- High cation exchange capacity & surface area binds ammonia & other malodorous substances
- Adsorptive (i.e., adhering) & absorptive (i.e., dissolving) qualities reduce nutrient leaching in the soil
- Protects groundwater & lowers acidification of the soil
- Reported to nearly double fertilizer efficiency of liquid manure treatments





# Livestock Health & Productivity

- Feed supplement an ancient practice Cato the Elder (~200 BC)
- Common prescription in ag lit of early 20th century
- Nutrient uptake, adsorbs toxins, improve overall health
- Increased weight gain, feed efficiency, egg production, immunity, hygiene, odor control & lower vet costs (meta-analysis 27 studies)
- European Biochar Foundation has a certifications standard for use in animal feed



# Timeline & Workplan

- *Project Timeline*
  - March, 2022 - November, 2025 (3.5 years)
  - Data collection over 3 seasons: '22, '23, '24 (3 if we can find more \$)
  - 2025 - Analyzing results, report writing, and other deliverables
- *Workshops and Field Visits*
  - Inaugural Workshop in March '22
  - Farm Field Visits in Spring '23 and '24
  - Final Workshop in Fall '25



# Deliverables

- *Reports & Fact Sheets*
  - Peer-Reviewed Paper to document results scientifically
  - Project Report for policymakers and extension services (NRCS, Cornell, etc.)
  - Fact Sheet(s) for farmers and technical service providers
- *Conference Presentation*
  - Savannah Institute's North American Agroforestry Conference
  - Northern Nut Growers Association Annual Meeting
- *Web & Social Media*
  - Blog Posts
  - Video Report



# Farmer Treatments - Materials

- Trees (5 Chestnuts + 5 Black Locust)
- Biochar
- Compost
- Biochar-Compost
- Tree Tubes + Stakes
- Weed Mats
- Treatment Instructions



# Farmer Treatments - Site Visits (Spring '23 & '24)

- Deliver annual materials
- Check progress & answer questions
- Video interviews
- Check out your farms!



Thank You for Participating

