Prospects of Biochar Use in Forestry

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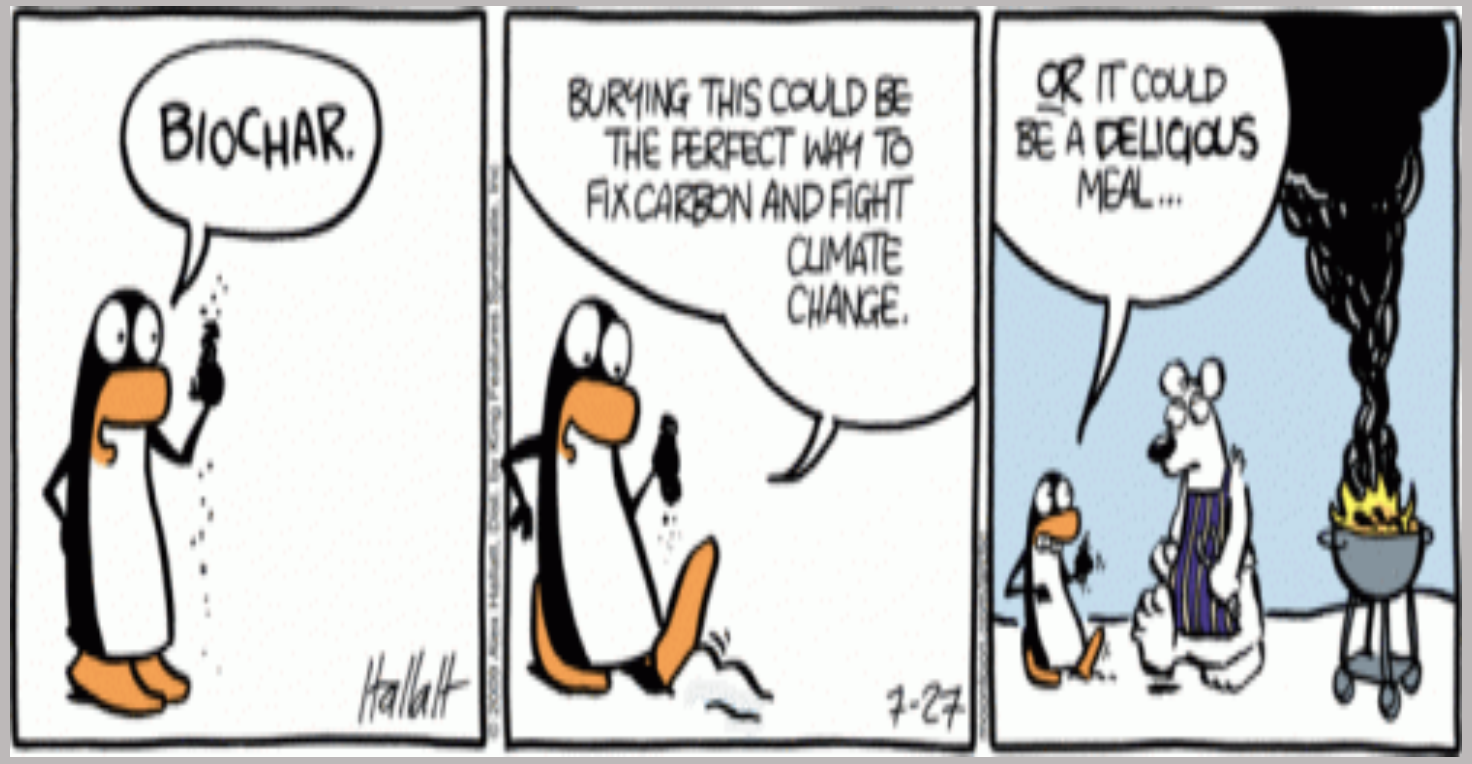
A little background



Using forestry feedstocks to:

- Reduce wildfire risk
- Lessen insect and disease risk
- Improve soil water relations
- Healthy trees/forests
- Soil resilience to drought and flood
- 10 long-term forestry field trials

Overview

- Forest harvesting and feedstock management
- Changing forest productivity
- Understanding the benefits
- Climate change mitigation

Historic Issues of Land Management in the USA

- 1979
  - "A major problem confronting forestry is how to more efficiently harvest timber without creating unacceptable impacts on the forest environment."
  - "The full utilization of residual material left in the woods following logging and thinning operations, and disease, and insect attack, and windthrow has long been a source of concern and frustration to the forest manager."

From: Environmental Consequences of Timber Harvesting in the northern Rocky Mountains. GTR-INT-190

Too much of a good thing…

- Sites with too much logging slash
- Wildfire risk
- Not feasible to broadcast burn
- Piles are created (and burned)

Common practices on many forest sites

- Piled and burned
- Biomass from harvest operations
- Burning alters soil conditions
  - Long-term alterations

Long-term impacts of pile burning

- Many hectares impacted from hot, concentrated fires
  - Loss of OM
  - Nutrient volatilization
  - Few trees or shrubs
  - Often non-native species

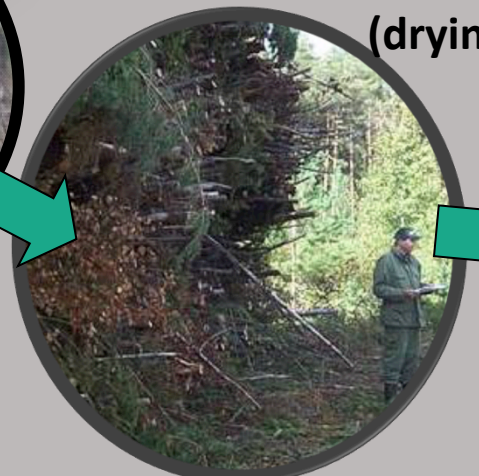
Forest Supply Chain Context

Biomass Production	Feedstock Logistics	Conversion	Distribution Logistics	End Use
Cultivation	Harvest and collection	Biochar	Packaging	Blending
Silviculture	Processing	Post-conversion treatment	Transportation	Processing
Sustainability	Transportation	Heat and power	Storage	Application
	Storage	Other Co-products		

Current harvesting model: Forest biomass to bioenergy

1. Felling trees (harvester)

2. Moving biomass (forwarding)



3. Storage (drying)

4. Chipping (roadside or mill)

5. Trucking (chipped biomass)

6. **BIOENERGY**!

Or: Forest biomass to waste

1. Felling trees (harvester)

2. Moving merchantable biomass

3. Piling or Storage (drying)

4. Burning

6. NO ENERGY and no C sequestration!

Envisioned ‘in woods’ model: Forest biomass to bioenergy

1. Felling trees (harvester)

2. Moving biomass to landing (forwarding)

3. Slash piles (drying)

4. Chip, create biochar, spread on forest sites

5. Trucking (high value bio-oil, Biochar, pellets)

6. BIOENERGY!

Concerns about biomass harvesting and ecosystem services

- Destruction of wildlife habitat
- Decline of fresh water quality and quantity
- Visual impacts
- Erosion
- Overall negative impact on long-term productivity, sustainability, or changes in succession

Assessing the Effects of Biomass Removal for Bioenergy

Stand level

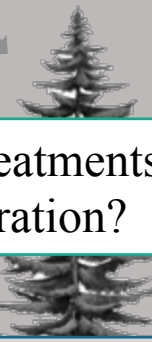
Do biomass utilization treatments impact stand production?

Do biomass utilization treatments impact vegetation composition, natural regeneration, and ecosystem structure?

Do individual trees respond to biomass utilization treatments?

Tree level

Regeneration



Do biomass utilization treatments impact artificial regeneration?

Soil productivity

Does total removal of excess biomass alter soil productivity?

(Jang et al., 2014)

40 years of Bioenergy Harvesting data

- Forest sites are resilient
- Identify sites that are sensitive to compaction or other impacts
- Soil carbon rebounds within a rotation (or less)

BIOMASS: GATE TO GRAVE

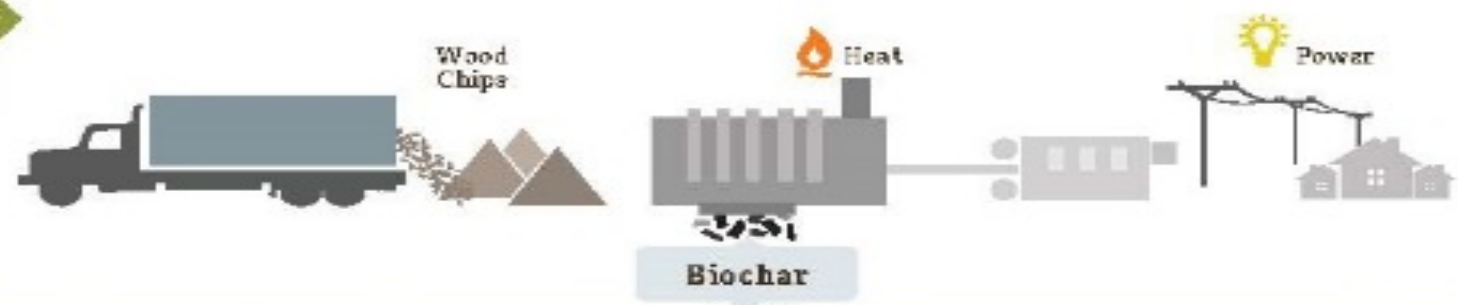
The Gate to Grave segment of the supply chain includes steps to convert processed forest biomass into valuable products that are delivered to end users who drive the demand for bioenergy and bioproducts.

Social & Economic Context

Successful use of woody biomass for energy requires public support. Understanding how the public views woody biomass energy and related trade-offs is critical to future adoption of forest-based bioenergy.

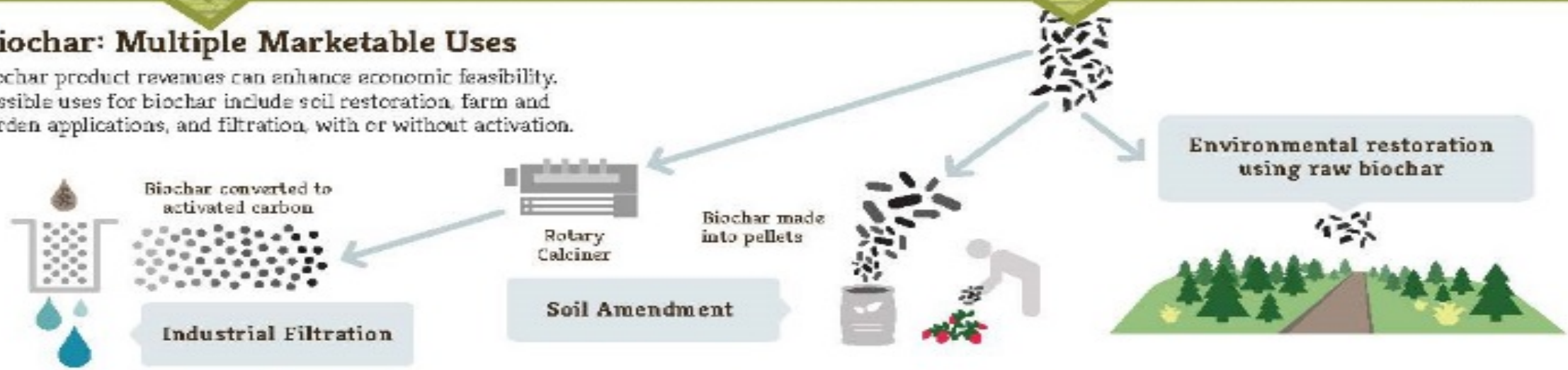
Biomass Conversion Produces Heat, Power, and Biochar

Conversion of biomass can yield: heat and power for manufacturing, power for the power grid, and a charcoal product called biochar, which has a several uses in agriculture and industry.



Biochar: Multiple Marketable Uses

Biochar product revenues can enhance economic feasibility. Possible uses for biochar include soil restoration, farm and garden applications, and filtration, with or without activation.



Biochar is equivalent to native charcoal in forest ecosystems

- Char is common in fire-adapted ecosystems
- Fire suppression decreases charcoal inputs
- Biomass removal decreases the likelihood of fire occurring
- Applying biochar as a co-product of pyrolysis removes wildfire hazard *and* retains soil ecosystem function

What can biochar do on forest sites?

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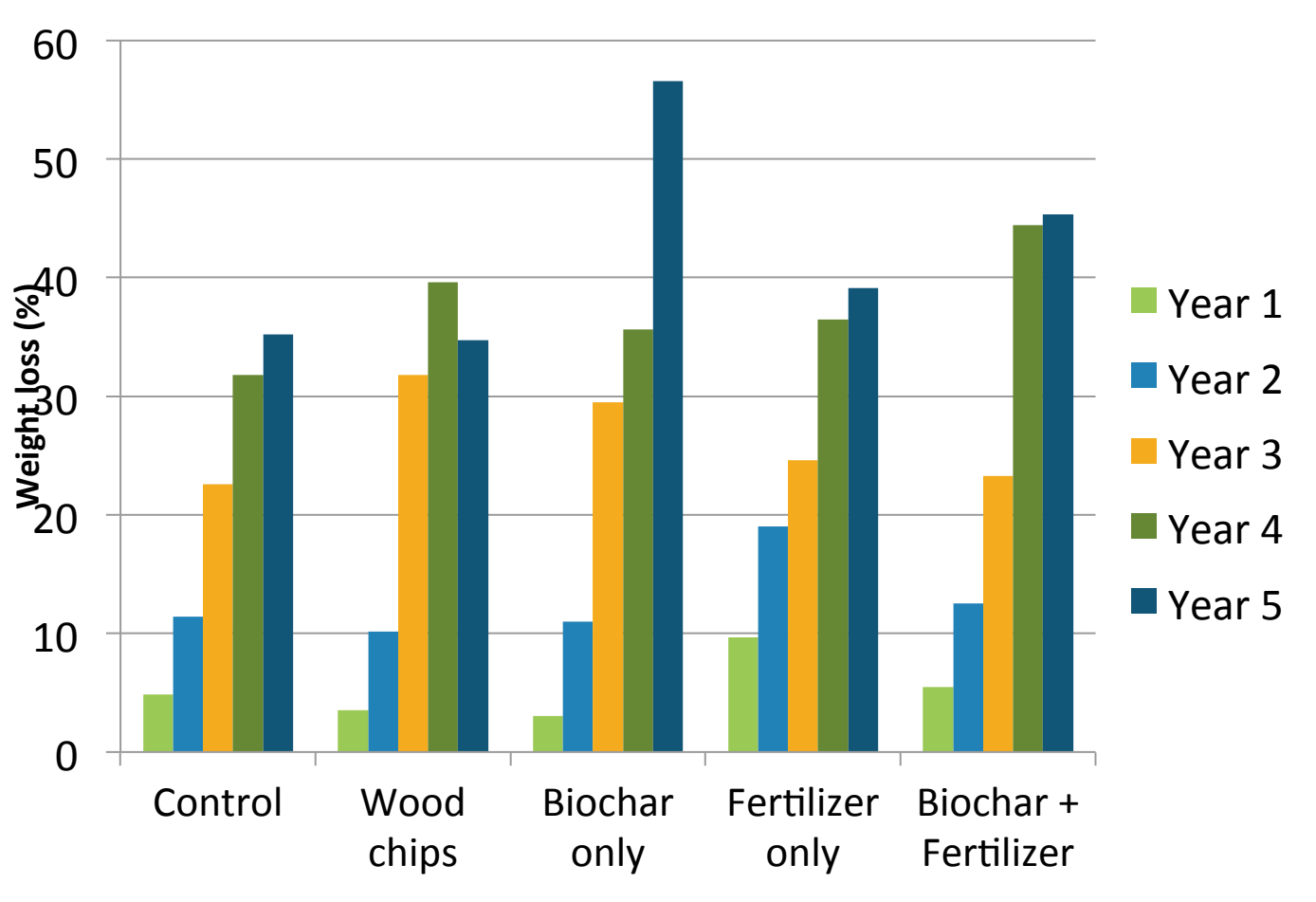
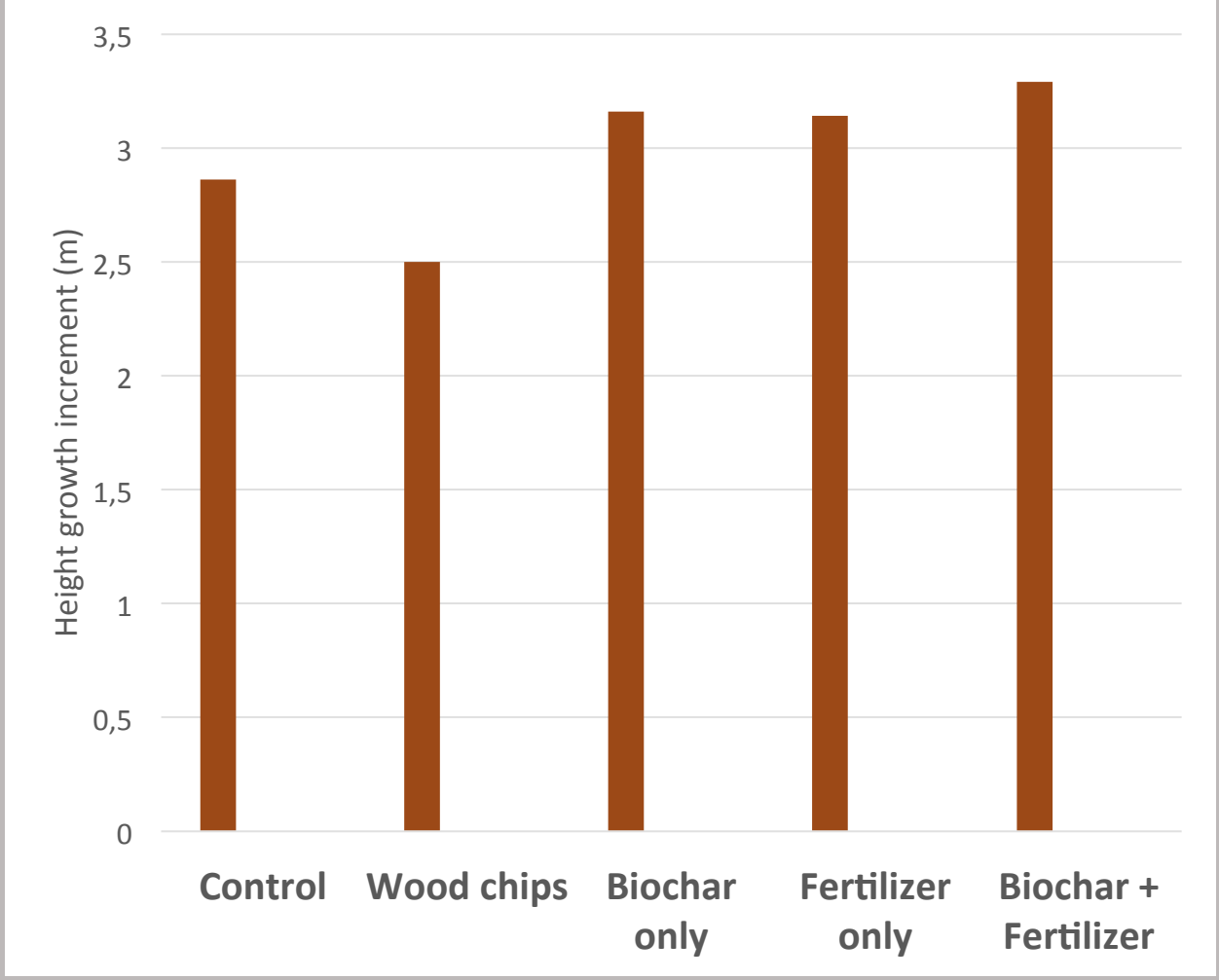
Changes in decomposition rate



Biochar alters the rate of wood decomposition

- Increasing soil organic matter for water, nutrients and microbial activity

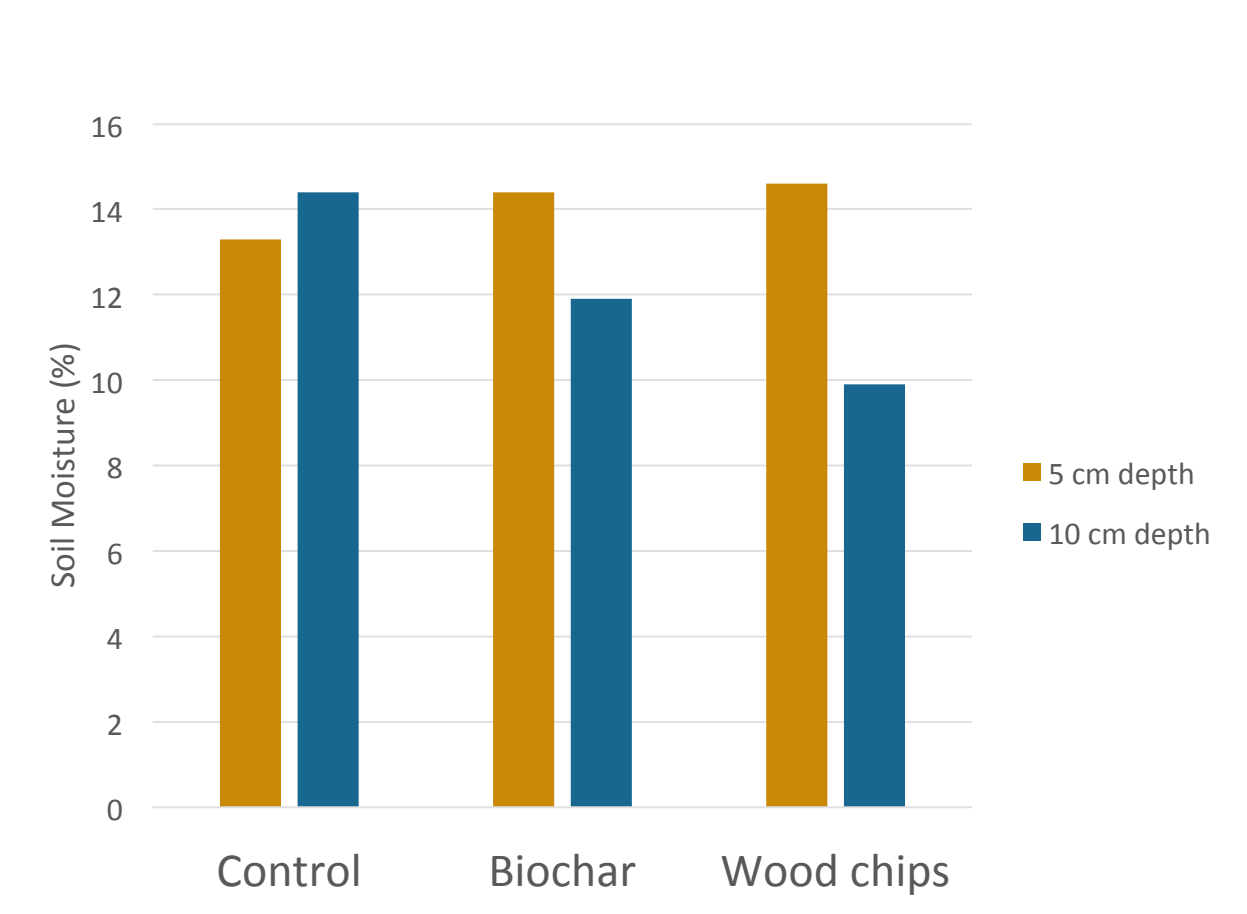
What can biochar do on forest sites?
Changes in tree growth



Biochar alters tree growth

- Within 5 years an 8% increase in tree height increment.
- Both above- and belowground long-term carbon sequestration

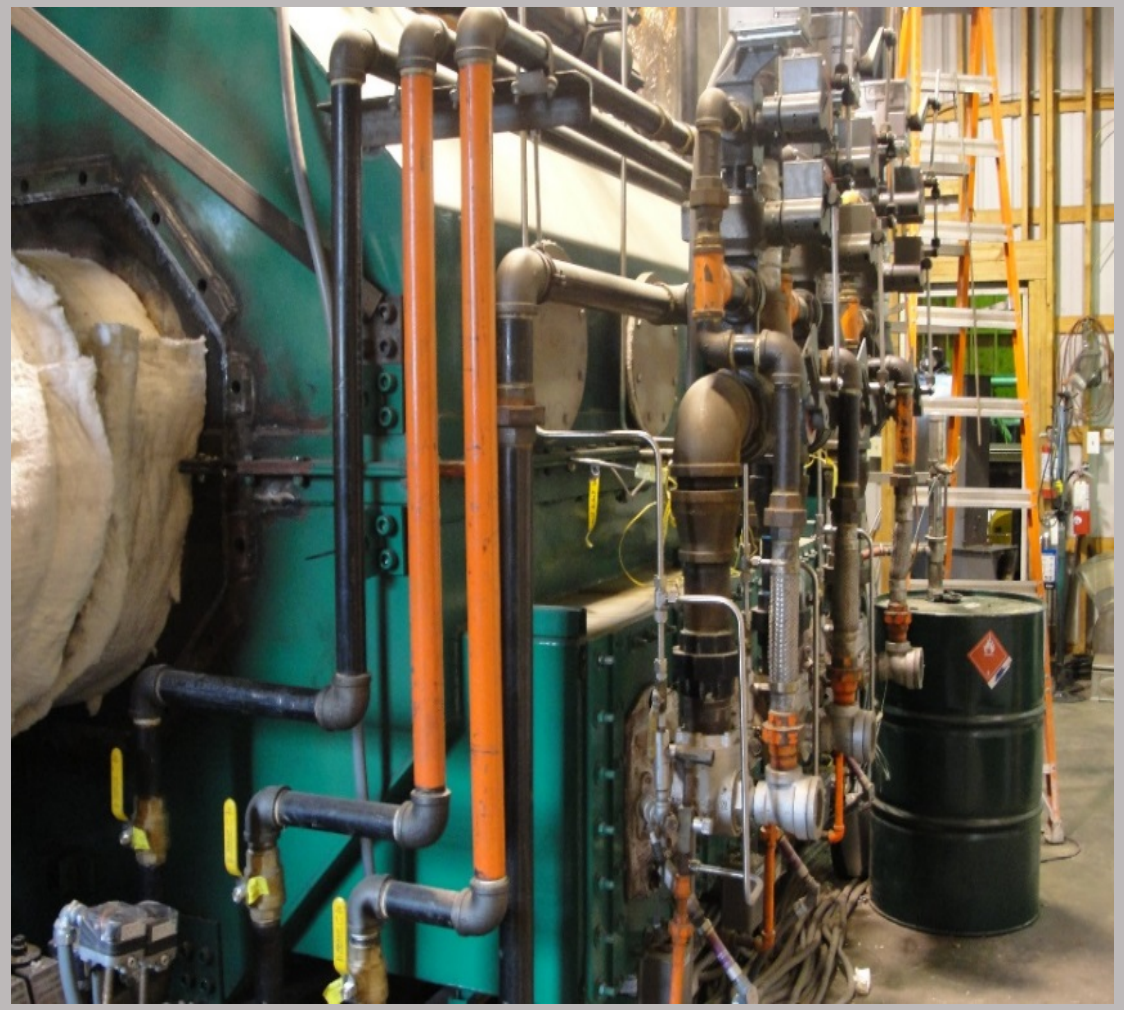
What can biochar do on forest sites?
Changes in soil moisture



Biochar alters soil moisture

- Within 3 years we see increases in soil water holding capacity
- Decreases insect and disease risk
- Healthier forest stands

Is this feasible?

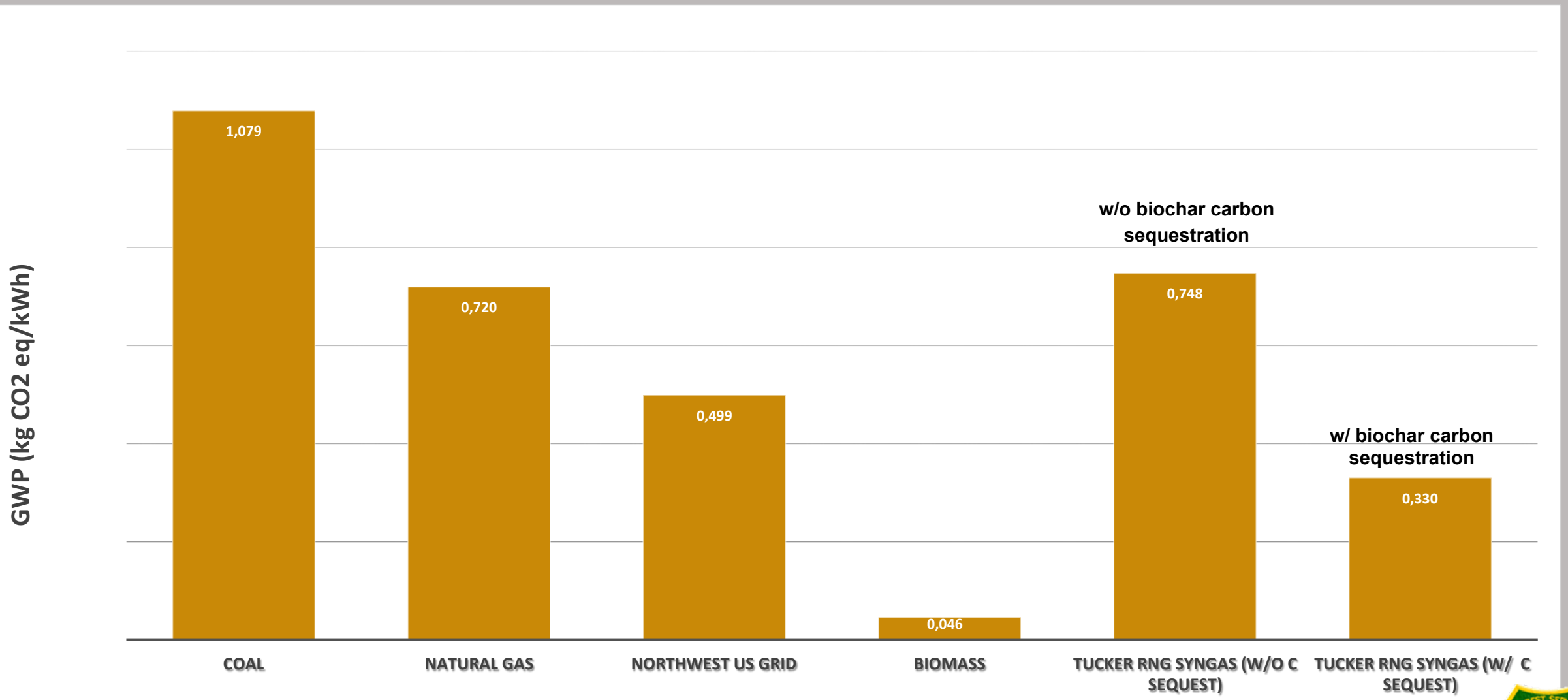


- Conducted Life-Cycle Analyses for Biochar-based Activated Carbon(AC) and compared to Coal-based AC
  - Cradle-to-gate LCA

Impact category	Unit	Biochar AC	Coal AC
Global warming	kg CO2 eq	8.60	18.28
Fossil fuel depletion	MJ surplus	17.09	22.65

- Made activated carbon from managed forest residues
  - Physical properties of activated carbon were better than coal-based AC

Global warming impacts for electricity



Understanding harvest and biochar risks and benefits

Harvest

- Little evidence that long-term site productivity declines with bioenergy harvesting
- Biochar increases carbon sequestration and may increase site productivity

Biochar

- Match biochar to sites to maintain microbial activity

Some final thoughts

Forest biomass is a promising feedstock for bioenergy, biochar, and biofuel

- Widely available as a byproduct of timber harvesting
- Avoids slash pile impacts on the soil
- Renewable
- Can achieve energy objectives of reducing GHG emissions of fossil fuel
- Revive the declining industrial base in many rural US communities
- Using a supply chain approach increases efficiencies for delivering biochar products

Thank you