

# Making and Using Biochar

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## Biochar Basics: An A-to-Z Guide to Biochar Production, Use, and Benefits

### **A** A Little Background

When considering the amount of organic matter in soil, there is too much in some places and not enough in others. Many forests have too much organic material, in the form of dense tree stands and fuels on the ground, while many soils don't have enough. Soil organic matter is needed in degraded range, forest, mine, and agricultural soils that have been stripped of key nutrients.

We know that healthy forests are resilient and support a wide range of human and ecological benefits. But many forests are overgrown and crowded. Too many trees compete for too little water; they become stressed, are vulnerable to disease and insect infestation, and die and become fuel for catastrophic wildfires. Therefore, excess biomass must be removed.

By turning excess forest organic material into economically and environmentally valuable biochar,



*Biochar, shown above, is made from excess organic forest material and is proving to be a valuable economical and environmental resource. Photo by Pam Voth Photography.*

# Overview

- What is biochar?
- Why biochar?
- How do I make biochar?
- Barriers?
- Benefits?



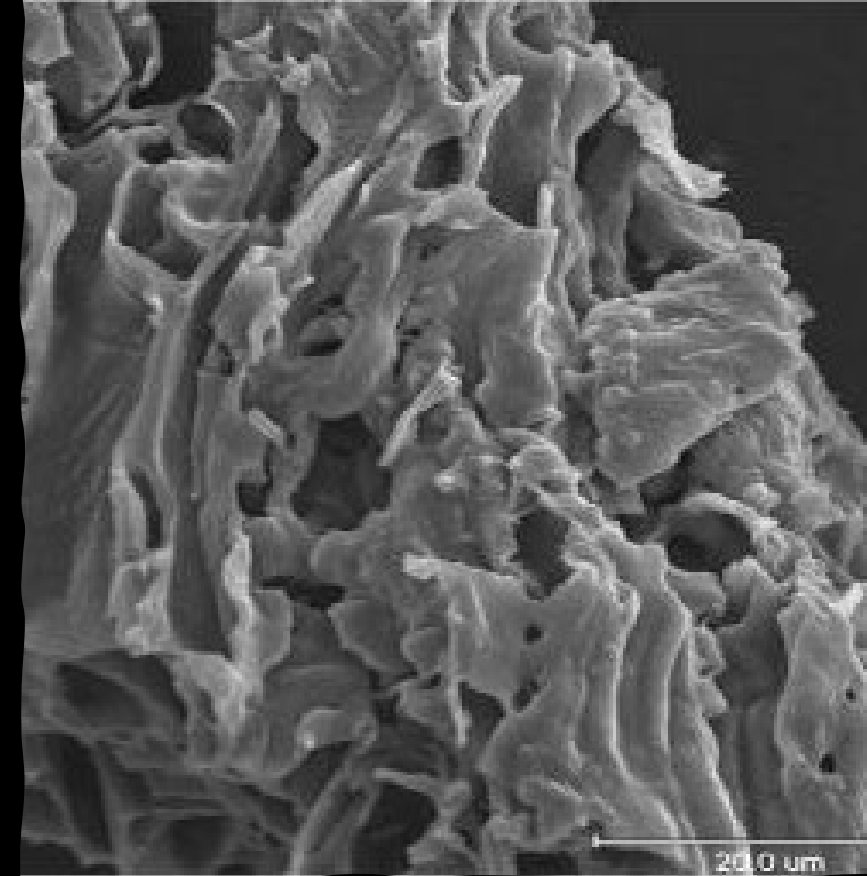
# What is Biochar?

## SHORT ANSWER:

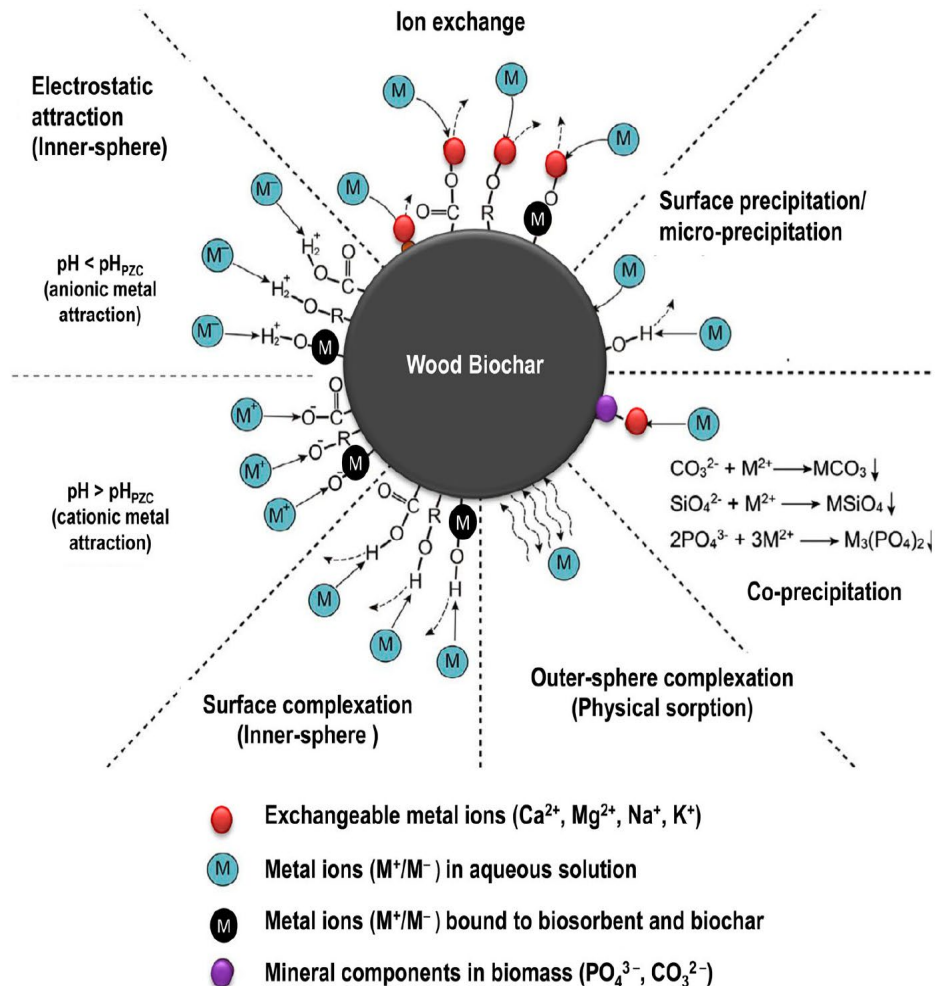
- Charcoal intentionally made for land application
  - Various sizes
  - High organic carbon content (20-80%)

## LONG ANSWER:

- Indigenous cultures would add firepit charcoal to soil
  - Increased plant growth



# Why is biochar so great?



- Nutrient adsorption
- Heavy metal adsorption
- Water holding

From Shaheen et al. 2019. International Materials Review. 54: 216-247

# The biggest biochar benefit to soils:

Restore the sponge! Add biochar!

Biochar increases available water:

- 38%: coarse-textured soil
- 19%: medium-textured soil
- 16%: fine-textured soil



Data from: Blanco-Canqui, 2017; Edeh et al., 2020; Razzaghi et al. 2020



What to do with residues?





# Overarching ecosystem problems



- Overstocked Forest stands
- Too much organic matter



- Degraded soils
- Low in organic matter



- Wildfire
- Insects
- Disease
- Drought
- Climate change

# Small diameter trees



Fuel reduction and forest restoration treatments are ideal sources of biomass





The size of the problem is huge!



# Slash piles to biochar

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Reduce:

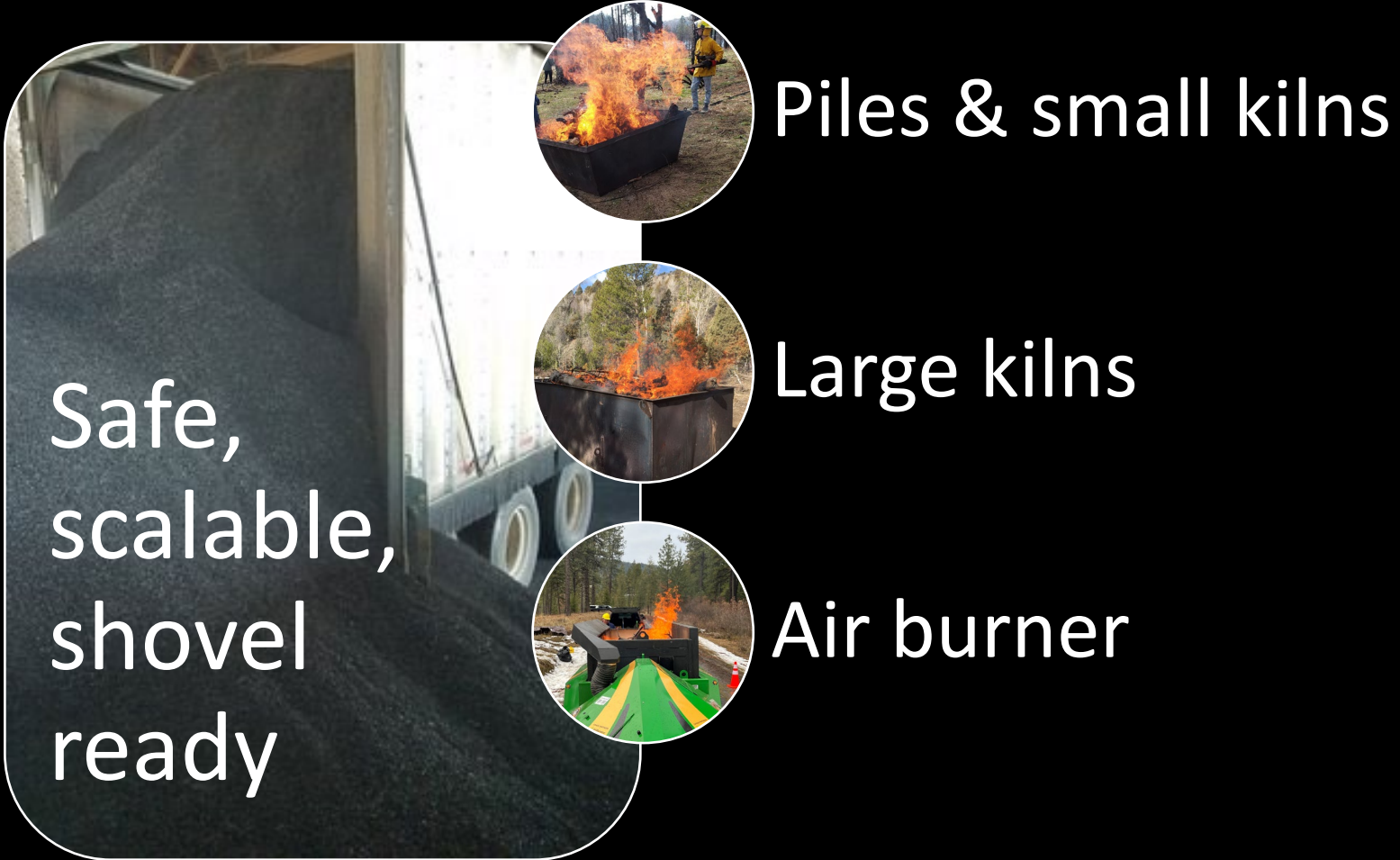
- Soil impacts & burn scars
- Pollution (smoke/particulates)
- Wildfire risk
- Insect/disease risk





**Making biochar**

# In-woods biochar production



Safe,  
scalable,  
shovel  
ready

Piles & small kilns

Large kilns

Air burner

# Making biochar: Slash piles



Jack Daniels rick piles create 'biochar' for filtering whiskey

- Easily extinguished or self-extinguishing

Similarly created forest biochar can be made on-site and used as a soil amendment

Heat dissipated away from the soil

Char increased soil cover and moisture holding

New (to me!) ways to top-light piles



# Making biochar: Kilns

- **Big Box Kilns:** Developed by Darren McAvoy (Utah State University)
- **Ring of Fire Kilns:** Developed by Kelpie Wilson (Wilson Biochar)





# Making biochar: Air curtain burner (retooled)

- Patented technology:
  - Move biochar to the bottom of the burner
  - Quench the biochar
- Field testing in progress
- Cooperative work with Air Burners, Inc., U.S. Biochar Initiative, and U.S. Forest Service



# Some costs (approximate)

- Ring of Fire kiln= \$2,200
- Big box kiln = \$12,000
- CharBoss (air burners, inc.) = \$150,000
- Carbonator (Tigercat) = \$600,000



# Other modular biochar production methods

- Power pallet (All Power Labs)
- Large air burners
- Carbonator™ by Tigercat
- Containerized biochar pyrolyzer (Biochar Solutions, Inc.)
- Retort kilns (Exeter Retort)
- And more!



# Production rates

- Ring of fire kilns
  - 2 cy biochar in 5 hours
  - ~5% efficiency
- Big box kilns
  - 2 batches/day
  - ~5-10 cy biochar/day
- CharBoss air burner
  - ~1 ton/hour
  - 15-20% efficiency



# Application rates

Anything up to 10 tons/acre!





**Biochar spreader for wildland sites**














# A few opportunities

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- Reduce fuel loads
- Sequester carbon
- Restore soil health
- Reduce erosion
- Improve infiltration
- Decrease compaction
- Abandoned mine soil restoration
- Gas and oil pad restoration
- Feedlots/nutrient management



# Summary of Forest Soil Changes

- Carbon sequestration 
- Available water 
- Greenhouse gas fluxes  
- Soil biology 
- Water erosion 
- Wind erosion 
- Nutrient leaching 
- Vegetation productivity  
- Invasive species 





**Financial assistance to farmers, ranchers, and forestland owners to apply carbon amendments, such as biochar and compost, to their soil as a way to sequester carbon, improve soil health, and increase yield and productivity.**



# Soil Carbon Amendment

- Natural Resources Conservation Service
- National Standard code 336
  - Starting Oct 1, 2023
- Environmental Quality Incentive program (EQIP)

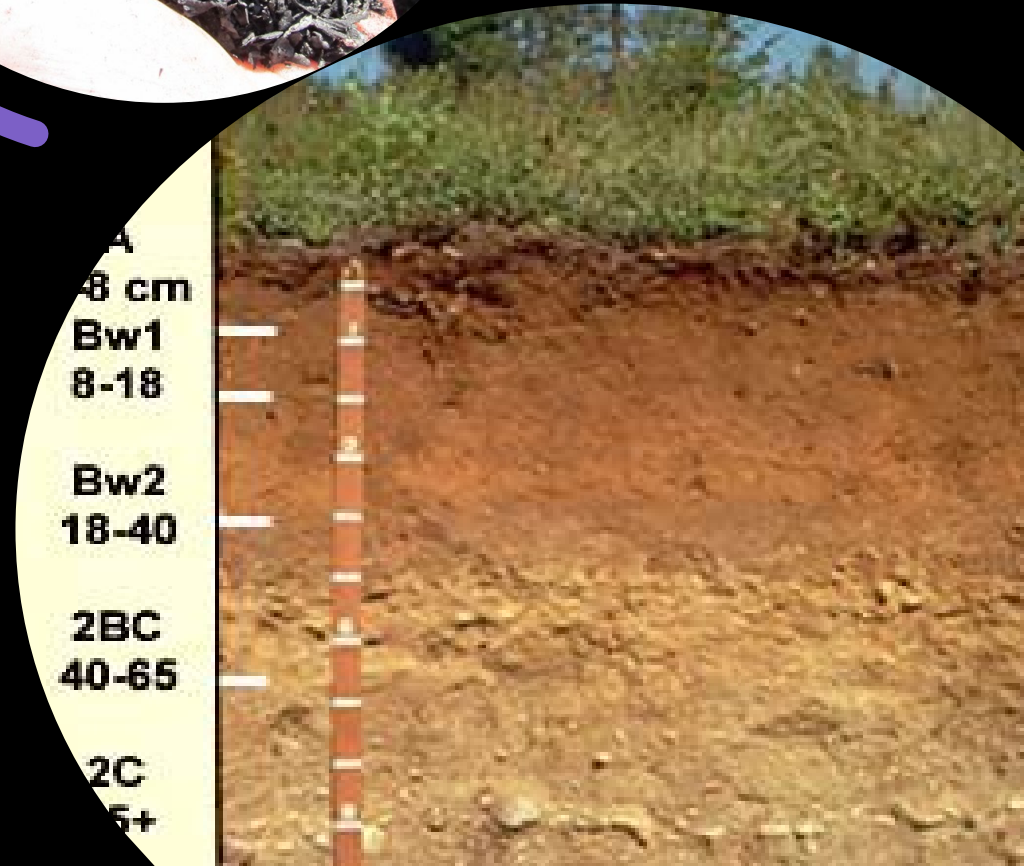
# Biochars are different & soils are different

## FOREST biochar – FOREST soils

- Western woody feedstocks
- Woody shrubs
- Soil texture
- Current organic matter levels

## FOREST biochar - AGRICULTURAL soils

- Soil and biochar testing
- Composting
- Soil texture
- Current organic matter levels
- Nutrient limitations



# Biochar barriers?

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- Contracting
  - Logging
  - Slash piles
- Lack of equipment
- Technical skills
- Cost?
- Production rates
- Application rates



# Why is biochar important?

- Wildfire risk reduction
- Provides a rapid increase in soil C
- Climate change mitigation
- Ecosystem services
- Improve degraded soils
- Rural economies

*Biochar is: Safe, shovel-ready, scalable*



10 tons/acre biochar on a forest site

Thank you for your time!



USFS  
National  
Soils  
Program

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