Biochar: A slash reduction method

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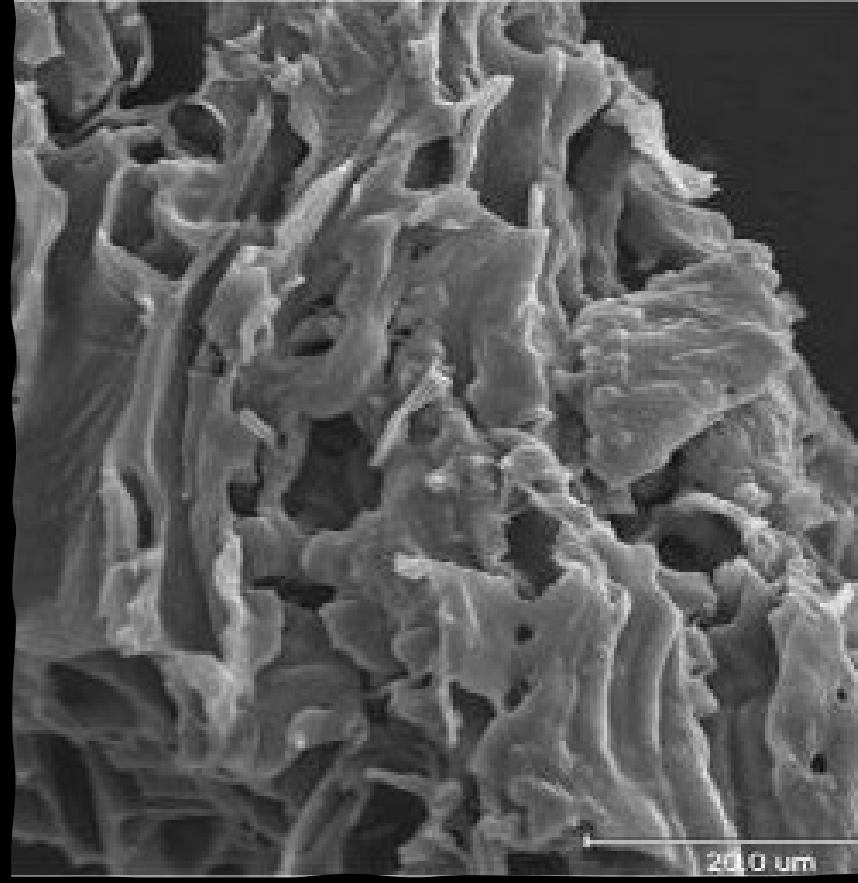
OVERVIEW

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

What is Biochar?

- **Charcoal intentionally made for land application**
  - Various sizes
  - High organic carbon content (20-80%)
  - Retains most of the carbon and nutrients contained in biomass
  - Porous structure and extremely high surface area (microbes & nutrient retention)

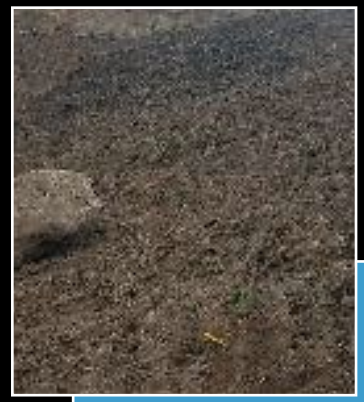
- **Builds a recalcitrant soil carbon pool**



Why make biochar?

Overarching ecosystem problems

- Overstocked Forest stands
- Too much organic matter



- Low organic matter soils

- Wildfire
- Insects
- Disease
- Drought

Small diameter trees

Fuel reduction and forest restoration treatments are ideal sources of biomass

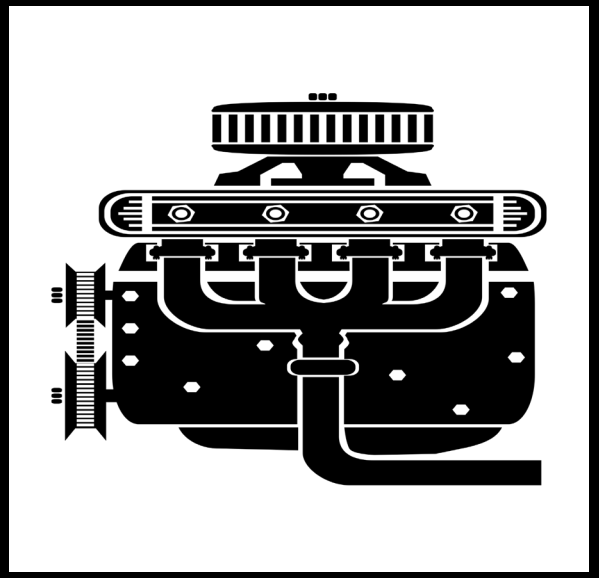
Residues present significant challenges…

Prohibitively costly to collect and transport, therefore…

…they are often collected and burned in the woods, jeopardizing air quality and increasing costs of management

Open burning costs

...and significant opportunities



Turn residues into valuable bioenergy or bio-based products

Reduce transportation costs by alternative residue treatments

Create biochar on-site for soil and site benefits + ecosystem services

Waste to Wisdom (www.wastetowisdom.com)

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Overstocked stands – an opportunity for biochar!

- Low-value wood burned in slash piles
- Burn scars
- Pollution
- Soil impacts

USDA United States Department of Agriculture

Rocky Mountain Research Station

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

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.

https://www.fs.usda.gov/rmrs/sites/default/files/documents/SYCU-Bulletin-BiocharAtoZ-May2022.pdf

Making biochar

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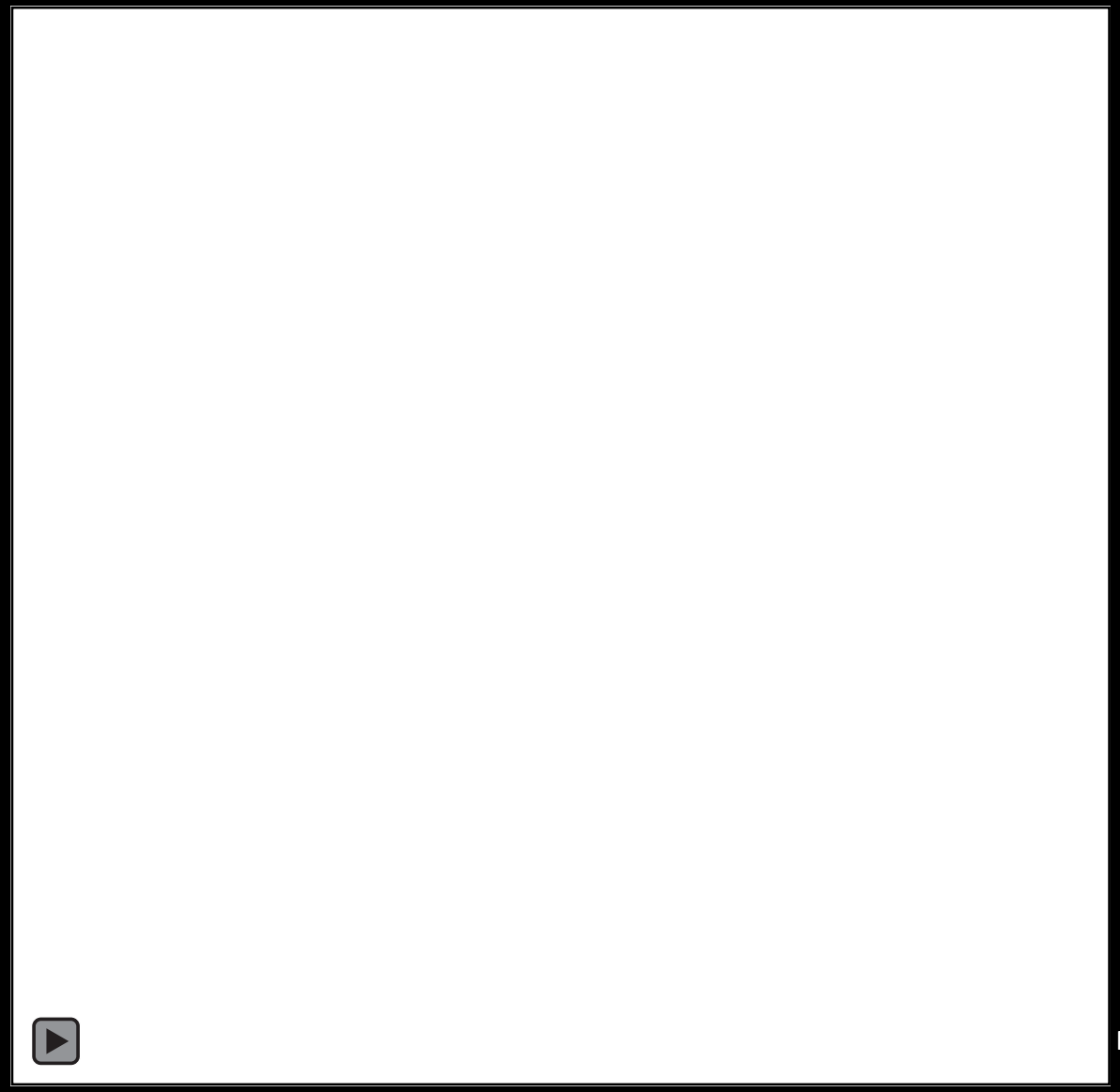
Making biochar: Slash piles

- 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

Biochar spreader for wildland sites

Some costs (approximate)

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

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 or less than 10 tons/acre!

A few opportunities

- 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

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

Biochar and forest soil microbiome

- Increase in fungal biomass
- Increase or decrease native OM decomposition?
- Change in enzyme production
- Greater nutrient availability

Biochar and invasive species

- Weeds challenge restoration efforts
- Alter soil properties and processes
- **Biochar** can:
  - be used by heterotrophic microbes
  - alter CEC, pH, water, nutrients to limit invasive species
  - increase biomass of native grasses
- Consider combining biochar with compost

Adams et al. 2013. The effect of biochar on native and invasive prairie plant species. Invasive Plant Science and Management 6: 197-207

Biochar and mine site restoration

- 1000's of abandoned mine sites
- Contaminated or non-contaminated
- Biochar can alter soil properties
- Increase vegetation cover
- Reduce wind/water erosion
- Bring non-productive soil into production

Rodriguez-Franco, C. and Page-Dumroese, D. 2020. Woody biochar potential for abandoned mine land restoration in the U.S.: A review. doi: 10.1007/s42773-020-00074-y

Summary of Forest Soil Changes

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

Biochar and seedlings

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Growing healthy seedings

Control
No biochar

75%
peat/25%
biochar

50-50
peat/
biochar

25% peat/
75%
biochar

TABLE 3

Number of irrigation events, as triggered by a 75% container capacity threshold.

		Biochar (%)		
Species	**Control**	**15**	**30**	**45**
Clarkia pulchella	38	36	32	27
Festuca idahoensis	31	26	21	20
Gaillardia aristata	53	51	44	41
Pinus ponderosa	49	44	39	37

Notes: For all 4 species, irrigation frequency was inversely related to biochar content.

Biochar Barriers

POLICY

The use of National Forest slash for biochar production requires improvements in policy and operational support for private contracting, air quality, environmental and land use permitting, commercial markets, and incentives for biochar applications.

- **Administration and Permitting**
- **Funding and Initiatives**
- **Land Management Decisions**
- **Public Support and Science Communication**

These policy-related factors present overarching challenges for biochar production and applications.

PROCESS

Forest harvest and thinning operations produce large amounts of waste biomass (slash). Without value, slash is typically burned, harming air quality, carbon emissions, fire risk, and forest soils.

On-site Production

On-site production of biochar reduces transportation and handling costs.

However, generating biochar from forest slash requires additional funding and support for project planning, technology, transportation, safety and personnel.

Off-site Production

Provides the best opportunity to produce slash-based wood products, biochar and energy.

Requires a stable supply of biomass and consistent demand to cover production costs. Transportation decreases profit margin and net carbon benefits.

APPLICATIONS

Biochar has many useful applications for soil remediation and agriculture.

Yet, widespread use remains limited by knowledge gaps, prohibitive cost and insufficient supply of biochar.

- Post-wildfire rehabilitation
- Cropland soil amendment
- Mine land soil remediation
- Skid trail/log landing remediation
- Vegetation diversity
- Carbon sequestration
- Animal bedding
- Wetland rehabilitation

Other barriers

- 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
- 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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