

# Waiting for the comet: Slash piles are dinosaurs



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# Overview

- Slash pile review
- Alternatives
- Ecosystem benefits



# Current slash pile use and impacts

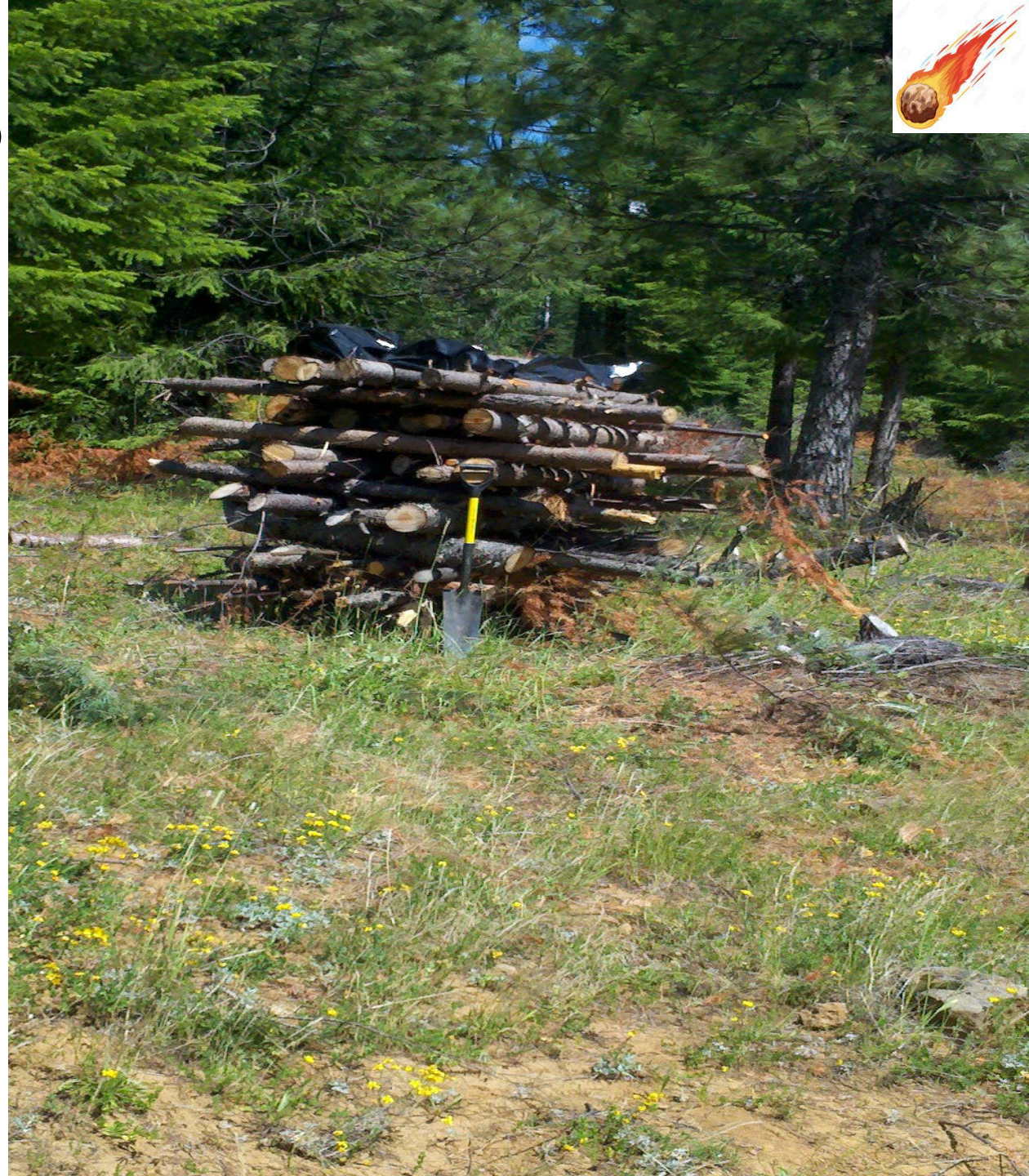




# Why pile and burn slash?

- Effective tool to meet management objectives
- Reduce fuel loads
- Seed bed preparation
- Fast and efficient
- Weather conditions
- Economically feasible

Mott et al. 2021. Post-harvest slash burning in coniferous forests in North America: A review of ecological impacts. For Ecol & Manag. 493, 119251





# Forest management

- 18-25% of aboveground harvested material is in
  - Tops
  - Branches
  - Foliage
  - 60% of this material gets piled
- Salvage logging of drought, disease, insect and wildfire killed trees
- Thinning operations



# 'Typical' burning slash pile emissions

## 2.5 m high x 5 m diameter piles



Pollutant	Wet pile	Dry (uncovered) pile	Dry covered pile
	----- g/kg biomass consumed -----		
Carbon dioxide	1869	1785	1795
Carbon monoxide	82	29	46
Methane	5.7	1.1	2.0
PM <sub>2.5</sub>	18	4.5	3.4

- Wet piles > dry piles
- Wet piles take longer to burn
- PM<sub>2.5</sub> continue to be produced up to 4 days after ignition



# Hand piles

- ~1-5 tons of wood
- Release 1-9 tons of CO<sub>2</sub>
- Generally, few soil impacts







# Machine piles



- Vary in size and density
- ~10-60 tons of wood
- Burning often exceeds EPA guidelines for
  - PM<sub>2.5</sub>
  - CO<sub>2</sub>
- Affects a large air-shed



# Leaving piles unburned

- Reduce soil temperature
- Pulse of nutrients in one place
- ↓ Temperature + ↑ nutrients = change in microbial processes
- Home for small mammals
- Little vegetation







# Prescribed pile burning

- Mitigating wildfire risk
- Increased biomass from forest health restoration treatments
- Slash disposal
- Environmental burden – reduced air quality



# Soil impacts from pile burning



- Heat transfers directly to soil
- Heat penetrates up to 1.3 m (4')
- Generate temperatures that kill most soil biota
- Elevated temperatures can persist for 18 months at depth

Soil temperature	Ecological impact
<b>Degrees C (F)</b>	
50 (122)	Some microbial death
60 (140)	Lethal to seeds, roots, plant tissue
120-160 (248-320)	Lethal to all living organisms
500 (932)	Irreversible soil physical, chemical, biological, and hydrological changes
>1000 (1836)	Maximum reported soil temperature at 10 cm (4") depth

# Additional soil impacts from pile burning



- Burn scars can last for >5 decades
- Loss of nutrients
- Loss of productivity
- Increase in invasive species



# Other slash pile impacts

- Diminish understory richness
- Kills plants with shallow rhizomes
- Destroys seed bank
  - Usually non-native (invasive) species are viable
- Lodgepole pine benefits from high fire severity
  - Serotinous cones
  - Less competition
- Other tree species
  - High severity is detrimental
  - Low severity is beneficial





# Burn Scar Rehabilitation

**Stabilize** soils through:

- **Residue additions**
  - often no better than doing nothing
- **Mulching**
  - suppresses native plant cover & available N
- **Mastication**
  - alter seed bank and germination

Rhoades et al. 2017. Scientifica 2017 p. 1-10





# Slash pile alternatives

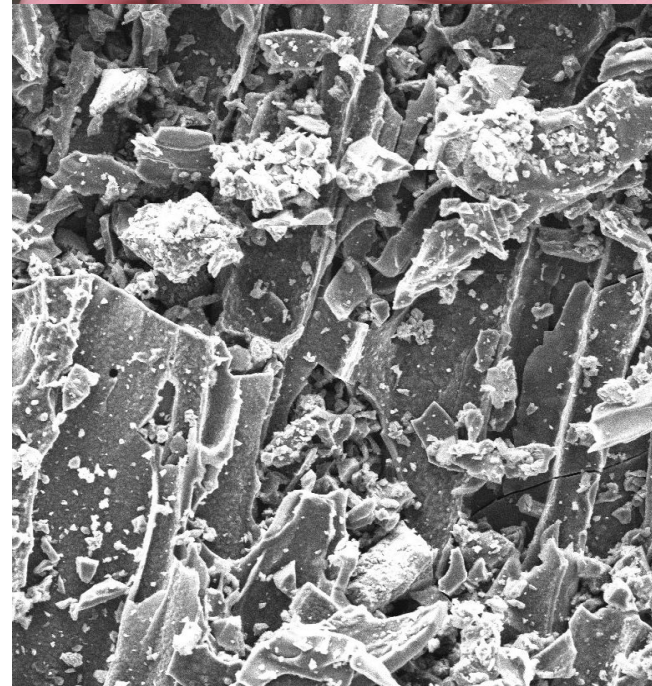




# Making a change with biochar

## How to:

- Make it
- Use it
- Benefits



HV	WD	spot	mag	田	30 μm
00 kV	11.0 mm	3.0	1 583 x		KH2 30816.40ft



# Make biochar on site: slash piles



- Forest biochar can be made on-site and used as a soil amendment
- Heat is dissipated away from the soil
- Char increased soil cover and water holding capacity
- Partnered with National Forests



# Make biochar on-site: Kilns

- Home-made kilns (retired FS employee)
- Box Kilns: Developed by Darren McAvoy (Utah State University)
- Ring of Fire Kilns: Developed by Kelpie Wilson (Wilson Biochar)





# Make biochar on-site: 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 Burner, Inc., U.S. Biochar Initiative, and U.S. Forest Service
  
- Check out this video at:  
<https://www.youtube.com/watch?v=lqiQPYhbmXk>





## Making biochar on-site: Mobile pyrolyzers (Carbonator made by Tigercat)





# Benefits of biochar

- *No slash pile burning impacts!*
- Used for:
  - Log landing/skid trail restoration
  - Increase soil water holding capacity & available water
  - Increase nutrient retention
  - Sequester C/mitigate climate change
  - Rehab abandoned mine lands
  - Increase rural community economies
  - Keep understory green longer
  - Reduce fuels
  - Employ conservation crews







# How much biochar to add to forest sites?

- Our best results have occurred at 10 tons/acre
- Other rates (1-10 tons/acre) are possible
- Any rate will sequester C



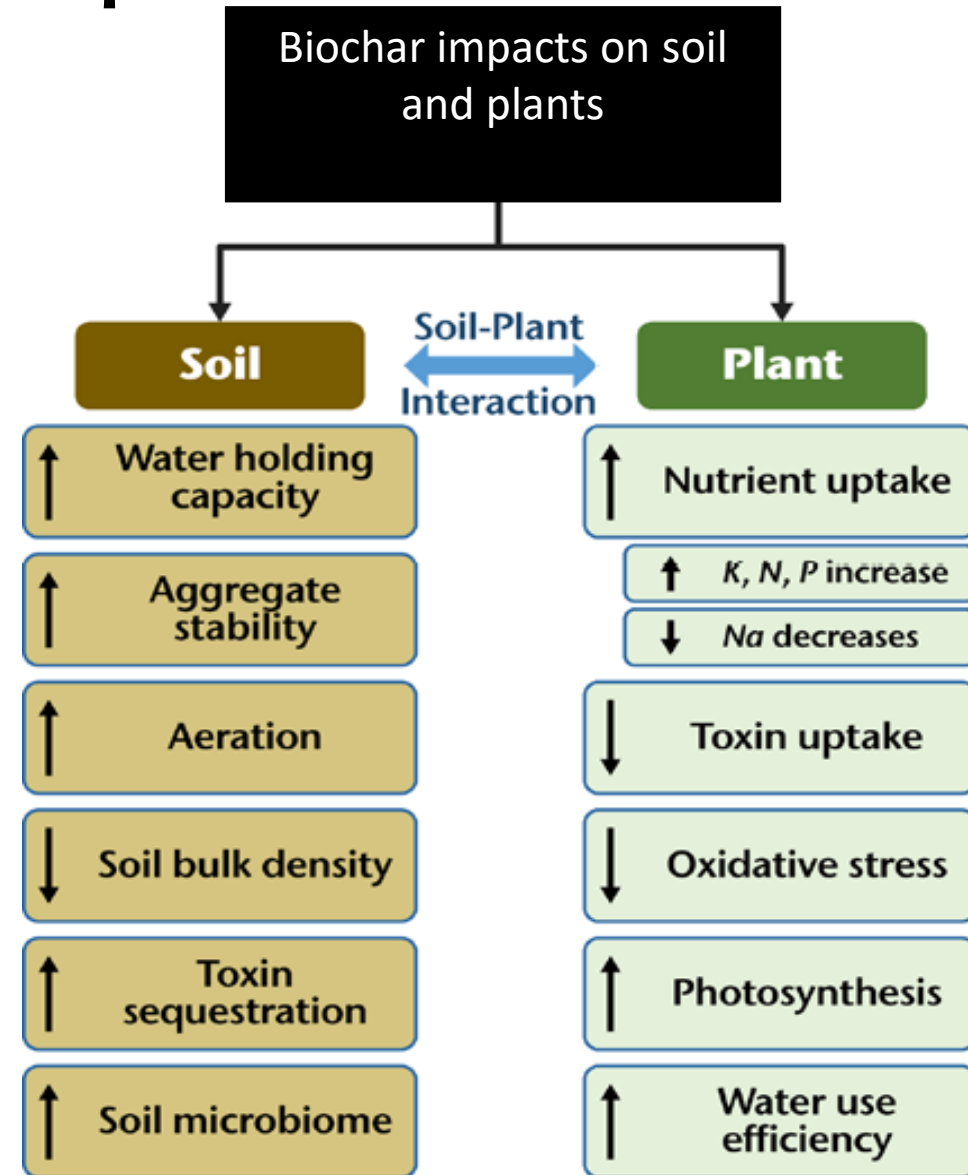
# It's all different

- Soil are different
- Biochars are different
- Different results from different soils
- There are some commonalities!
- Forest biomass for wildland soils





# Links between biochar and plants







# Biochar and soil water: building a soil sponge and avoiding a dust bowl

Biochar increases plant 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 soil respiration
- Increase or decrease native OM decomposition
- Change in microbial biomass
- Change in enzyme production







# 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 





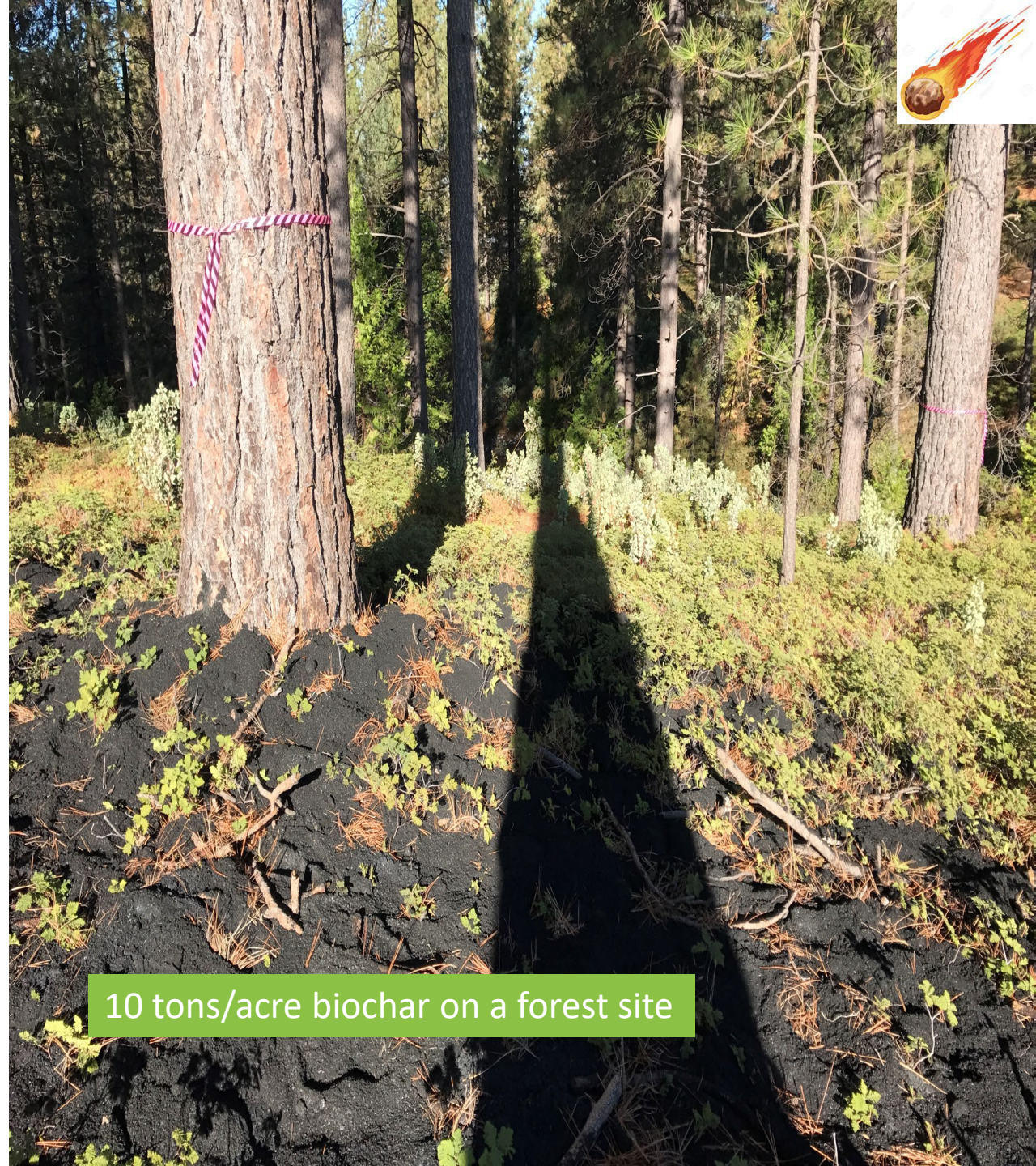


# Why is biochar important?

- Wildfire risk reduction
- Rapid increase in soil C
- Climate mitigation
- Ecosystem services
- Rural economies

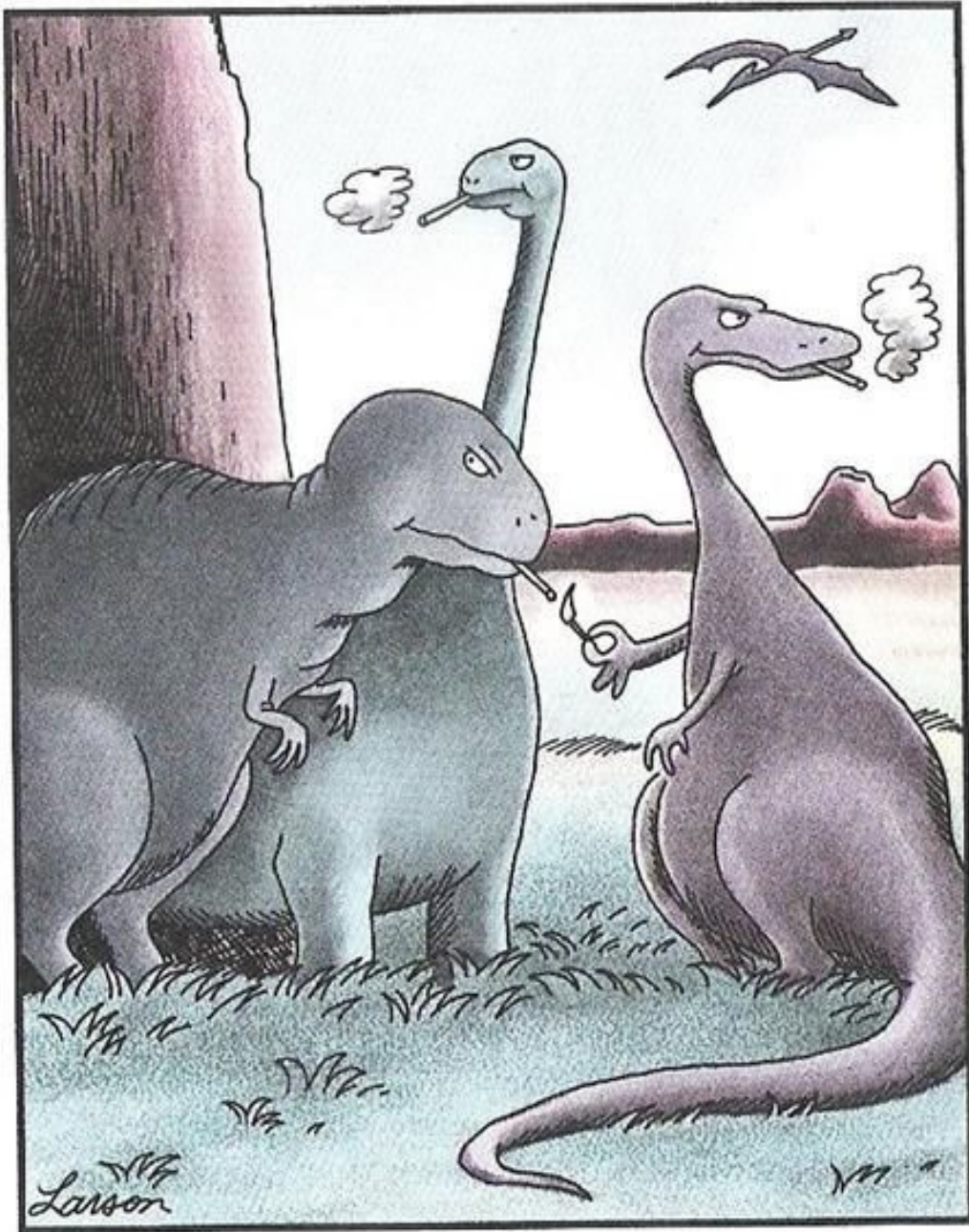
*Biochar is:*

*Safe, shovel-ready, scalable*



10 tons/acre biochar on a forest site





The real reason dinosaurs became extinct



# Thank you for your time

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