

# BIOCHAR DEMONSTRATION KILN

COFE-FETEC 2023

Chris Jones, Extension Agent



THE UNIVERSITY OF ARIZONA

Cooperative Extension



# TODAY'S SLIDES

- Introduction: Cooperative Extension
- What is biochar?
- How is it made?
- Demonstration Kiln
- Use as a soil amendment and for carbon sequestration
- Discussion



Pine Brush Pit, AZ  
Image credit: Chris Jones



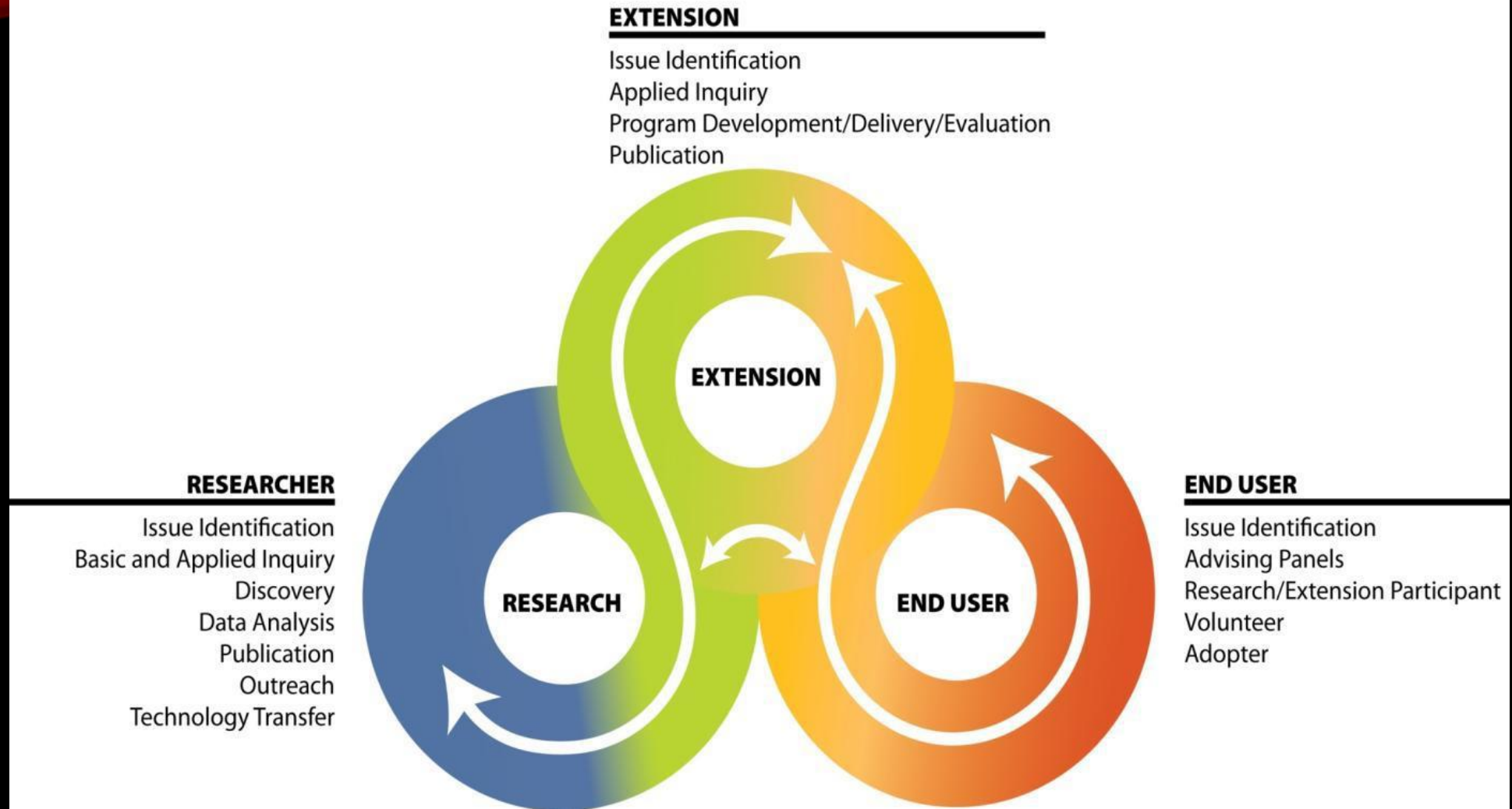
# WHAT IS COOPERATIVE EXTENSION?

United States Land Grant Universities – Many Program Areas, including Forestry

- Workshops
- Field days
- Train-the-trainer
- Grants
- Bulletins
- Journal articles
- Working groups
- Surveys



# THE RESEARCH—EXTENSION—USER CONTINUUM



Johnson, J.E. 2010. Extension in forestry: Lessons from a century of experience. *Forestry Ideas* 16(1): 5-10.



# Darren McAvoy

- Utah State University – Logan
- Extension Wood Products Specialist



Russel Gulch Landfill, AZ  
Image credit: Chris Jones



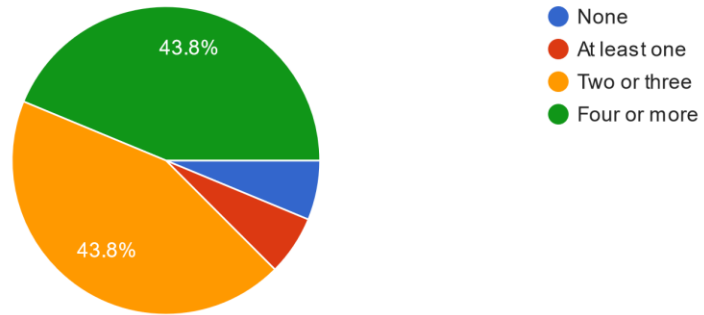
# BIOCHAR KILN EXTENSION PROGRAM

- Program lead: Chris Jones
- March 2023 to Present
- Live Demonstrations to date: 9
- Classes, webinars and presentations: 7
- Total Participants: ~370



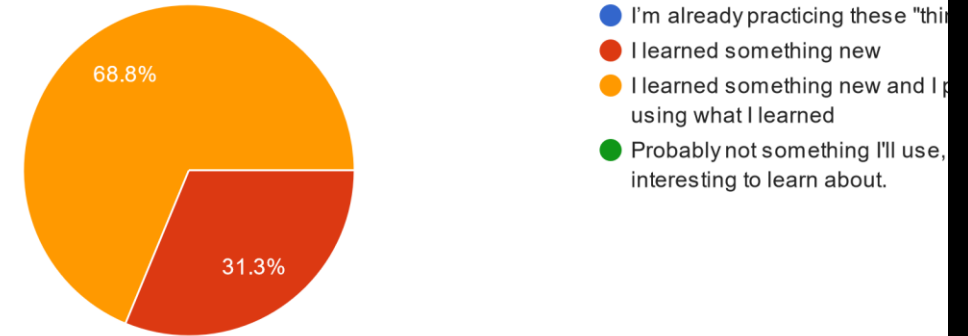
As a result of participating in today's event, how many useful techniques/practices/"things" did you learn that would benefit you that you weren't aware of previously:

16 responses



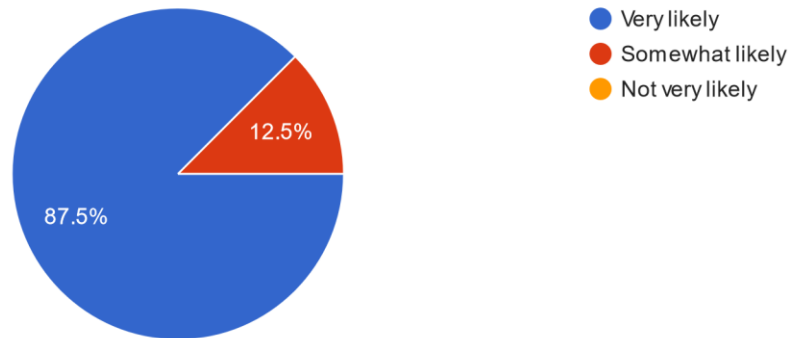
Please indicate the usefulness of this event:

16 responses



How likely are you to share what you learned from this event with others?

16 responses



# EVALUATION



# WHAT IS BIOCHAR?

- Basically, it's charcoal.
- Not ash.

Slide courtesy of Darren McAvoy

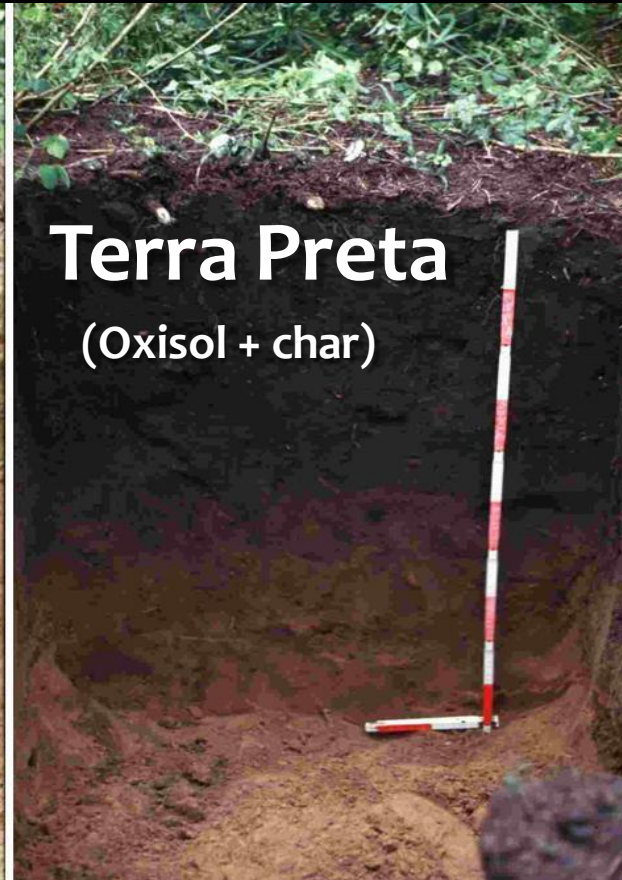




# TERRA PRETA

(“AMAZONIAN DARK EARTH”)

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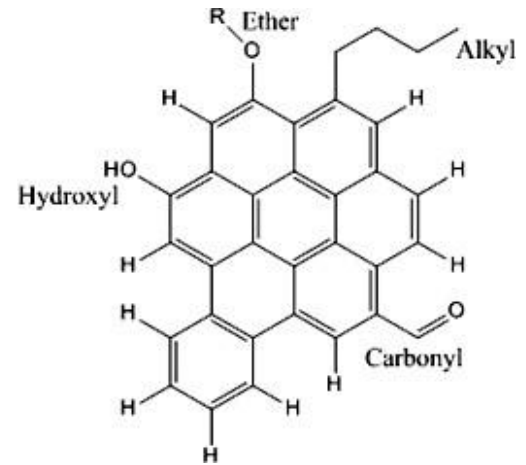


biomass

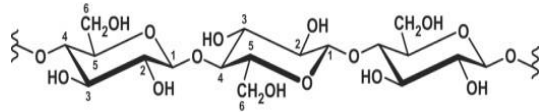
Pyrolysis  
~300-800°C  
No/Low O<sub>2</sub>



biochar



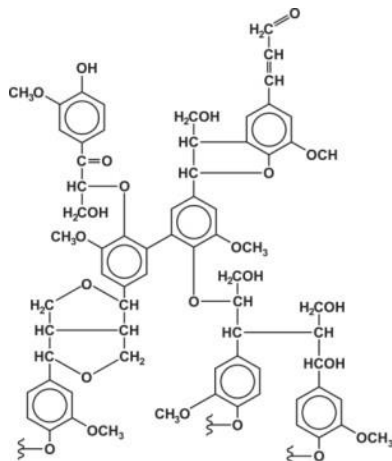
cellulose



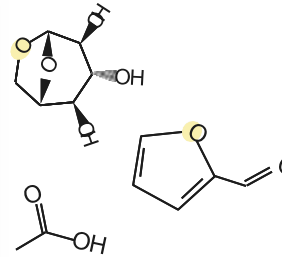
hemicellulose



Lignin  
(possible structure)

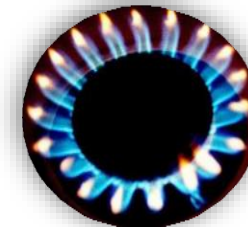


Bio-oil



Syngas

H<sub>2</sub>, CO,  
CH<sub>4</sub>, CO<sub>2</sub>

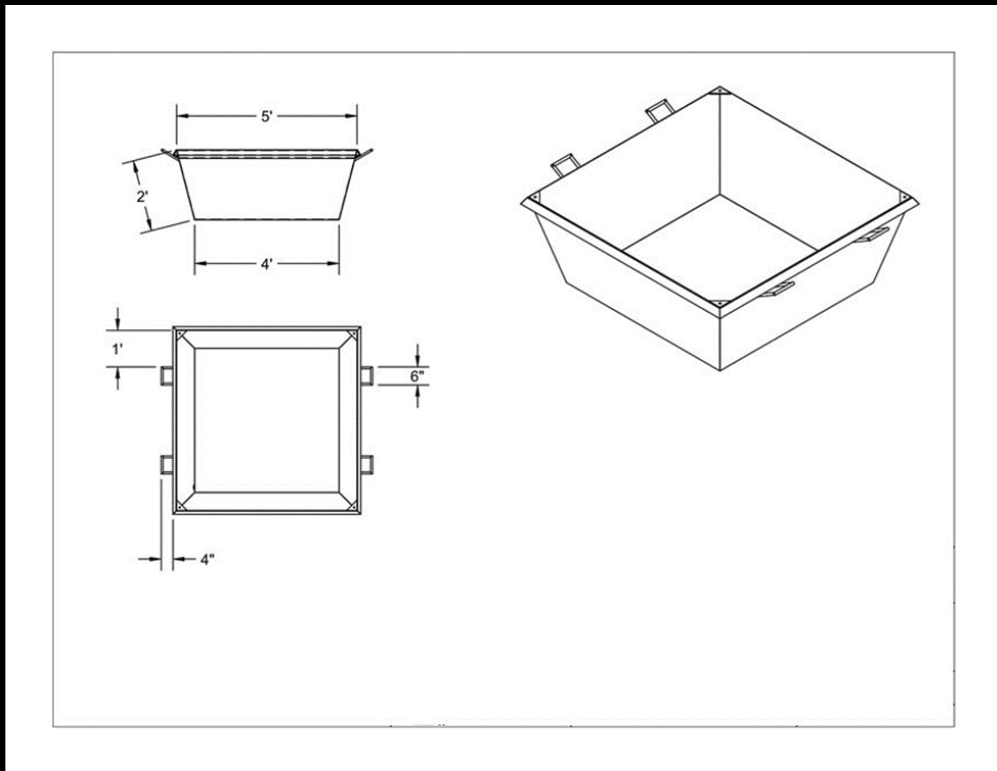




# Example pyrolyzers at different scales



# CUSTOM DEMONSTRATION KILN



Oregon-style kiln; 14-gauge steel

DATE: January 11, 2022

**RAM Specialists**

Quote # 22-501R

**LLC.**

ROC 147646  
Fabrication & Construction  
1165 W Live Oak St  
Miami, AZ 85539  
(928) 473-3232  
Fax (928) 473-3983

Quote

Attn: Christopher Jones  
Cooperative Extension  
Gila County

Email: ckjones@arizona.edu  
Phone: 928-402-8586

Description of work: Fabrication of 4' x 4' x 2' bio-char bins quantity 2.

#### Scope of Work

1. Acquire any needed equipment.
2. Design and develop cut sheet and parts schedule based on preliminary concept provided for bio-char bins.
3. Acquire all needed materials (mild steel used for all parts).
4. Cut all items per RAM developed part schedule for fabrication of 2(two) 4' x 4' x 2' deep bins.
5. Assemble all components and weld per RAM developed plans.
6. Coordinate delivery or pickup of completed units.

2 units @ \$825 Ea. \$1650.00

#### Note:

RAM estimates this work will require approximately 1-2 weeks for material acquisition and scheduling and 1 working days to complete.  
This estimate is subject to availability of manpower and equipment on date and time required.

Choose an item.	Choose an item.	
<b>Total</b>		<b>\$1650.00</b>

#### This Estimate includes the following:

Taxes for materials used, materials, Labor, equipment and tools.

#### This Estimate does not include the following:

Any items beyond above scope of work (to be billed at cost plus 25%).  
Any overtime work rate

Terms: \$500 down, balance due upon completion.

We appreciate the opportunity to offer our services on this job and look forward to working with you throughout the year.

Respectfully submitted,

*Lucas Karvegaard*

Authorization to proceed

Owner/Representative signature \_\_\_\_\_ Date \_\_\_\_\_





# HOW DO YOU MAKE BIOCHAR? Flame-capped Kiln

Slide courtesy of Darren McAvoy



# BEFORE YOU BURN

- Permission to burn.
- Participation from the local fire department, ideally.
- A sufficient clearing to safely conduct a fire, 30' plus radius ideally.
- At least 1.5 cubic yards of woody forest debris, 1" to 4" branches. Dry is best for demonstration.
- Driptorch or means to light fire.
- A light water tender or source of water to douse the fire.
- Tools: light chainsaw, shovel, loppers, axe, etc.
- Fire extinguisher.

Pine Brush Pit, AZ  
Image credit: Chris Jones







THE PROCESS:

LOAD KILN

BUILD RICK OF LOGS  
(CRISSCROSSED)

DRY FEEDSTOCK BEST

UP TO 6 INCHES  
DIAMETER





SMALL FUELS ON  
TOP

TOP-LIGHT

PROPANE  
TORCH, DRIP  
TORCH, LIGHTER





LET IT COOK

Slide courtesy of Darren McAvoy



READY TO QUENCH  
ASH VS CHAR





# QUENCHING



Slide courtesy of Darren McAvoy



# FINISHED PRODUCT





# TIPPING





# CRUDE BIOCHAR





# SCALABLE

- 12' Big Box
- Front loader used to handle wood and logs
- Can burn ~20 tons of fuel, and make ~7 tons of biochar/day





# SCALABLE

- No kiln, no problem



Image courtesy of Quivira Coalition

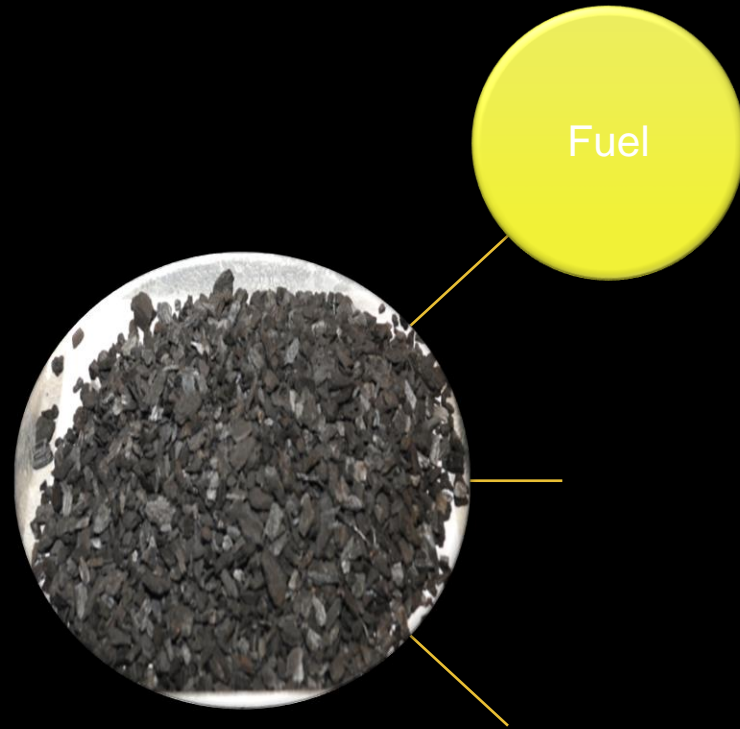


# RESEARCH QUESTIONS

- ❖ Smoke and air quality impacts?
- ❖ Wider window for burning?
- ❖ Creating markets and demand
  - ❖ Gardening and Horticulture
  - ❖ Agriculture: Cotton, vegetables
  - ❖ Dairy and stockyard manure
  - ❖ Viticulture



# USES FOR CHAR







# HIGH QUALITY BIOCHAR IS:

Black in color

Consistent

Not greasy

Not smelly

Friable

Made from clean feedstock (free of heavy metals)

Tailored to the application



# BIOCHAR IMPACTS IN SOILS



Nutrient Use Efficiency

Microbial Activity

Soil Organic Matter

Plant-Available Water

Long-Term Crop Yields



Fertilizer/Irrigation Needs

Greenhouse Gas Emissions

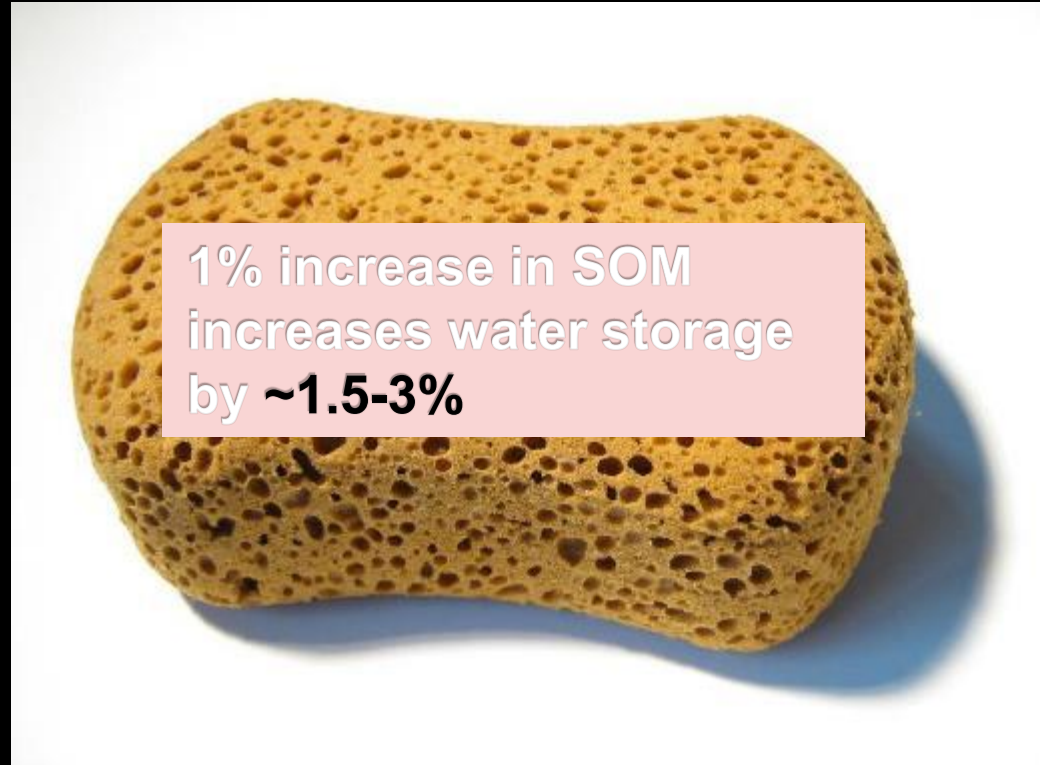
Nutrient Leaching

Soil Bulk Density



# HOW TO BUILD SOIL ORGANIC MATTER

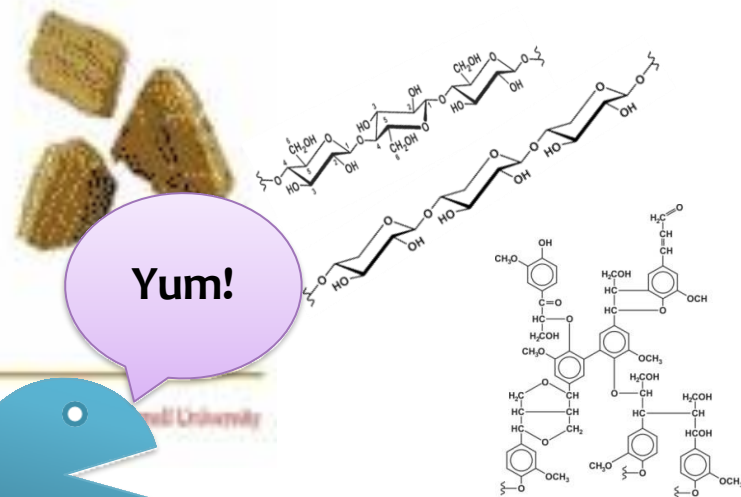
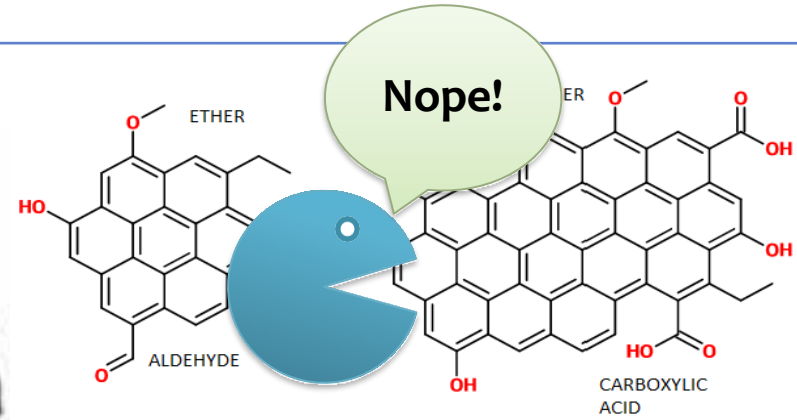
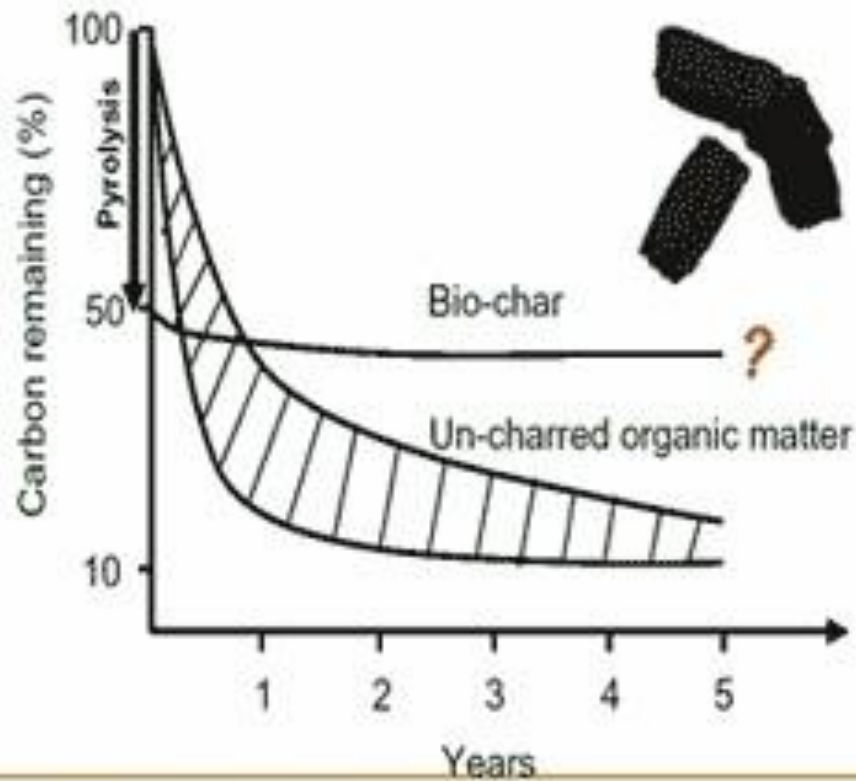
- crop residues
- cover crops
- wood chips
- biosolids
- biochar or charcoal



Libhova et al. 2018. Reevaluating the effects of soil organic matter and other properties on available water-holding capacity using the National Cooperative Soil Survey Database. JSWC. doi:10.2489/jswc.73.4.411



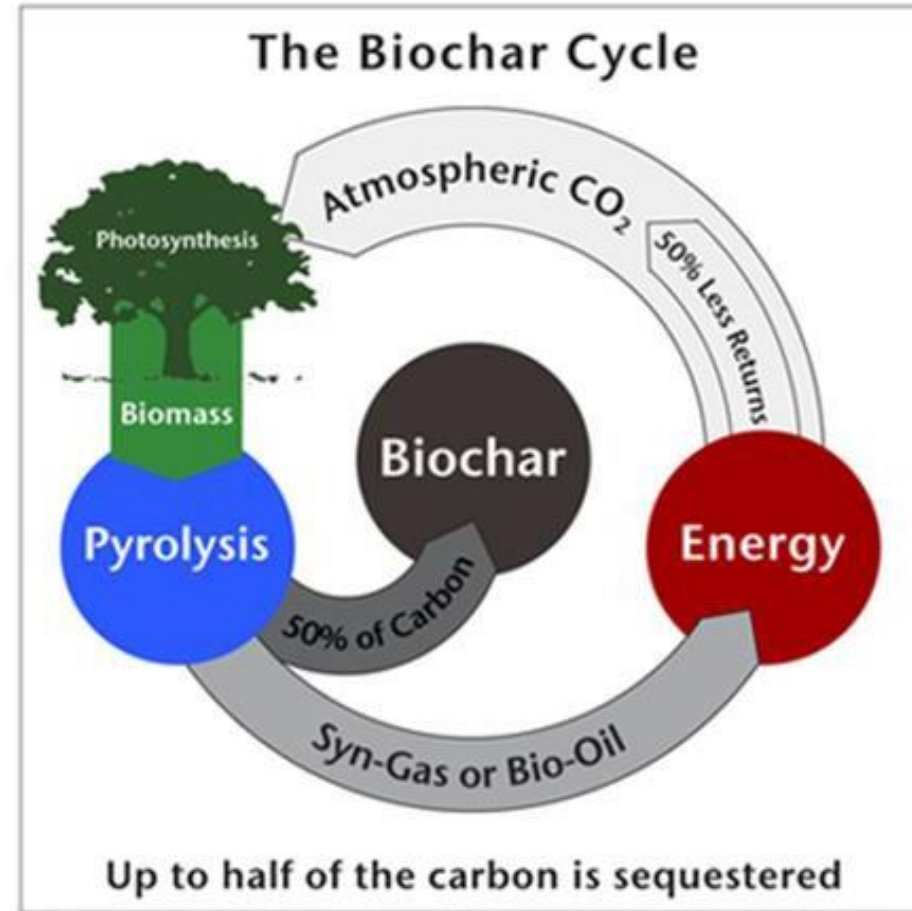
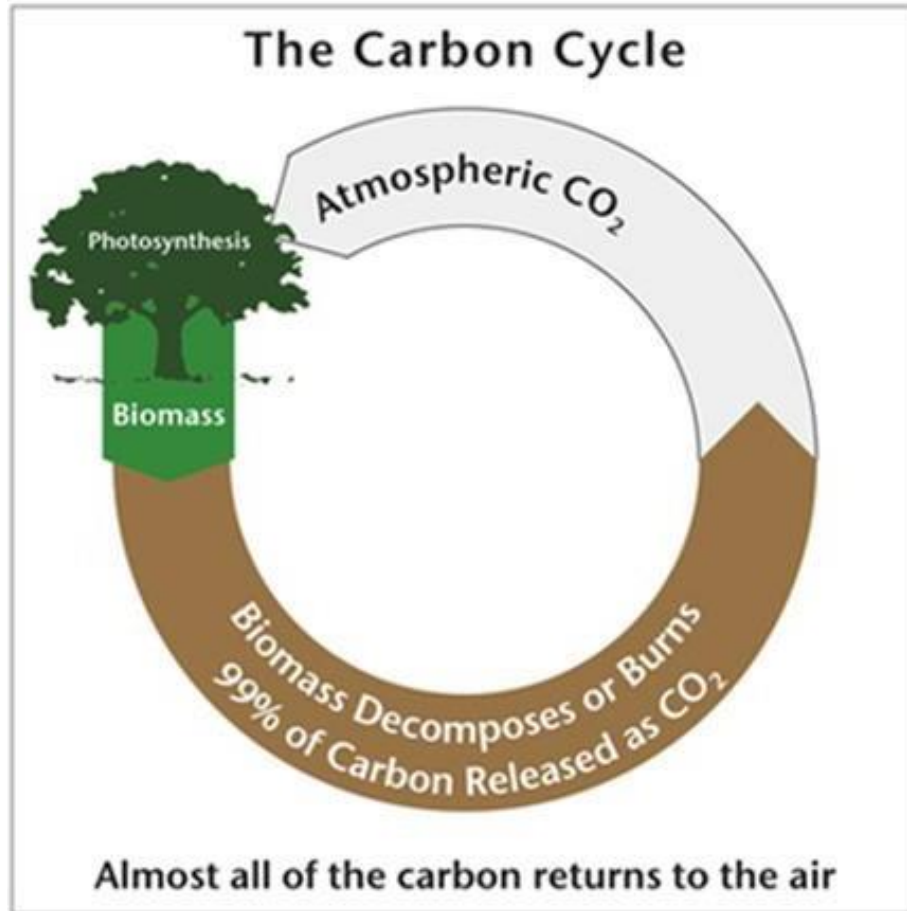
# Biochars Persist in Soil



Lehmann et al., 2006, *Mitigation and Adaptation Strategies for Global Change* 11, 403-427



# Carbon-Negative Energy





# Soil & biochar components and properties interact

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## Biochar

- Surface area
- Porosity
- Sorptive capacity
- Ash content
- Carbon stability

## Soil

- Particle size distribution
- Porosity
- Organic matter
- Mineralogy
- Nutrient content

➔ Lots of variability!!

But, we can still gather clues & make inferences

# Biochars with which Properties Alleviate which Soil Problems?

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## **Key Biochar Properties**

- Porosity
- Surface area
- Sorption capacity
- Ash or metal content
- Carbon stability

## **Soil Problems**

- Poor structure, high density
- Too Acidic
- Too dry (or ↑ irrigation cost)
- Too salty
- Nutrient deficiency/loss
- Contaminated
- Greenhouse gas emissions



# Improve Structurally Degraded Soil

Commercial wood biochar\*  
improved construction-impacted  
soil with poor structure

\*Sold as charcoal briquettes w/out chemical treatments



*The most degraded soils stand to see the greatest improvement with **any** biochar*

# How should I apply biochar?

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## Till in

- Pro: Minimal char dust
- Con: disturbs soil

## Co-compost

- Pro: adds nutrients
- Con: time consuming

## Inject or seed coat

- Pro: close to plant
  - → Efficient
- Con: logistically challenging

## Surface apply\*

- Pro: easy, no disturbance
- Con: dust pollution
  - Need to cover!!

\*not recommended in dry environments.  
Cover thoroughly w/ mulch or compost.



# Beware of dust!

Pre-wet biochar to reduce dust and increase water holding capacity



Pre-washing biochar also reduces risk of plant salt stress

# BIOCHAR MARKETS

## Market Opportunities: Biochars are Used in Many Ways



### Forestry

Forest Fuels and Reforestation, Range Improvement  
Growing media for nursery and out planting  
Revegetation, Reclamation of mines and degraded land



### Water quality

filtration and erosion control, wetlands



### Agriculture, Retail Garden, Landscape, Turf, Horticulture

Biochar, Compost  
Composted biochar (5%-20% biochar)  
Biochar-Based Compound Fertilizers (15%-25% biochar)  
Biotic Soil Amendments (biochar + organics+ minerals and biologicals)  
Granulated and liquid products for seeding  
Micro/nano carbons



### Environment, Remediation, Erosion Control

Mine reclamation, Oilfield remediation, Filtration  
Stormwater filtration, water treatment - functionalized chars



### Non-soil carbon products

Animal feed, odor, building products, electronics





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