



PHRAGMITES MANAGEMENT

UNDERSTANDING BIOCHAR AND USE OPPORTUNITIES



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What is Biochar(s)?



Produced from the carbonization of biomass using little or no oxygen

Solid carbon material
Produced from organic matter
Resistant to decomposition
Unlike charcoal, not used for energy



An Ancient Technology, Rediscovered – Terra Preta “Dark Earth”



Carbon-Negative Process CO₂:C ratio = 2:1-3.1

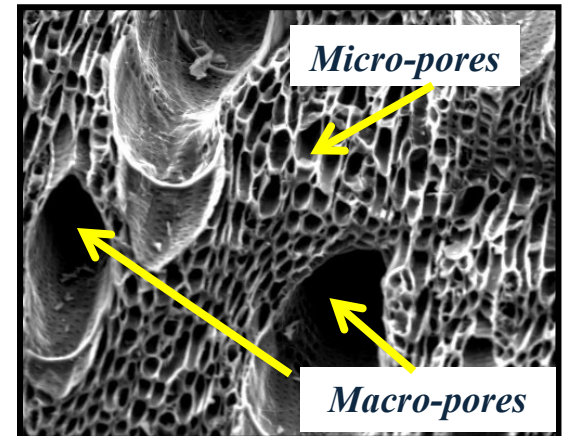


Biochar's Are Not Created Equal

High Carbon & High Mineral Carbon
Not all biomass should become biochar



Microbial Real Estate – 1 cy≈~16,000 acres of surface area.



Ancient Technology, Re-Discovered

- Terra Preta ("Dark Earth")
- Dates back more than 7,000 years in the Amazon (Valev et al., 2022)
- 1st documented in Amazon by James Orton (1870)
- 1st researcher of Terra Preta soils by Wim Sombroek (1966)
- International Awareness 2001-2002 led by Johannes Lehmann, Cornell
- Still actively being created in small clusters throughout Southeast Asia and Africa

BLACK GOLD OF THE AMAZON

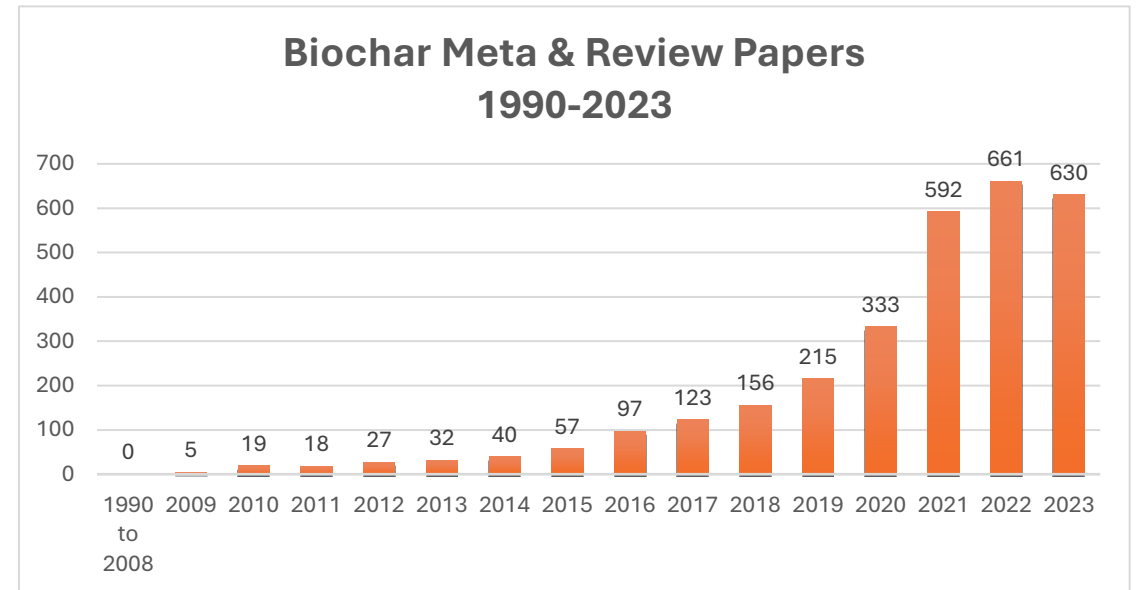
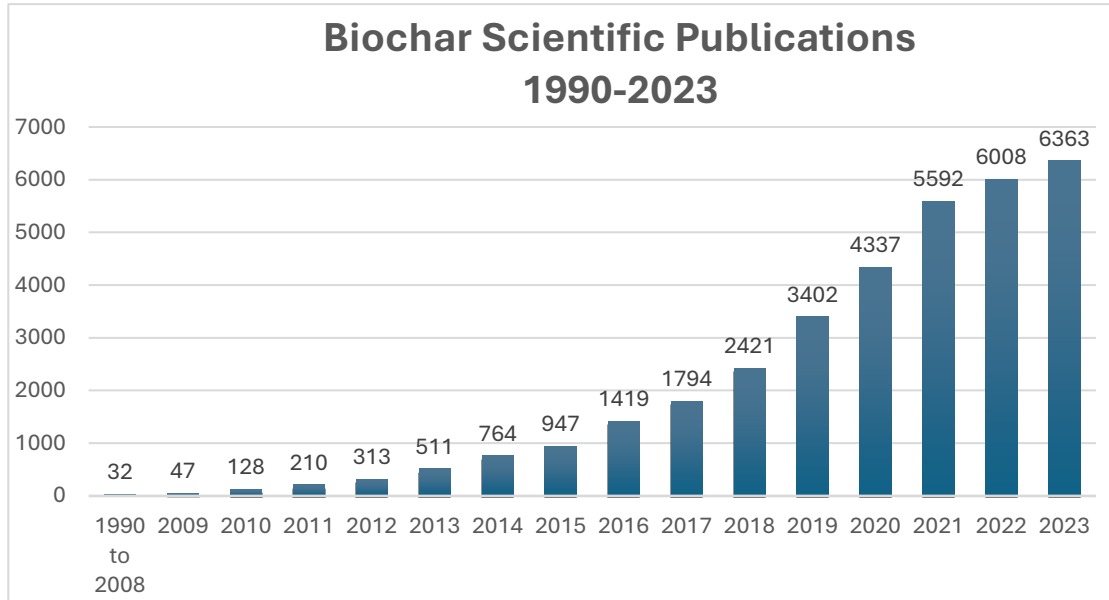
Fertile, charred soil created by pre-Columbian peoples sustained surprisingly large settlements in the rain forest. Secrets of that ancient "dark earth" could help solve the Amazon's ecological problems today.



Anthropogenic Dark Earth (terra preta), Manaus, Brazil (Photograph by Manuel Arroyo-Kalin).

BIOCHAR'S RAPID SCIENTIFIC GROWTH

No Longer a Boutique Industry...It's Booming!



BIOCHAR RESEARCH METRICS

- 1ST recorded 'biochar' publication – 1998
- Dec. 2023 - 34,288 publications
- 3,005 Biochar meta & review articles
- >80% published in last 5 years
- >50% of publications (>13K) in past 3 years
- >90% of the documents (>21,000) being research articles
- Primary topics – pollutant removal, soil improvements, waste management, energy production and climate mitigation
- Future – AI could be critical in producing Fit-to-Purpose Biochar

Thermochemical Biomass Conversion Technologies



"Ring of Fire"
Wilsonbiochar.com



CharBoss
airburners.com



Carbonator 6050
tigercat.com



Pyreg 500
Pyreg.de



ARTIchar
artichar.com



Biomacon
Biomacon.com



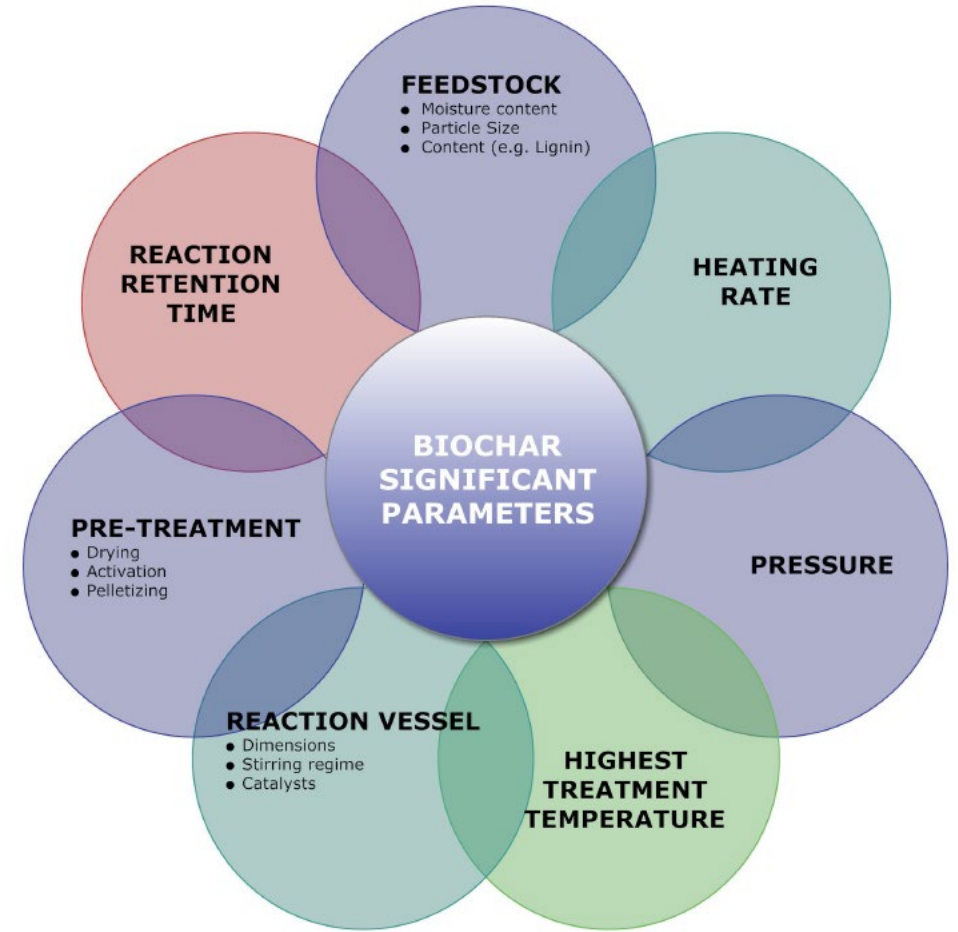
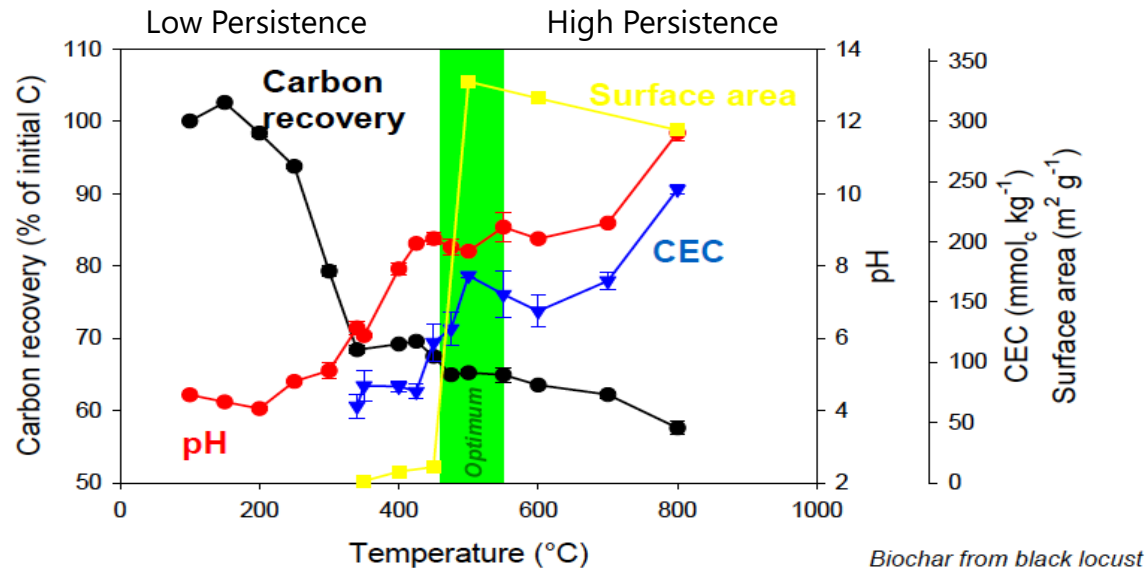
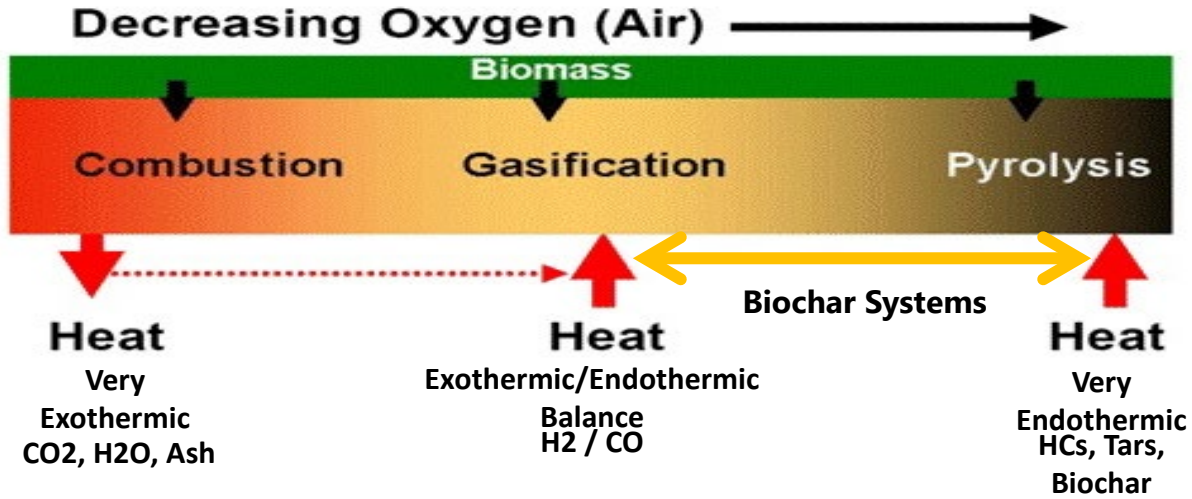
Earthcare, LLC
Earthcarellc.com



Oregon Biochar Solutions
Chardirect.com

Thermochemical Biomass Conversion Process

THERE IS NO 'BURNING' OR 'INCINERATION' IN THE PROCESS



1. Graphic C. Hegberg as modified
2. Lehmann, 2007
3. Graphic C. Hegberg as modified

Biochar's Different Forms & Uses

BIOCHAR'S ARE NOT CREATED EQUAL

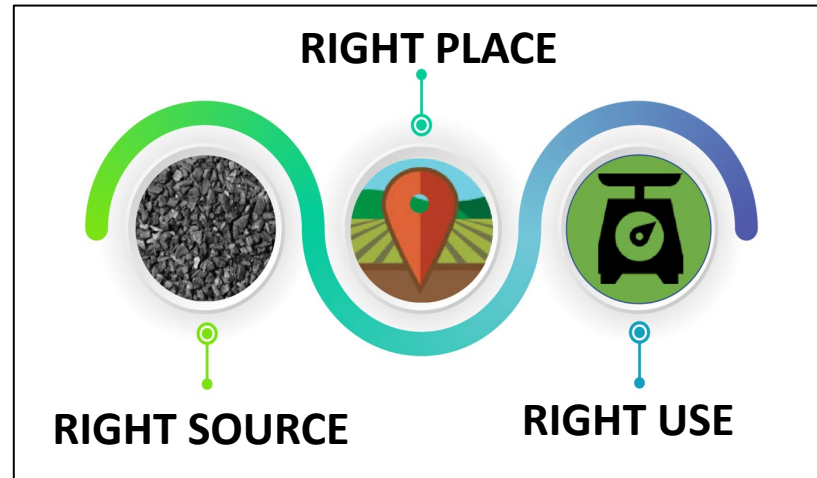
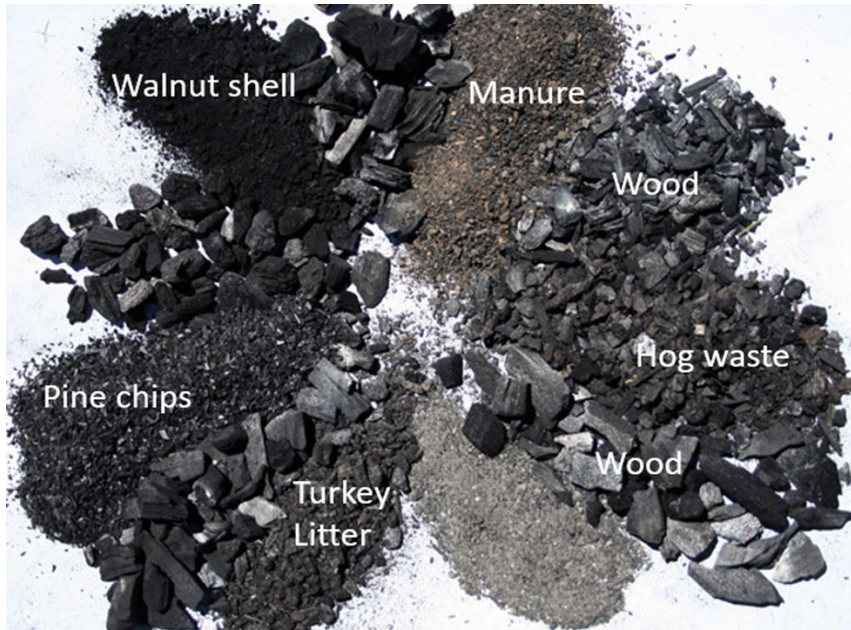


Image source: Adapted from original graphics provided by K.M. Trippe



Be sure your Biochar(s) are certified or supplier proof of lab analysis that meets IBI Biochar Standards Version 2.1 ([Link](#))



Raw Biochar



Pelletized Biochar



Granular Biochar

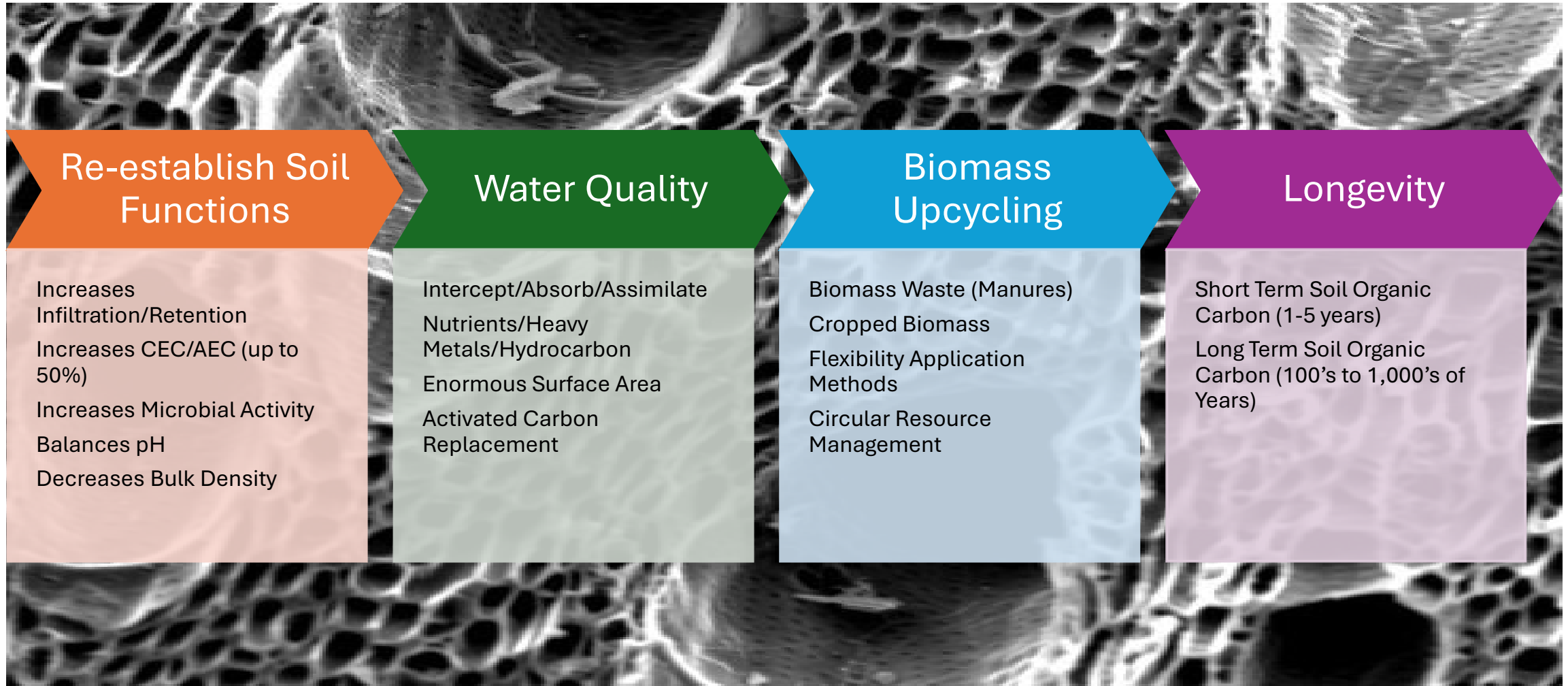


Blended Biochar



Liquid Biochar

Summary of Biochar Benefits



Biochar in Urban Landscapes (Green Infrastructure)



DelDOT Greenway Soil Amendment



DelDOT Bioretention Facility Retrofit



Turf Management & Bioretention Facility



Biochar in Ecological Restoration

Forest Buffers, Grass Buffers & Tree Plantings



Biochar in Ecological Restoration

Wetland Overseeding Restoration



Hydro-seeding/mulching with Biochar



U.S. Patent No. 8,430,589 Other U.S. Patents pending. **BIOTIC SOIL AMENDMENT**

Biochar in Agriculture & Compost

NRCS Code 336 – Soil Carbon (Biochar) Amendment



United States Department of Agriculture

336-CPS-1

Natural Resources Conservation Service
CONSERVATION PRACTICE STANDARD
SOIL CARBON AMENDMENT
CODE 336
(ac)

DEFINITION

Application of carbon-based amendments derived from plant materials or treated animal byproducts.

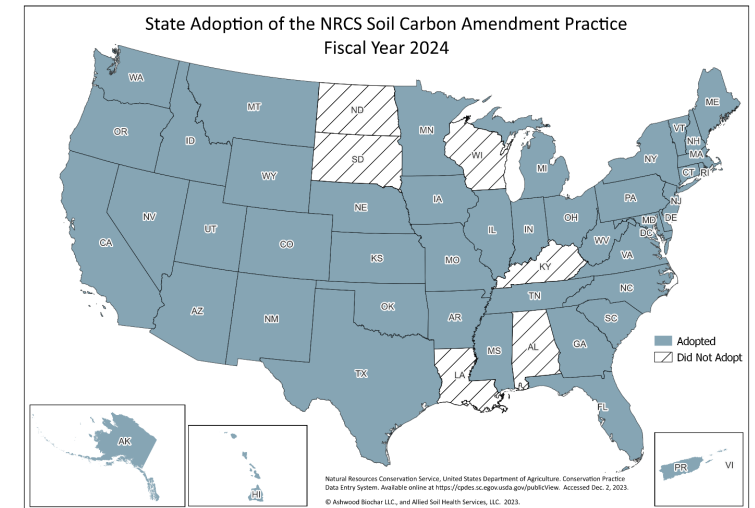


National Water Quality Initiative Practices				
Core Practice	Code	Avoiding	Controlling	Trapping
Composting Facility	317			
Conservation Cover	327			
Cover Crop	340			
Critical Area Planting	342			
Denitrifying Bioreactor	605			
Drainage Water Management	554			
Field Border	386			
Filter Strip	393			
Grassed Waterway	412			
Nutrient Management	590			
Riparian Forest Buffer	391			
Riparian Herbaceous Cover	390			
Tree/Shrub Establishment	612			
Waste Storage Facility	313			
Waste Treatment Lagoon	359			

NRCS Code 336 Biochar Scenarios					
State	100% Biochar/ 0% Compost	80% Biochar/ 20% Compost	60% Biochar/ 40% Compost	40% Biochar/ 60% Compost	20% Biochar/ 80% Compost
DE	X	X	X	X	X
MD	X	X	X	X	X
NY	X	X	X	X	X
PA	X	X	X	X	X
VA	X	X	X	X	X
WV	X	X	X	X	X

Typical Payment Rates per Acre*					
Based on IA Scenarios. Individual state rates may differ ± 5% based on state COLA. Assumes 4 cubic yards per acre. *New England payment rates are per cubic yard, not per acre, and differ from what is shown below.					
Biochar Component Cost		\$201 per cubic yard			
Practice Reimbursement	Scenario				
	100% Biochar/ 0% Compost	80% Biochar/ 20% Compost	60% Biochar/ 40% Compost	40% Biochar/ 60% Compost	20% Biochar/ 80% Compost
100%	\$1,016	\$945	\$840	\$736	\$632
90%	\$914	\$851	\$756	\$662	\$569
75%	\$762	\$709	\$630	\$552	\$474

Information compiled by Dr. Brandon Smith, Allied Soil Health Services, LLC, 2024



Natural Resources Conservation Service, United States Department of Agriculture. Conservation Practice Data Entry System. Available online at <https://spdes.sc.nrc.usda.gov/public/view>. Accessed Dec. 2, 2023.
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Biochar in Agriculture & Compost

Enhanced Compost Opportunities with Biochar



CARBON CHICKEN
PROJECT LLC

Poultry Litter Compost + Biochar

Acts as a slow-release fertilizer and limits loss or reactive nitrogen to the environment compared to raw manure and synthetic fertilizers
Co-composting with biochar decreased losses of TN by 51% & NH₃ by 60% resulting in higher nitrogen retention (Eunice Agyarko-Mintah et al, 2016)

Biochar can enhance the composting process:

- Reduces Odor & Ammonia Loss
- Increases Nitrogen Retention
- Accelerates the Composting Process
- Greatly Enhances the Beneficial Biological Populations in Compost

Biochar in Agriculture & Compost

BMP Barnyard Runoff Control & Loafing Lot Management & Biofilters



Climate Smart Agriculture & Forestry

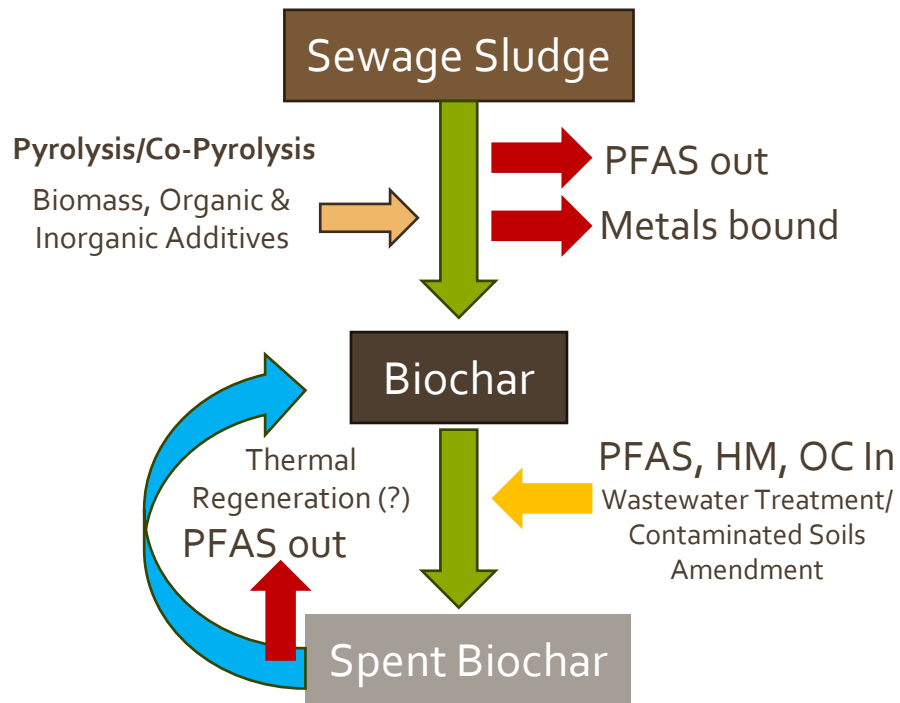
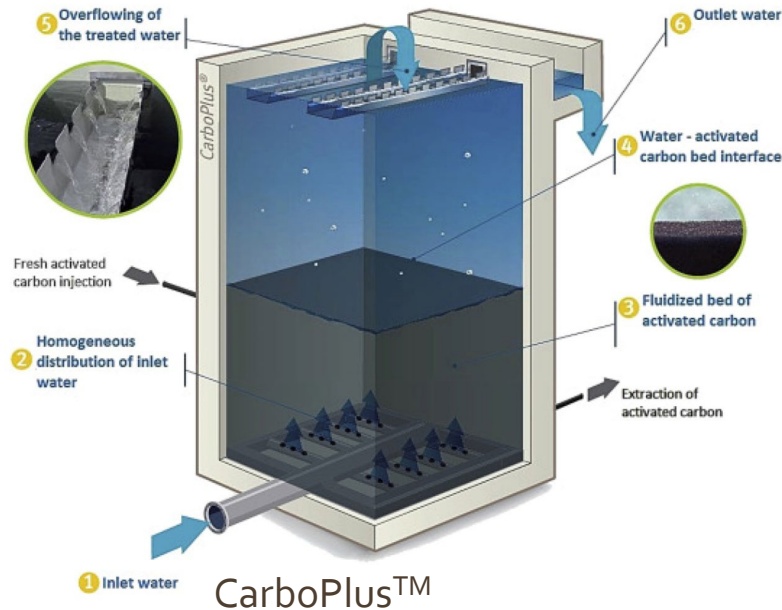
Agriculture Slurry Lagoon Covers



“Biochar’s have unique physical and chemical properties that make them promising covers in terms of reducing odor and gas emissions, and also nutrient sorption, which other covers don’t address.”

Brian Dougherty, Oregon State University

Biochar in Biosolids (PFAS/PFOS) Management



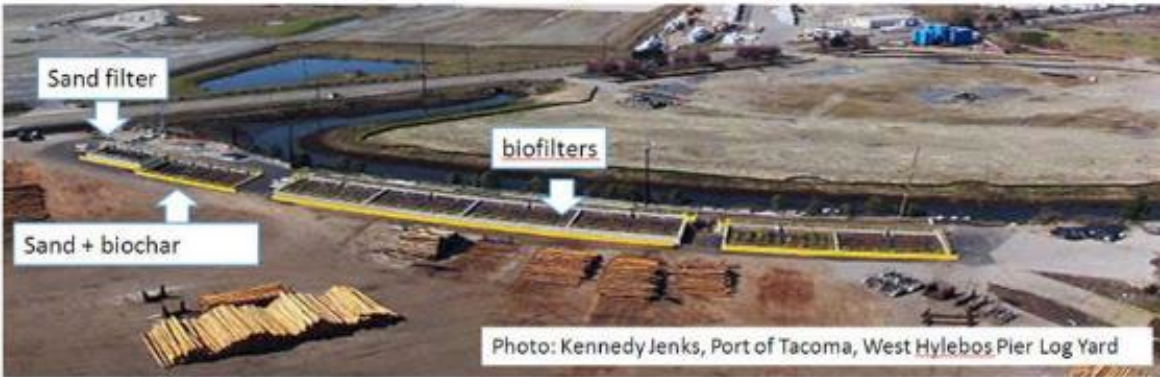
PFAS/PFOS REMOVAL POTENTIAL

- Gasification can destroy +95% of PFAS in sludge
- Less than 3% emitted in flue & can be reduced with biofilter
- Activated sewage sludge carbons can effectively sorb 91.5-98.9% PFOS depending on temperatures created
- Activated biosolids carbon pore sizes are the key to accommodating PFAS molecules

Biochar in Remediation (Industrial & Mines)

Hope Mountain Mine, Aspen CO

GAC+Sand versus Biochar+Sand



Port of Tacoma Log Yard
 pH, Zinc, Copper, Turbidity & TSS
 80-90% reduction in concentrations



313% Increase in plant cover over conventional alternatives
 3.5 times more moisture in soil over conventional alternatives

Heavy Metal Sorption



Dec, 2011. Method- Columb of packed biochar, saturated with IR treated water and sat for 24hrs, columb was drained. Loaded solution was filtered through char with a 4 to 8x repetition.

Metal	Aluminum, Al	Arsenic, As	Barium, Ba	Beryllium, Be	Cadmium, Cd	Cobalt, Co	Chromium, Cr	Copper, Cu
	91%	54%	66%	99%	98%	92%	98%	99%
Metal	Mulybdenum, Mo	Nickel, Ni	Lead, Pb	Selenium, Se	Tin, Sn	Vanadium, V	Zinc, Zn	Lithium, Li
	45%	91%	99%	54%	100%	75%	98%	39%

Presentation Discussion



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