



# ***US Biochar Initiative***

## ***Exploring Biochar***

### ***Colorado Specialty Crops***



CSU – Exploring Biochar - 2023



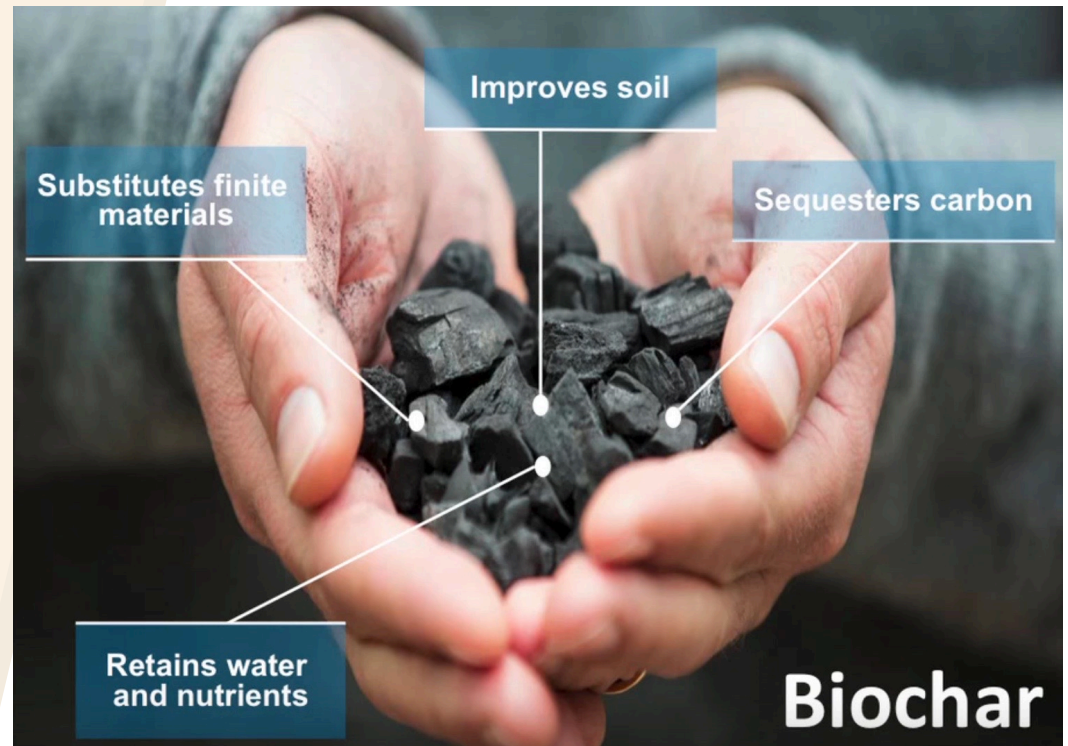


***John Webster***  
***Director of Communications***  
***US Biochar Initiative***  
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***linkedin.com/in/john801***

# A STORY OF REGENERATIVE BAKING

- **Ancient Soil Conditioner** — Used in agriculture for thousands of years, biochar is gaining traction as a safe and scalable soil health amendment.
- **Waste Materials Solution** — Biochar is fine-grained charcoal suitable for biological systems made by pyrolysis, the process of heating biomass with limited to no oxygen.

**Biochar: A solid material obtained from thermochemical conversion of biomass in an oxygen-limited environment. (IBI, 2012)**



# *IS BIOCHAR MAGIC?*



***NOPE***



# ***BUT IT IS SCIENCE***



***WITH OVER  
30,000 PEER REVIEWED  
TECHNICAL PAPERS  
AND ARTICLES***



***Biochar is beyond novelty.***



## ***US Biochar Initiative Mission***

Promoting biochar in North America for sustainable food security, improved soil fertility, environment, and climate resilience.

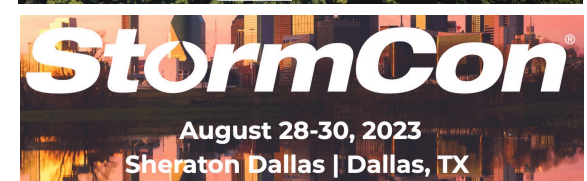
### ***Our solutions***

Fully engage the scientific, agriculture, and biomass communities to use safe, stable, sustainable biochar through collaboration to learn, educate, inform, demonstrate, and develop markets, policy incentives, and quality standards.

# USBI Projects

## Projects:

- Factsheets and Roadmap, UNL
- NRCS/USDA ARS, AFT CSP 336
- Chesapeake Bay Program – Science and Technical Committee (STAC) Workshop
- Center for Watershed Protection NFWF National Fish and Wildlife Foundation 2021-2024
- “Scaling Up Biochar Applications for Accelerated Stormwater Runoff Reduction and Resiliency in the Chesapeake Bay” Education and Outreach
- Restoration fuels, Oregon Dept Enviro Quality – Regional Biochar farm Demonstrations
- CharBoss Demos/Air Curtain Incinerator Permits USFS, Oregon DEQ
- Workshop: Biochar in the Woods January 2022
- International Carbon Standards discussion with Carbon Standards International and Regional Groups (European Biochar Initiative, Australia New Zealand Biochar Initiative, etc. )
- Biochar Urban Task Group - Sam Dunlap, Cincinnati, Minneapolis, Lincoln NE, others
- International Standards Organization Subcommittee on Biochar material standards



Want us to participate? [communications@biochar-us.org](mailto:communications@biochar-us.org)

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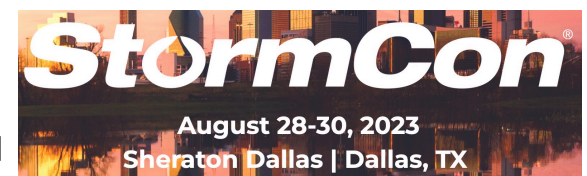
# USBI Conferences

## Conferences:

- International Biomass Conference and Expo 2023
- Society of American Foresters
- Forest Products Society
- Soil and Water Conservation Society
- Soil Science Society of America
- Great Plains Regional Biochar Conference
- Forest Biomass Utilization in the Pacific Northwest
- Regions agricultural, Organic and Horticultural Conferences
- Regional Planning and Advisory Councils
- USFS Monthly Biochar Webinar Series
- Water Environment Federation, WEFTC conference - biochar and PFOS/PFAS
- USBI at COP27
- VERGE23 (Thanks to IBI Partnership)
- ASLA2023
- Compost 2023

## Conferences: (Future)

- North American Carbon World
- Stormwater 2023



Want us to participate? [communications@biochar-us.org](mailto:communications@biochar-us.org)

# North America Industry Changes and Opportunities

Carbon Credits are a real impact providing access to capital for biochar producers. We are hearing from producers that were able to secure funding based on credit opportunities.

Growth in production and producers

Now reaching nearly 200 producers and brokers

New small producers, major industrial biochar project in planning 20,000+ tpd biochar  
Biochar Industry survey to be performed 2023

Significant interest by foreign entities looking to locate in the US as producers and equipment suppliers thanks to friendly US Policy and Incentives.

New financing entities dedicated exclusively to Biochar Project Finance



# USBI Biochar Fact Sheets

Education ▾

Find on the Learning Center: [biochar-us.org](http://biochar-us.org)

## BIOCHAR GUIDELINES FOR AGRICULTURE APPLICATIONS

Practical insights for applying biochar to annual and perennial crops



US Biochar Initiative

[biochar-us.org](http://biochar-us.org)

### BIOCHAR INCREASES PLANT SURVIVAL



Use less water.  
Increase yields.

### BIOCHAR IMPROVES MANURE MANAGEMENT



Good for  
the animals.  
Good for the  
environment.

# BIOCHAR IN SOIL HAS MANY WINS



Water holding capacity



Improves nutrient distribution



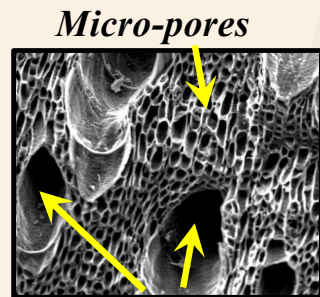
Increases soil organic matter and soil carbon



Reduces soil compaction



Luxury condo for microbes and fungi



Existing Soil



Existing Soil + 4% Biochar

# *Biochars are made in Different Forms and Qualities for Different Applications*



**Terra Preta – Biochar, Food Waste Compost in Clay**



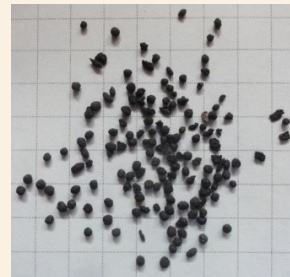
**Chip Char Filter Media**



**Loose Biochar 3-6mm**



**Biochar Pellets**



**Biochar Granules**



**Biochar in Hydromulch**



**Biotic Soil Amendment**

## ***BIOCHAR IS A SOLUTION***

Recent meta-analysis, a synthesis of 20 years of research, has found that biochars can remain in the soil for thousands of years. They increase phosphorus availability in soils by 4.6 times, decrease plant tissue concentrations of heavy metals by 17-39%, build soil organic carbon by 3.8%, and reduce greenhouse gas emissions by 12-50%.<sup>1</sup>

<https://pubmed.ncbi.nlm.nih.gov/33334517/>

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# Wood is Heated in Pyrolysis to Gas and Char Used in Structured Soils (Stockholm)



**Pilot plant**  
 AVC Trädgård in Högdalen  
 Renewable heat to 80 apartments  
 Biochar corresponding to CO2-emissions from 700 cars

**The projects full scale**  
 Renewable heat to 400 apartments  
 Biochar corresponding to CO2-emissions from 3500 cars




IBI Webinar June 2017

[www.biochar-international.org/webinar\\_series](http://www.biochar-international.org/webinar_series) Study Tour October 2017

Stockholm Biochar Project



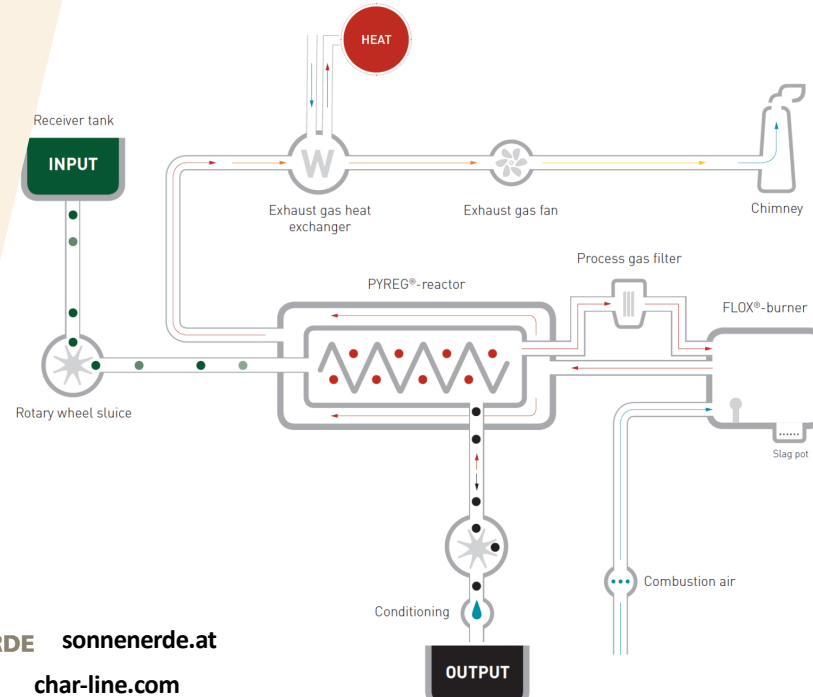
**Heat  
 Biochar  
 Activated Carbon**

- |              |   |  |
|--------------|---|--|
| Biochar soil |  <b>SONNERERDE</b> | <a href="http://sonnenerde.at">sonnenerde.at</a>                 |
| Biochar feed | Charline  | <a href="http://char-line.com">char-line.com</a>                 |
| Maine        | Standard Biocarbon  | <a href="http://standardbiocarbon.com">standardbiocarbon.com</a> |
| California   | Bioforcetech Corp.  | <a href="http://bioforcetech.com">bioforcetech.com</a>           |



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- Pyreg



Pyreg 0.5-1 t/hr wood 12-24 t/d  
[www.Pyreg.de](http://www.Pyreg.de)

# Mobile Carbonizers Recover Biochar from Wood



[www.tigercat.com](http://www.tigercat.com)



Biochar Recovered From Wildfire Debris  
Oregon 2020



## Onsite Systems: Three Types of Flame Cap Kilns

	Small Bin Kilns	Large Bin Kilns	Panel Kilns
<b>Mobility</b>	ATV, Hand Crew	Road-based	Hand Crew
<b>Feedstock diameter</b>	Up to 4"	Up to 8"	Up to 4"
<b>Feeding</b>	Hand fed	Machine or hand fed	Hand fed
<b>Quenching*</b>	Flood	Flood	Spray and Rake



Oregon Kiln  
1 CY



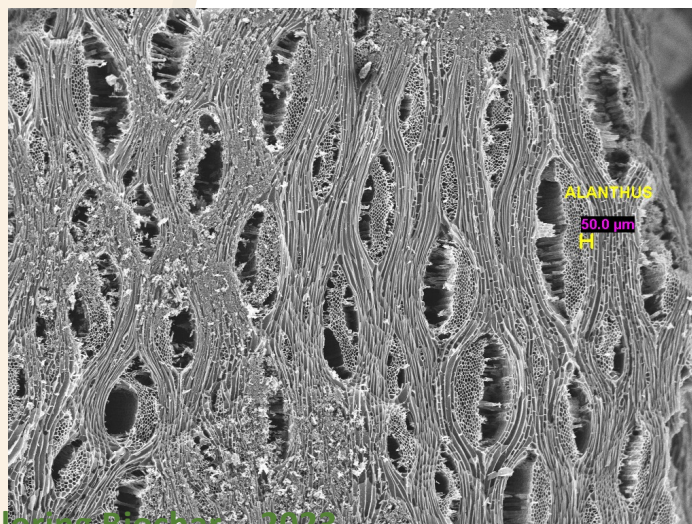
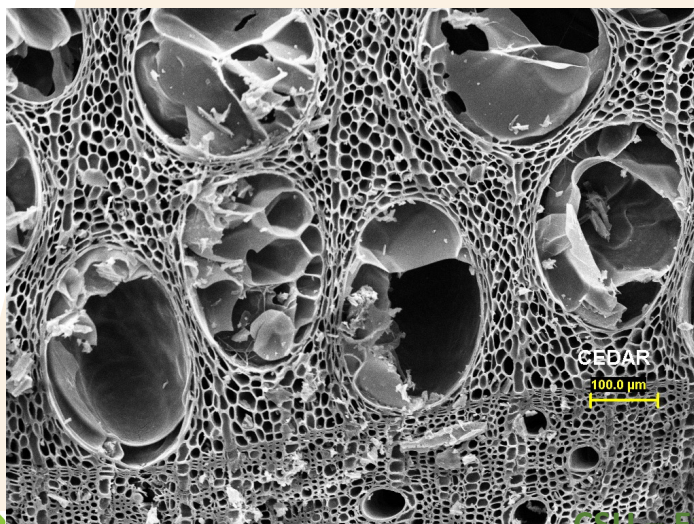
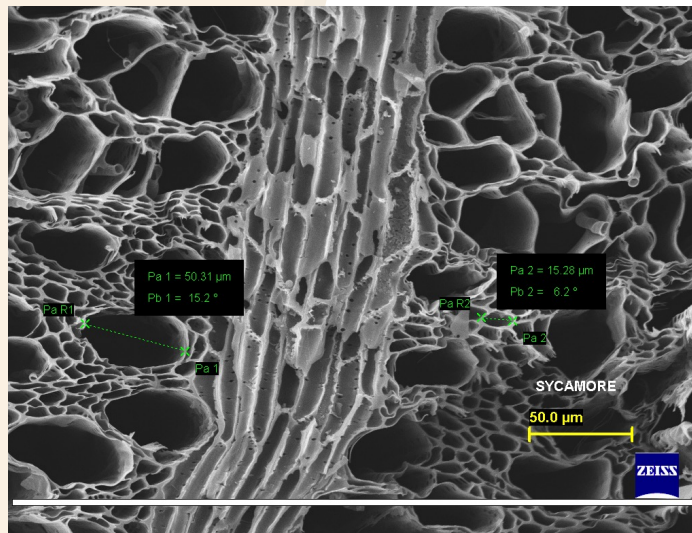
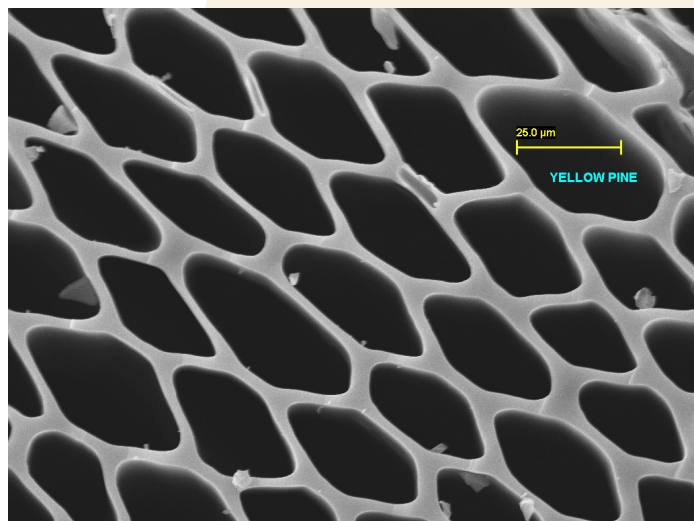
Big Box Kiln (McAvoy)  
10 CY



Ring of Fire Kiln™  
1 CY

\*All kilns can also be snuffed with a lid





- Pine
- Sycamore
- Cedar
- Alanthus



Copyright:  
James Madison University  
Wayne Teel

## PROBLEM STATEMENT

"Water promises to be to the 21st century what oil was to the 20th century: the precious commodity that determines the wealth of nations."

(from Fortune Magazine, Shawn Tully, May 15, 2000)

# Record Drought Driving Biochar Interest

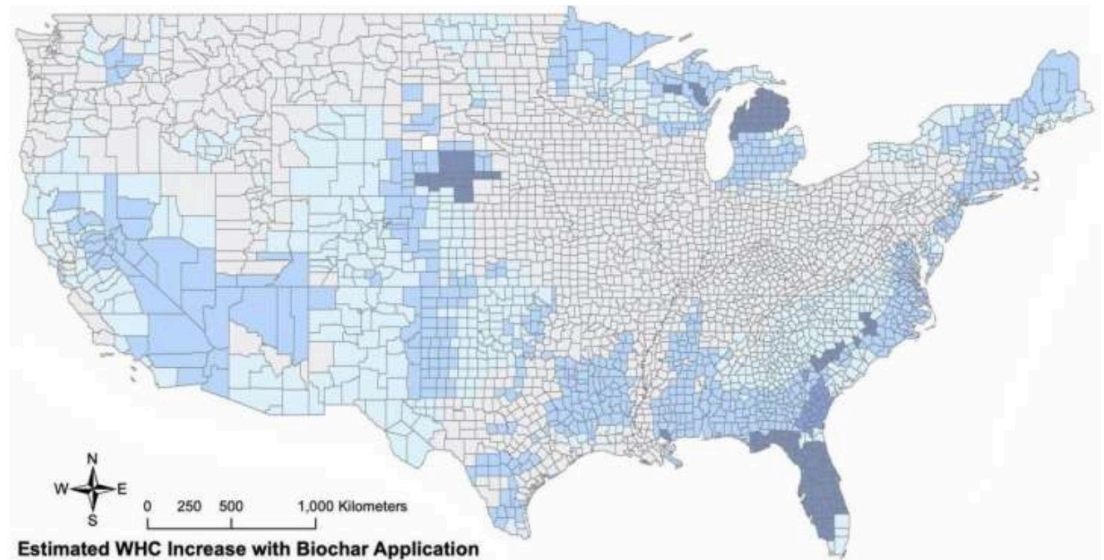
Potential Improvement in US Water Holding Capacity.

Up to 37% water savings in drought environments.

Sandy soils show the most benefit.

**Biochar helps hold water, saves money**

by Rice University



# Biochar Markets and Uses Continue to Grow



## Soil Health: Agriculture, Retail Garden, Landscape, Turf, Trees, Orchards, Vineyards, Horticulture

Biochar, Compost, Composted biochar (5%-20% biochar)

Animal bedding, litter, manure management, *feed trials*

Biochar-Based Fertilizers (15%-25% biochar)

Biotic Soil Amendments (biochar + organics+ minerals and biologicals)

Granulated and liquid products for seeding, foliar sprays (extracts)

Micro/nano carbons, nanofertilizers



## Environment, Remediation, Erosion Control

Revegetation, Biosolids, Urban Soils, Erosion Control, Wetlands, Odor, Waste, Remediation Persistent Herbicides (USCC), PFOS/PFAS



## Water quality stormwater filtration, water treatment, runoff controls



## Forestry Wildfire fuel reduction, Reforestation, Range Improvement

Growing media for nursery and out planting

Revegetation, Reclamation of mines and degraded land



## Carbon, Renewable Energy Offsets, and Non-Soil Products

Carbon markets, building products, odor control, batteries



# Biochar Complements Beneficial Supplements



American Biochar Company VITAL Blend Soil Amendment, Activated BioChar charged with freshwater-sourced Humate

[ambiochar.com/products](http://ambiochar.com/products)



The Andersons® Hemic DG Granular Soil Conditioner (Humic Acid) with Biochar - Hemic DG CharX

[andersonshumates.com/products/#HemicDG](http://andersonshumates.com/products/#HemicDG)



# Biochars are Ingredients in High Value Retail Garden, Horticulture, Turf, Tree, and Landscape



Rexius/OpusGrows, US  
[www.opusgrows.com](http://www.opusgrows.com)



Carbon Gold, UK  
[www.carbongold.com](http://www.carbongold.com)



G&B Organics Eden Valley Blend Potting Soil with **BiocharMax™**  
[www.kelloggarden.com](http://www.kelloggarden.com)

## Ingredients in Green Frontier Compost

Yard Waste  
Food Waste  
**Biochar\***  
Loess Clay



Harvest Quest Fungal Inoculant  
Azomite Mineral Supplement  
Wood Vinegar

**\*16% biochar by finished volume**

Missouri Organic Recycling  
[www.missouriorganic.com/compost](http://www.missouriorganic.com/compost)

**Others: America Biochar Company, Biochar Supreme, Sustane Organic + Biochar, Mirimichi Green CarbonizPn Turf Enhancer, Lesco, Wakefield Biochar Soil Conditioner . . .**

# Biochar Products for Environmental Management: Nutrients, Metals, Organics, Remediation



## 14. LIFE BELOW WATER

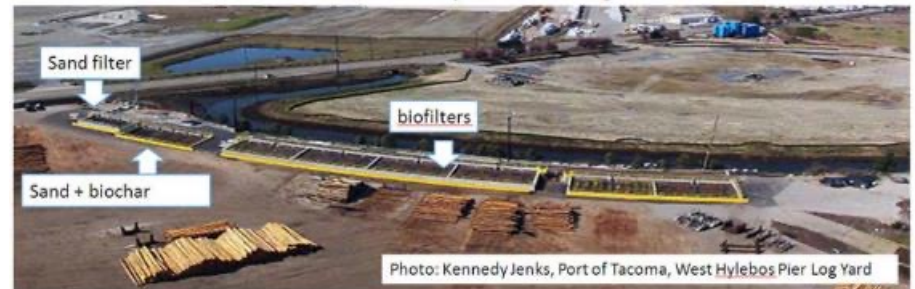
- Manage storm water
- Reduce nutrient pollution
- Clean up spills with biochar
- Carbonize aquatic invasive species



Permamatrix.com



Storm water retrofits prevent water from washing into storm drains, allowing it to soak and filter into the ground



**\*Biochars help meet 12 United Nations Sustainable Development Goals (SDG)**

# Increased Use of Solid and Liquid Biochars in Tree Care

**TREE TIPS**  
TREE & SHRUB CARE FROM BARTLETT TREE EXPERTS

**Bartlett researches biochar** by Drew Zwart, PhD

Biochar is a relatively new term for the substance created from the ancient practice of converting agricultural waste into a stable, carbon-rich charcoal for soil enhancement ("terra preta" Dark Earth). The potential of biochar to reduce stress on urban plantings due to inferior soil quality has intrigued us at Bartlett Tree Experts for many years. As such, the Bartlett Tree Research Laboratories has implemented numerous studies to evaluate biochar's effects on soil and plant health. We set out individually and in partnership with universities to verify claims that biochar:

- Enhances soil fertility while reducing nutrient leaching and ground water contamination
- Increases soil microbial activity
- Increases water retention
- Stimulates plant growth
- Reduces disease and insect susceptibility

Other potential environmental benefits include the use of existing agricultural and horticultural waste debris streams, carbon sequestration from this biomass for hundreds of years or more, reduced needs for fertilizer, and reduced greenhouse gases such as nitrous oxide and methane.

These possible benefits have led us to establish many research projects across the country to examine such claims using real-world and controlled scenarios. Trials are comprehensive

*Continued on page 2*

Biochar is mixed into soil to improve nutrition and growing conditions.

**Sudden oak death**  
by Drew Zwart, PhD

Tree mortality due to *Phytophthora ramorum*, the cause of 'sudden oak death' (SOD), continues to spread in areas known to be infested with the pathogen. Whereas the winter of 2019/2020 was not particularly wet, the wet winters of 2017/2018 and 2018/2019 led to increased infection rates, and current tree mortality is due to infections that occurred during those winters.

SOD bleedout on an oak trunk.

The two long-standing recommendations for managing SOD include potassium phosphite bark treatments to improve resistance, and removal of bay laurel foliage from within the immediate area of valuable oaks. These remain the best options, and research from UC-Berkeley has shown improvement in efficacy of these treatments when gypsum

*Continued on page 2*

Test tree pits at the Bartlett Tree Experts Research Laboratories.



## Urban Tree Care and New Planting



# Increased Use of Biochars in Soil Repair

*Geohydrology, Compaction, Infiltration, Drainage, Aggregation, Filtration*



**Urban Soil Repair - Highway /Toll Plaza Biochar Filter Strip, MD & DE**

Maryland Transportation Authority | DeIDOT | UNIVERSITY OF DELAWARE | TERRA AERATION



Courtesy Ecotone [ecotoneinc.com](http://ecotoneinc.com)

# Remediate Mine Sites



- 160,000 abandoned mines in the West
- Biochar reduces acidity, absorbs toxic metals
- Good for mine sites, fracking pads, brownfields



# Biochar to Filter Toxic Stormwater

- In the Pacific Northwest, biochar filters keep water clean for salmon
- Biochar removes zinc, copper, iron, oil and other pollutants that harm salmon eggs
- Biochar is 4x less expensive than activated carbon



# Tile Drains



Construction of a bioreactor with alternating layers of woodchips and biochar for nitrogen and phosphorus removal – Michigan State University



# ***Strong Funding Support For Domestic Growth***

The US has a growing number of project finance, venture capital, investment firms, climate funds, private equity, and banks actively seeking to back new biochar projects.



# *Government Programs Driving Markets*

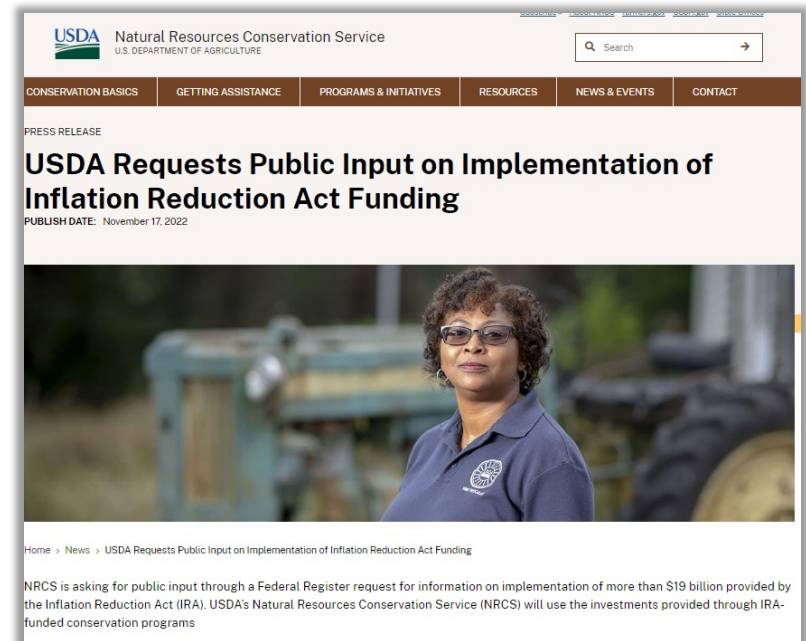
- US Farm Bill
- Conservation Programs – Code 336 / 808
- Bipartisan Biochar Research Network Act 2023
- Inflation Reduction Act
- Friendly State-level Policy & Incentives
- Bioenergy & Biochar (BeCCS)
- Carbon Markets
- Industrial Decarbonization Programs
- 45Q The Carbon Capture Tax Credit
- Biochar in the Infrastructure Bill
- USFS Wood Innovations Program

# Inflation Reduction Act

IRA provides unprecedented funding levels targeted to improve soil carbon, reduce nitrogen losses, or reduce, capture, avoid, or sequester carbon dioxide, methane, or nitrous oxide emissions, associated with agricultural production for several NRCS programs. The increased funding levels begin in FY 2023, and rapidly build over 4 years, resulting in the following total additional funds by program and NRCS administrative costs:

- Environmental Quality Incentives Program—\$8.45 billion; EQIP
- Conservation Stewardship Program—\$3.25 billion; CSP
- Regional Conservation Partnership Program—\$4.95 billion; RCPP
- Agricultural Conservation Easement Program—\$1.4 billion;
- Conservation Technical Assistance—\$1 billion;
- Greenhouse Gas (GHG) Monitoring—\$300 million; and
- Administrative costs—\$100 million.

\*Essentially Doubles the NRCS Budget



<https://www.nrcs.usda.gov/news/usda-requests-public-input-on-implementation-of-inflation-reduction-act-funding>

# US Gov't Conservation Programs For Biochar



- **EQIP:** Flagship program used to develop a conservation plan that outlines conservation practices and activities to help solve on-farm resource issues (problems).
  - Soil Carbon Amendment practice is in EQIP

- **CSP:** Improve land that has been treated for resource concerns already. Enhances existing efforts.
  - Uses enhancements based on practice standards
  - One biochar enhancement

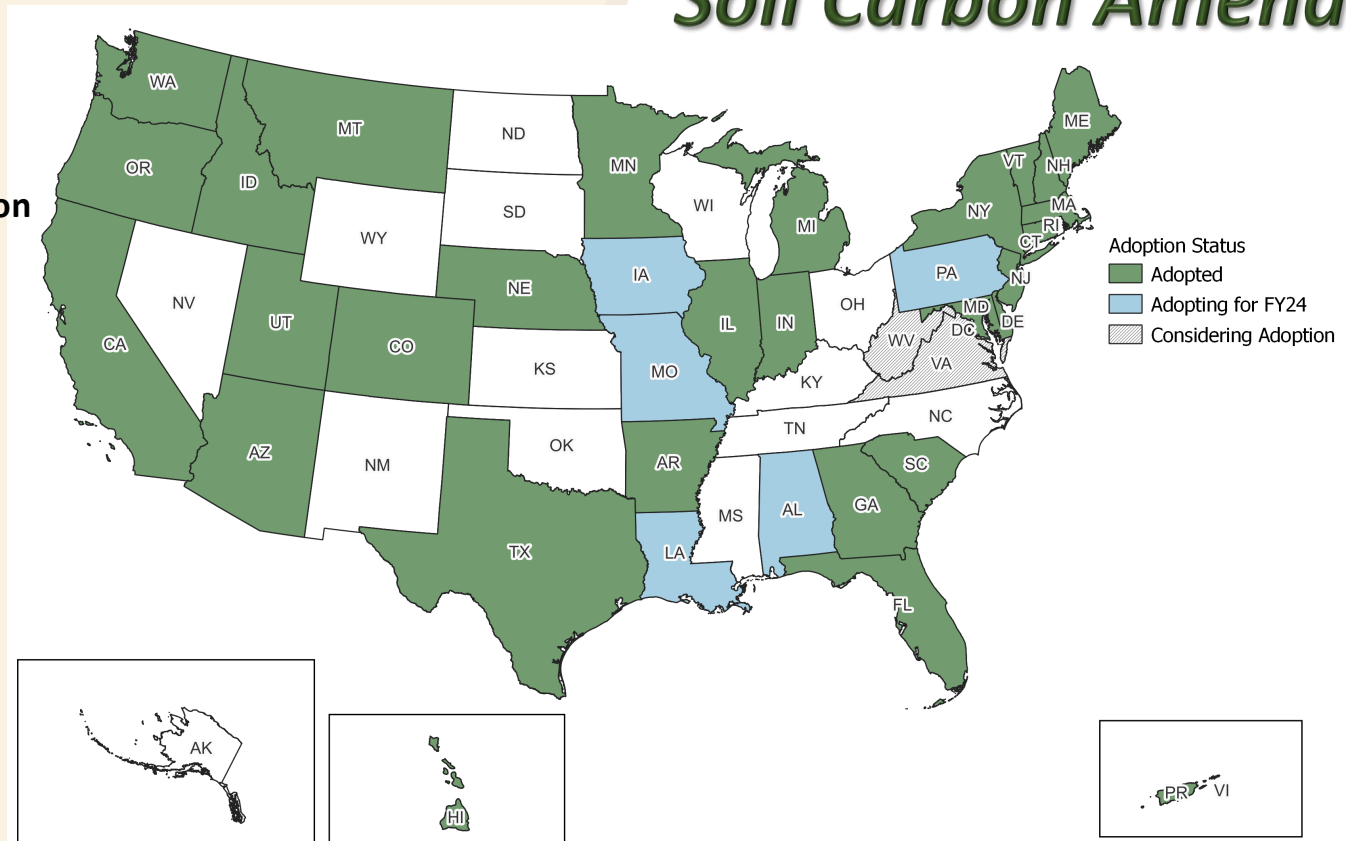


- **RCPP:** Partner-driven approach that funds solutions to natural resource challenges on agricultural land.
  - Classic: Focused projects using EQIP
  - Grants: New or innovative approaches

# State Adoption of Code 808 Soil Carbon Amendment

Anticipate increased adoption  
for Code 336

Both codes work with  
EQIP, CSP, & RCPP



June 2023  
Allied Soil Health Services, LLC



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# *Climate Smart - Soil Carbon Amendment Key Federal Program To Drive Ag Markets*

## *US Biochar Initiative DAY 1 – USDA NRCS*



### *USDA NRCS Code 336 & 808 Soil Carbon Amendment*



*January 18 & 19, 2023*

<https://biochar-us.org> [info@biochar-us.org](mailto:info@biochar-us.org)



#### Highlights:

- Pays up to \$190 CY for Biochar (\$150 CY avg)
- Pays for installation
- Requires nutrient management program
- SIGNIFICANT funding available
- Code 808 already in 26 states
- Nearly 6 hours of content by USBI & NRCS

<https://youtube.com/@USBiocharInitiative/videos>

# US Biochar Initiative DAY 1 – USDA NRCS



**USDA NRCS Code 336 & 808  
Soil Carbon Amendment**



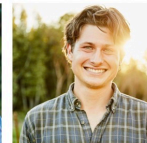
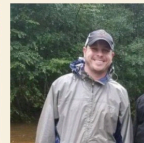
**January 18 & 19, 2023**

<https://biochar-us.org> [info@biochar-us.org](mailto:info@biochar-us.org)



## USBI Education Code 336 / 808

# US Biochar Initiative DAY 2 – USDA NRCS



**USDA NRCS Code 336 & 808  
Soil Carbon Amendment**



Natural Resources Conservation Service

**January 18 & 19, 2023**

<https://biochar-us.org> [info@biochar-us.org](mailto:info@biochar-us.org)



**Watch online:  
[youtube.com/@USBiocharInitiative](https://youtube.com/@USBiocharInitiative)  
8 hours free content**



US Biochar Initiative – Bio360Expo – February 2023

# Roger Kube – Stoney Crest Farm

(retired in 2019)

“In 2016 I applied Missouri Organic’s Green Frontier compost with bio char to my heavy Sneed clay soil at a depth of 3 inches on 30-inch beds. I worked it in to a depth of 4 inches. I did not apply any other nutrition because my soil tests did not indicate a need. My first-year yields were fantastic, and although I did not conduct precise scientific measurements, my brassica yields were close to 75 percent better than the previous year.”



**Collards**



Missouri Organic Recycling  
[www.missouriorganic.com/compost](http://www.missouriorganic.com/compost)

## Green Frontier Compost



Yates Curly Kale





**Biochar enhances composting:**

- Greatly enhances the beneficial biological populations
- Increases nitrogen retention
- Reduces ammonia loss
- Accelerates the composting process
- Reduces odor





# FOOD: NUTRIENTS STICK TO BIOCHAR (organic coating)

## Cations

- Ammonium
- Calcium
- Magnesium

## Organic compounds

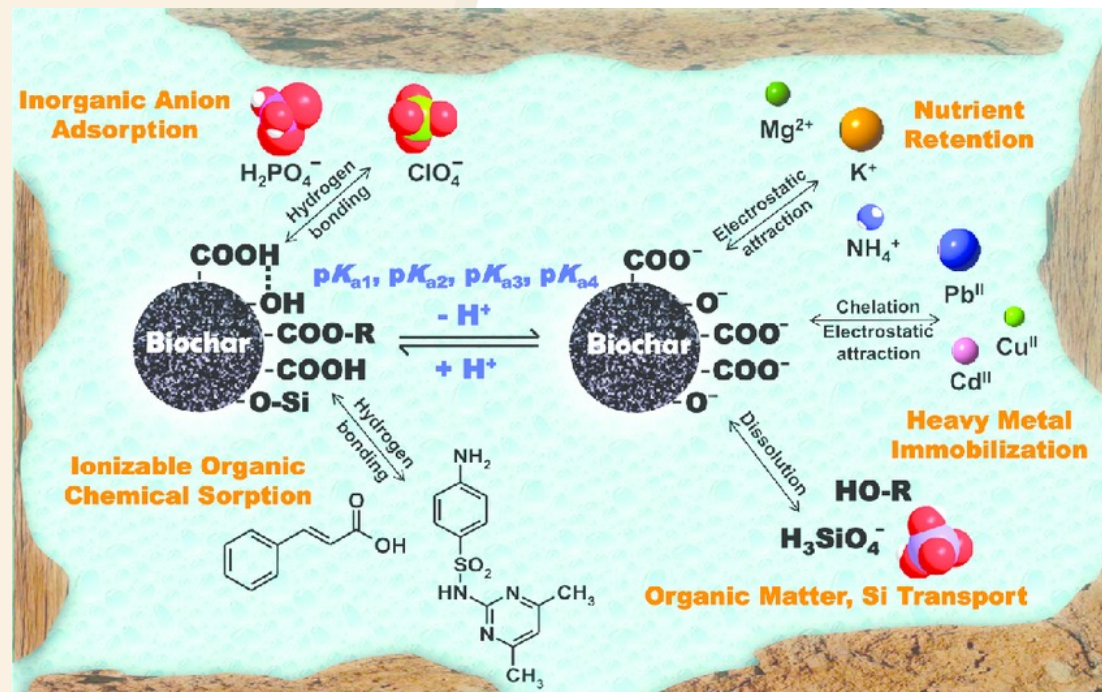
- Organic functional groups
- Humic acid

## Anions

- Phosphate
- Nitrate
- Sulfate

## Minerals

- Metals
- Clay



Schematic of the pH-dependent dissociation of acid/base groups on the biochar surface and the environmental implications.

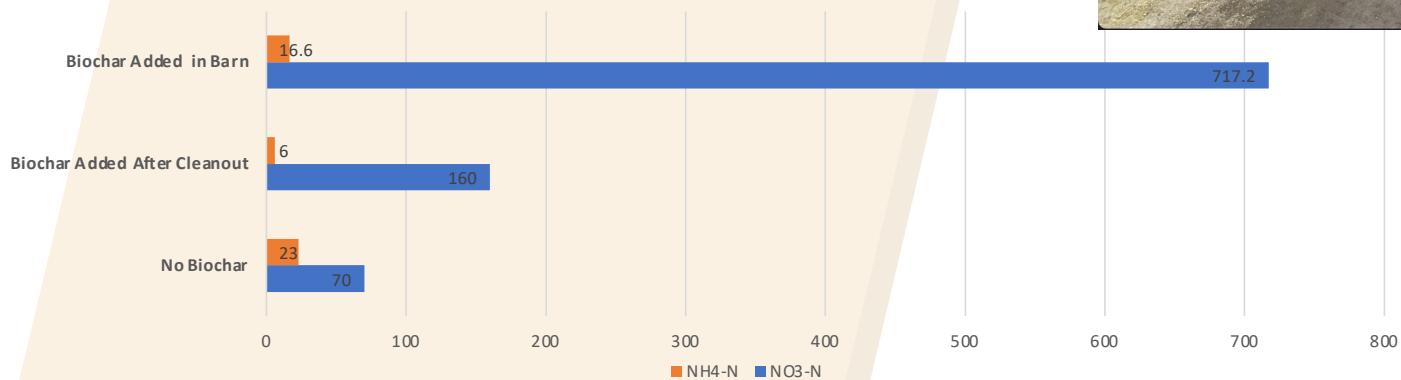
Chen, Zaiming, et al. "Quantification of chemical states, dissociation constants and contents of oxygen-containing groups on the surface of biochars produced at different temperatures." *Environmental science & technology* 49.1 (2014): 309-317.



*For best results, mix biochar with manure as it is generated*



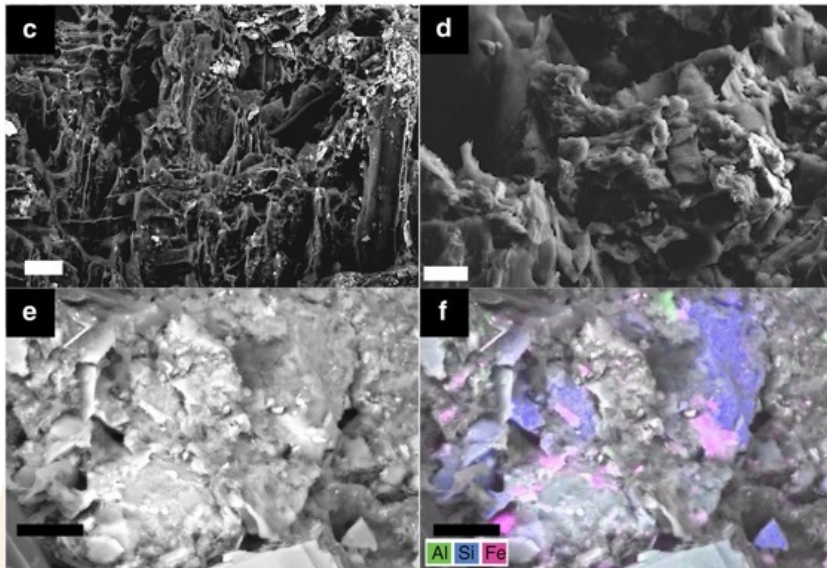
Nitrogen Content of Manure with Biochar (ppm)



**Biochar added in barn adsorbed far more N than biochar added after cleanout.**

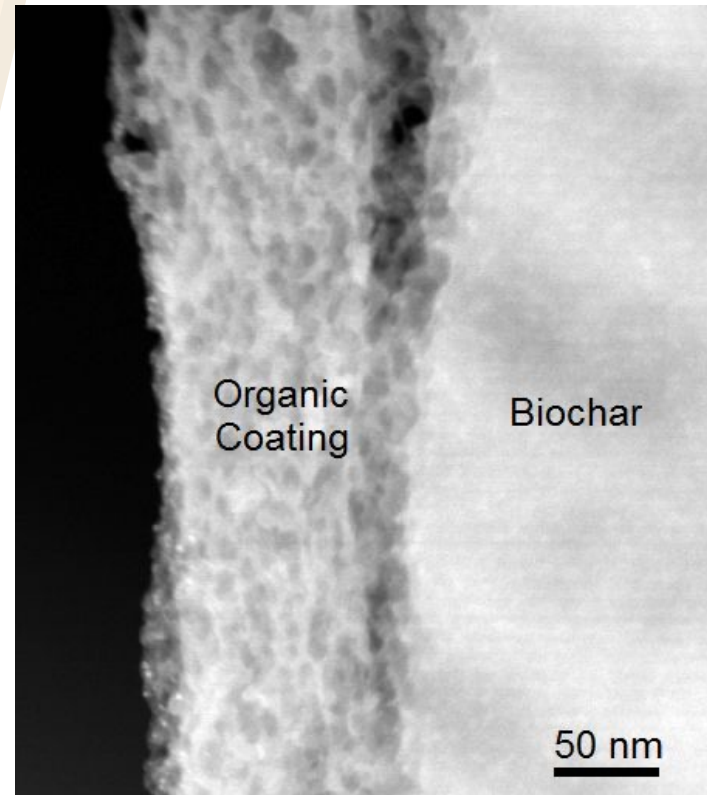
**Biochar added to dairy manure at 20% by volume reduced Methane emissions 84%. - UC Merced**

# ORGANIC COATING ON BIOCHAR SURFACES



Hagemann, Nikolas, et al. "Organic coating on biochar explains its nutrient retention and stimulation of soil fertility." *Nature communications* 8.1 (2017): 1089.

**Composting biochar with other organic material produces an organic coating on biochar surfaces.**



**Microbe poop is good stuff!**



# COMPOSTED BIOCHAR PERFORMS

We picked char particles out of the compost and tested them in soil mixes



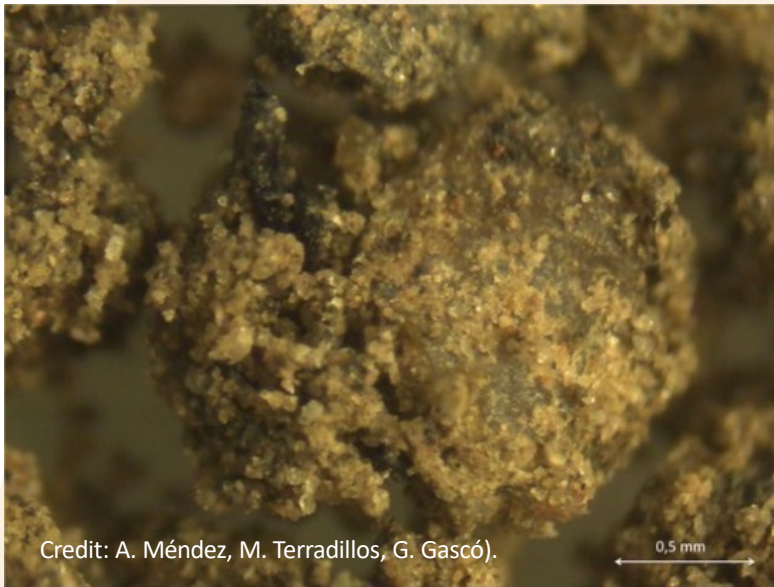
From L to R: composted biochar, worm castings, control

Treatment	Germination (%)	Secondary Leaves (count)	Biomass (grams)
Composted char	100	67	2.04
Worm Castings	84	57	1.87
Control	98	41	1.30

Organic coatings on biochar surfaces had an impact!



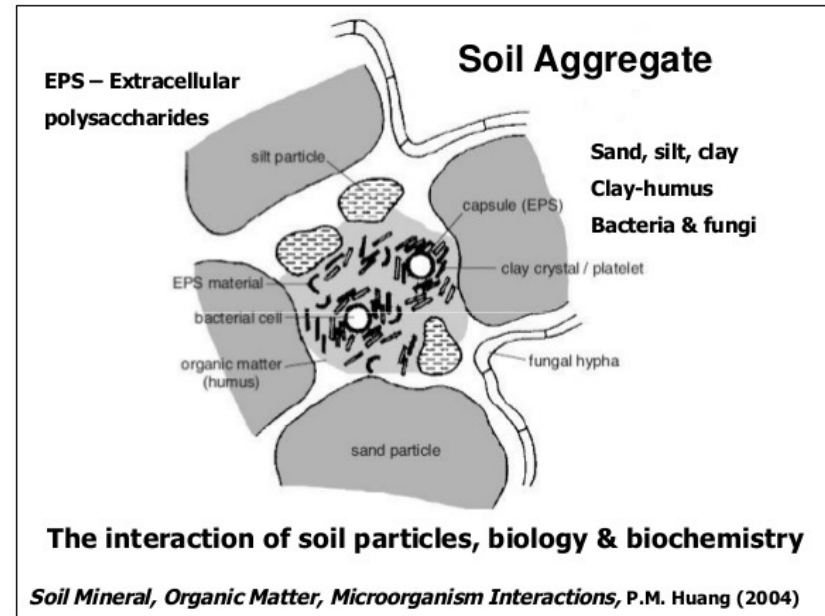
# SEEDING FORMATION OF HUMUS & SOIL AGGREGATES



Credit: A. Méndez, M. Terradillos, G. Gascó).

**Aggregate formation in soil after addition of biochar.**

<https://phys.org/news/2013-12-material-crop-yield.html#jCp>



**Improved soil aggregates  
#1 measure of good soil!**





 PACIFIC  
BIOCHAR

 USBI  
United States Biochar Initiative



# ***GOAL: RESTORE NORTH AMERICAN SOILS***

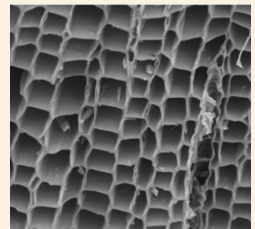
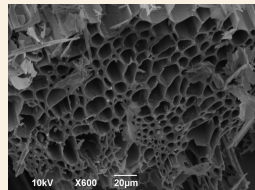
## ***IOWA SOILS – 50% OF SOIL CARBON IS CHARCOAL\****

- Iowa soils are some of the most fertile in the world
- Why? Natural biochar from prairie fires
- Thick stems exclude oxygen, producing char, not ash
- Helped by Native American burning practices



\*J.-D. Mao, R. L. Johnson, J. Lehmann, D. C. Oik, E. G. Neves, M. L. Thompson, and K. Schmidt-Rohr 2012  
Abundant and Stable Char Residues in Soils: Implications for Soil Fertility and Carbon Sequestration.  
9571-9576

# Drought Buster: Biochar Pores Hold Water



Iowa corn did better during the 2012 drought because the soils are high in natural biochar. Test plots with added biochar at Iowa State showed ~15% better water retention.





# *Trials Show Drought Tolerance*



2 weeks no watering



**Control**

**Biochar**

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# IDENTIFY MANAGEMENT GOALS TO USE BIOCHAR EFFECTIVELY

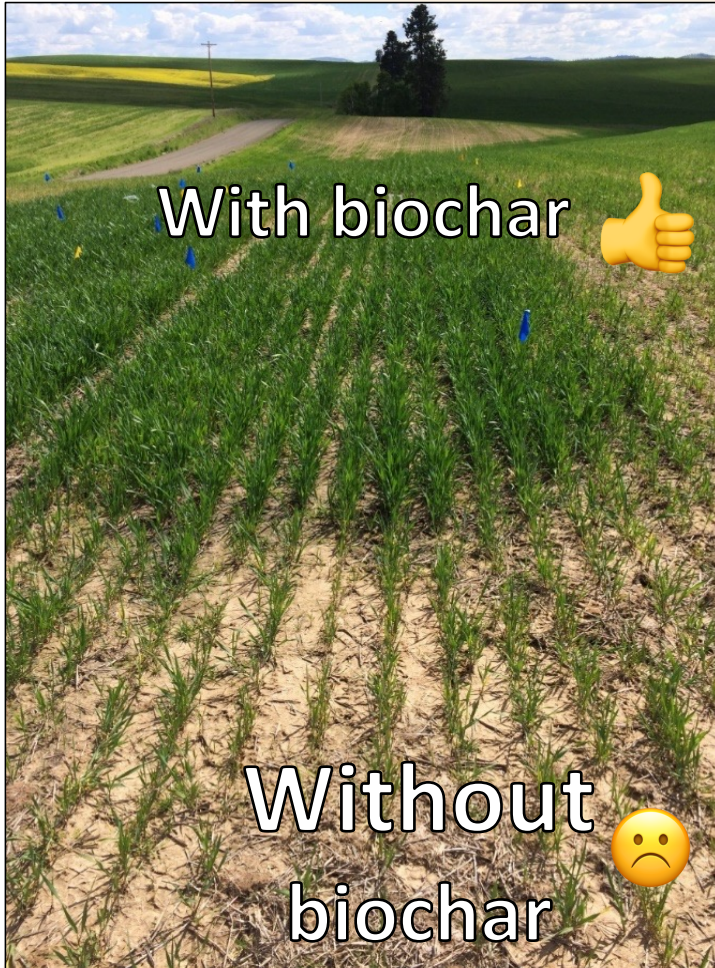
**Identify Goals**



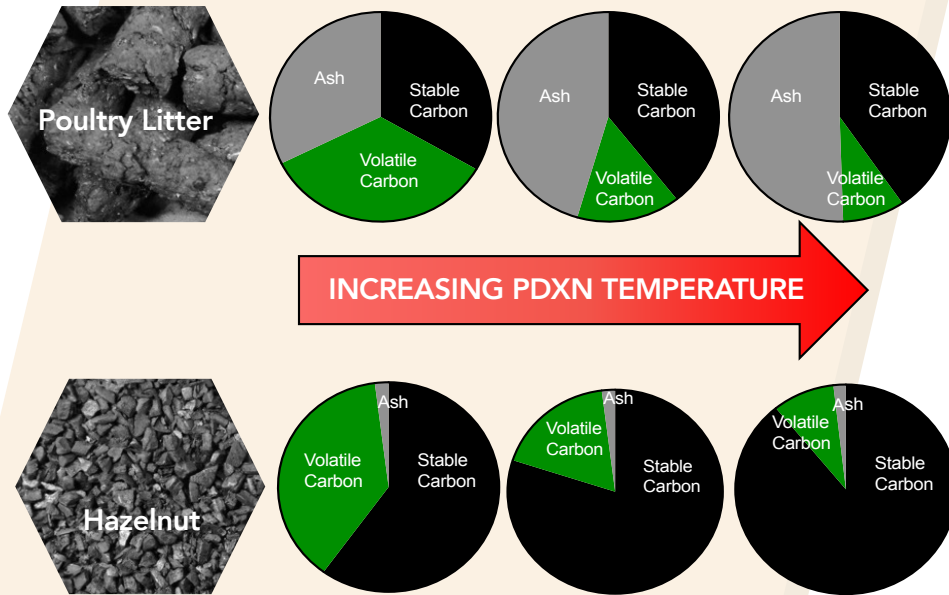
**Find product that meets needs**



**Find rate that meets needs**



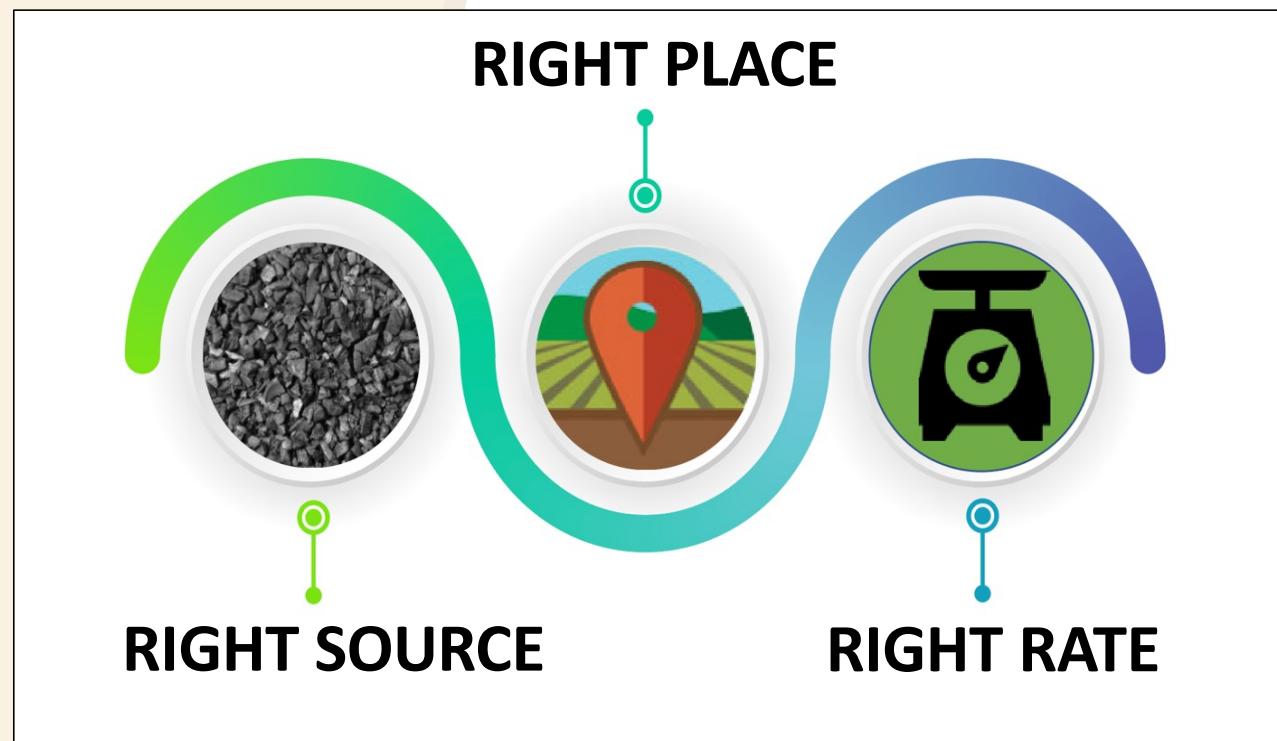
# Biochar Selection & Application



**WITH TOOLS  
WE CAN MATCH  
BIOCHAR  
PROPERTIES TO  
SOIL & CROP NEEDS**

**Biochar feedstock origin & production conditions impact physiochemical properties**

Use principles from nutrient management to inform amendment strategy



# Scaling Biochar Use Requires Tools

HOME ABOUT BIOCHAR CASE STUDIES TOOLS FIND BIOCHAR ABOUT THE ATLAS



## PNWBIOCHAR.ORG

- BIOCHAR EDUCATION
- FIND A BIOCHAR THAT MEETS YOUR NEEDS
- READ CASE STUDIES
- FIND PRODUCERS
- COMPARE BIOCHARS



### What is biochar?

Learn how charcoal-rich soils in ancient cultures influence modern farming practices.

### HOW DOES BIOCHAR IMPROVE SOIL FUNCTION AND ECOSYSTEM HEALTH??



Learn About Benefits



### How are people making and using biochar?

See applications in horticulture, farming, forestry, and environmental remediation.



### Will biochar do what I want?

Learn how feedstocks, production conditions, and additives determine how biochar interacts with your soil.



### Where can I get biochar?

A range of biochars are increasingly available for sale throughout the PNW.



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# US Biochar Atlas Expansion

## BIOCHAR PRODUCERS

DIRECT OUTREACH  
FACTSHEETS  
WEBINARS  
FEEDBACK



## FARMERS



American Farmland Trust

## INREACH NRCS

TRAININGS  
WORKSHOPS



## NRCS Funded Expansion



MODEL IMPLEMENTATION  
WEB DEVELOPMENT

## BIOCHAR LIBRARY

COLLECT &  
CHARACTERIZE  
BIOCHARS



## MODEL DEVELOPMENT

ADD GHG AND C  
SEQUESTRATION  
ESTIMATES



# USDA Web Soil Survey Tool



[Home](#) | [About Soils](#) | [Help](#) | [Contact Us](#)

You are here: [Web Soil Survey Home](#)

**Search**

Enter Keyword

All NRCS Sites ▾

**Browse by Subject**

- [Soils Home](#)
- [National Cooperative Soil Survey \(NCSS\)](#)
- [Archived Soil Surveys](#)

The simple yet powerful way to access and use soil data.



**I Want To...**

- [Start Web Soil Survey \(WSS\)](#)
- [Know Web Soil Survey Requirements](#)
- [Know Web Soil Survey operation hours](#)
- [Find what areas of the U.S. have soil data](#)
- [Find information](#)

## Welcome to Web Soil Survey (WSS)



Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service



<https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>

# USDA Web Soil Survey Tool

The screenshot displays the USDA Web Soil Survey Tool interface. At the top, there are navigation tabs: "Area of Interest (AOI)", "Soil Map", "Soil Data Explorer", "Download Soils Data", and "Shopping Cart (Free)". Below this is a search bar and a dropdown menu for "View Soil Information By Use: All Uses". The main navigation bar includes "Intro to Soils", "Suitabilities and Limitations for Use", "Soil Properties and Qualities", "Ecological Sites", and "Soil Reports".

The left sidebar contains a "Search" section with "Suitabilities and Limitations Ratings" and "Dynamic Soil Properties Response to Biochar". Under "Suitabilities and Limitations Ratings", there are several categories with expand/collapse icons: Building Site Development, Construction Materials, Disaster Recovery Planning, Land Classifications, Land Management, Military Operations, Recreational Development, Sanitary Facilities, and Soil Health. Under "Dynamic Soil Properties Response to Biochar", there are "View Description" and "View Rating" buttons, and a "View Options" section with checkboxes for "Map", "Table", "Component Breakdown and Rating Reasons", "Numeric Values", "Description of Rating", "Rating Options", and "Detailed Description".

The main content area shows a map titled "Map - Dynamic Soil Properties Response to Biochar". The map displays a satellite view of a rural area with a semi-transparent overlay of soil suitability zones in various colors (green, yellow, orange, red). A legend and scale bar are visible at the top of the map area.

Decision  
Support  
Tools  
Help  
Farmers  
Put  
Biochar  
In the  
Right  
Place



<https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>



# USBI Biochar Calculation Tool

Bulk Density	7.5	lbs/ft3
Moisture Content	40%	
Organic Carbon (Corg)	86.20%	
CaCO3 equivalent %	5.00%	
Nitrogen	42	ppm (dry weight)
Phosphorous	5	ppm (dry weight)
Potassium	1105	ppm (dry weight)

Looking at application rates and outcomes

Biochar volume and mass_converter		
Bulk density, lbs/ft3	7.5	
Moisture Content	40%	
lbs/yd3 (dry)	yd3/ton (dry)	
202.5	9.9	
lb/yd3 (wet)	yd3/ton (wet)	
337.5	5.9	
Wet ton	Dry ton	yd3
7	4.20	41.5
Dry ton	Wet ton	yd3
7	11.67	69.1

PROJECT SPECIFIC_ % SOC outcomes per application			
<b>Cultivation specs</b>			
Inches depth	Percent acreage cultivated		
6	100%		
<b>Biochar Application Rate_ %SOC Input, Ton/ Acre Output</b>			
% SOC increase desired	Tons Corg needed	Tons Biochar required (dry)	Tons Biochar required (wet)
0.40%	3.62	4.20	6.99
<b>Biochar Application Rate_ Tons/ Acre Input, %SOC Output</b>			
Tons Biochar (wet)	Tons Corg applied	Achieved Rate (SOC%)	
7	3.62	0.40%	
<b>Soil Volume and Weight</b>			
cu ft / acre	cu yd / acre	soil density ton/cy	tons soil/acre (treated)
21,780	807	1.12	904.10

Liming and NPK Outcomes per Application	
Tons biochar applied (wet)	7
Liming equivalent, tons CaCO3	0.21
N added (lbs)	0.3528
P added (lbs)	0.04
P2O5 added (lbs)	0.10
K added (lbs)	9.28
K2O added (lbs)	11.18



Web Tool Coming Soon to <https://biochar-us.org>



# TO THE FIELD!

## Biochar Application Methods

### Strip Till, No-Till, Liquid



Biochar slurry application using a sprayer. Photo by Kristin Trippe

## Incorporating Biochars and Blends



Overseeding pasture applying seed, biochar and organic amendments with a standard No-till drill.

Natural Plant Solutions, WA  
naturalplantsolutions.com  
[Great Plains 606NT](https://www.greatplains.com)



Moving floor bin and augers meter bulky organics.

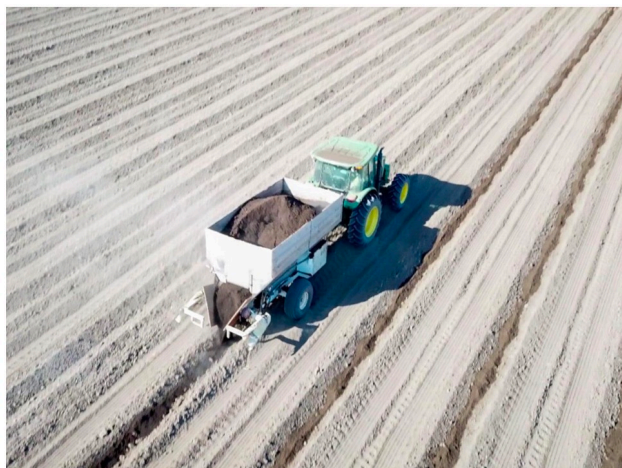
USDA ARS  
**Poultry Litter Subsurfer**  
[bit.ly/2UTdmBN](https://bit.ly/2UTdmBN)



# *Vineyard Field Application*



**Field application example: applied down aisle with manure/compost spreader, disked in**



**Field application : Applied down planting row, then ripped into soil profile**



**Field application: BROADCAST**



**NO TILL**



**Biochar Slurry Fed in No Till Cross Slot (Don Graves, NZ)**

# Biochar Improves Fertilizer Use in Row Crops



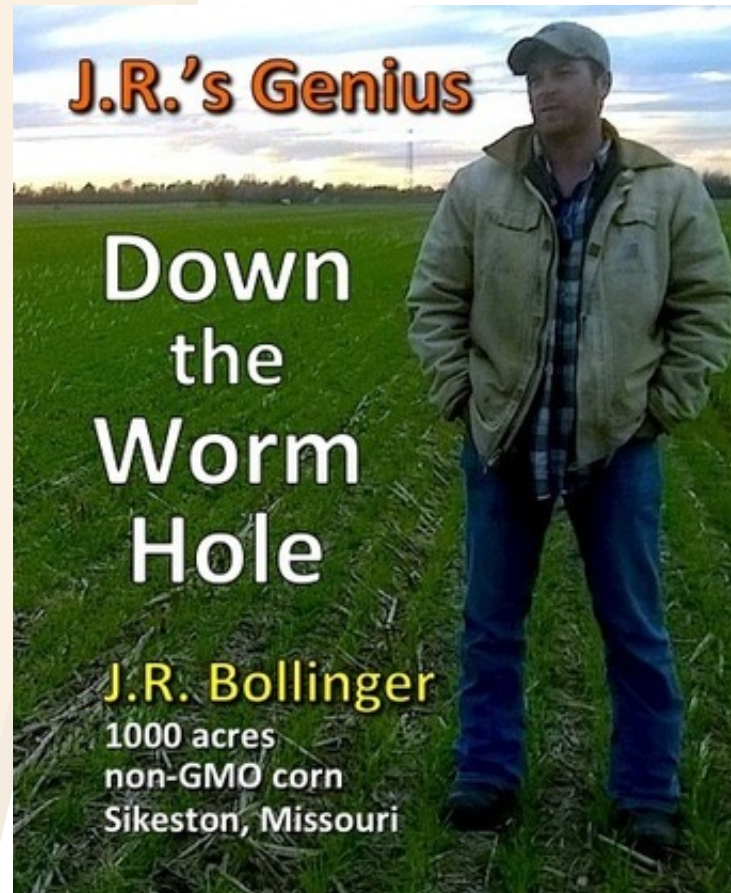
David Yarrow, Down the Wormhole, 2016

terra-char.com/jr-bollingers-corn  
Montag Equipment [montagmfg.com](http://montagmfg.com)



## Row Crops

- 2.5 percent biochar tilled in six inches is 8 tons per acre — at \$0.50 per pound (2016), and \$8,000 per acre, and that is too costly for farmers. (2023 prices range from \$0.23 to \$0.75 lb)
- Bollinger's genius is to concentrate biochar and nutrients in narrow bands, thus cutting rates to hundreds of pounds per acre, slashing annual costs and spreading expenses over several years.



Article by David Yarrow at  
<http://ecofarmingdaily.com/biological-farming-methods/>

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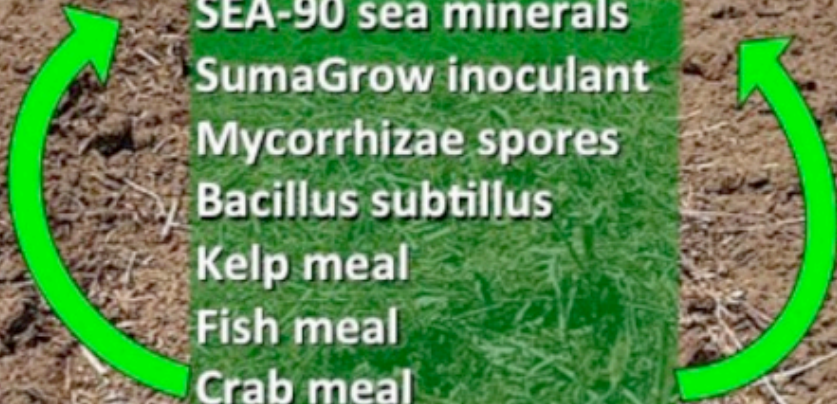


**J.R. Bollinger**

Sikeston, Missouri



Biochar sawdust fines  
SEA-90 sea minerals  
SumaGrow inoculant  
Mycorrhizae spores  
Bacillus subtilus  
Kelp meal  
Fish meal  
Crab meal  
Humates  
Humic & Fulvic Acids  
+ 50% N-P-K fertilizers



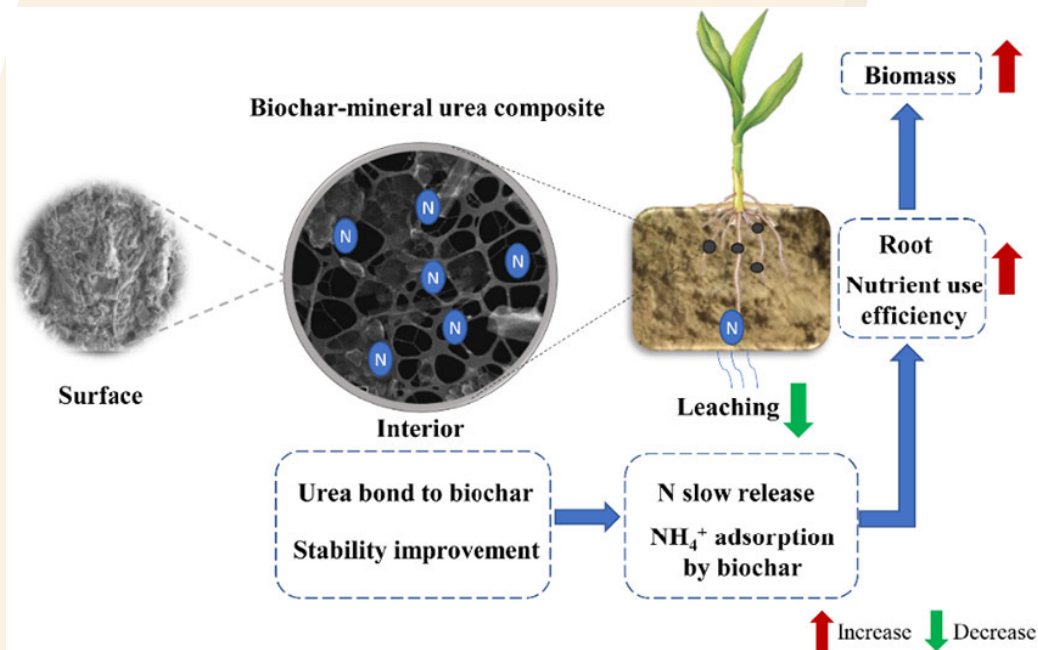
[terra-char.com/jr-bollingers-corn](http://terra-char.com/jr-bollingers-corn)





# MANUFACTURED FERTILIZER: Biochar + NPK

- Biochar-mineral urea composite reduced the N leaching in soil.
- Biochar-mineral urea composite was more effective on the retention of  $\text{NH}_4^+\text{-N}$ .
- Biochar-mineral urea composite increased maize root growth and N use efficiency.



Prilled biochar — A product like prilled urea with biochar can offer the most compatible substrate for farmers to use in existing fertilizer application equipment. Over 20 studies revealed a 15-69% delay in N release and 25-65% improvement in fertilizer use efficiency with prilled biochar-based N fertilizer.

<https://doi.org/10.1007/s42773-022-00160-3>

Shi, Wei, et al. "Biochar bound urea boosts plant growth and reduces nitrogen leaching." *Science of The Total Environment* (2019): 134424.



## Biochar and Hog Manure in Strip Tillage



*"99.9%+ of liquid hog sh\*t is applied within 5 miles of the animals. **Biochar is a change agent.** The value of manure biochar is more tactical than what it does to soil. It changes the attributes of N and P esp when coating a dry N source. Can't prove much until you do it 1st." @jasonmauck1, Jason Mauck April 1, 2020 <https://bit.ly/3hbCGLI>*

*"Its getting really hard to contain my excitement level here. @JoeatDawn when you were riding with me last fall did you know we were creating a new agronomic algorithm? **Biochar coated seed and fertilizer..leveraging sunlight and biology** expressing itself in ways I've never seen!"*

8:17 AM · Jun 23, 2020 from [Indiana, USA](#)  
<https://bit.ly/2CtyMyW>

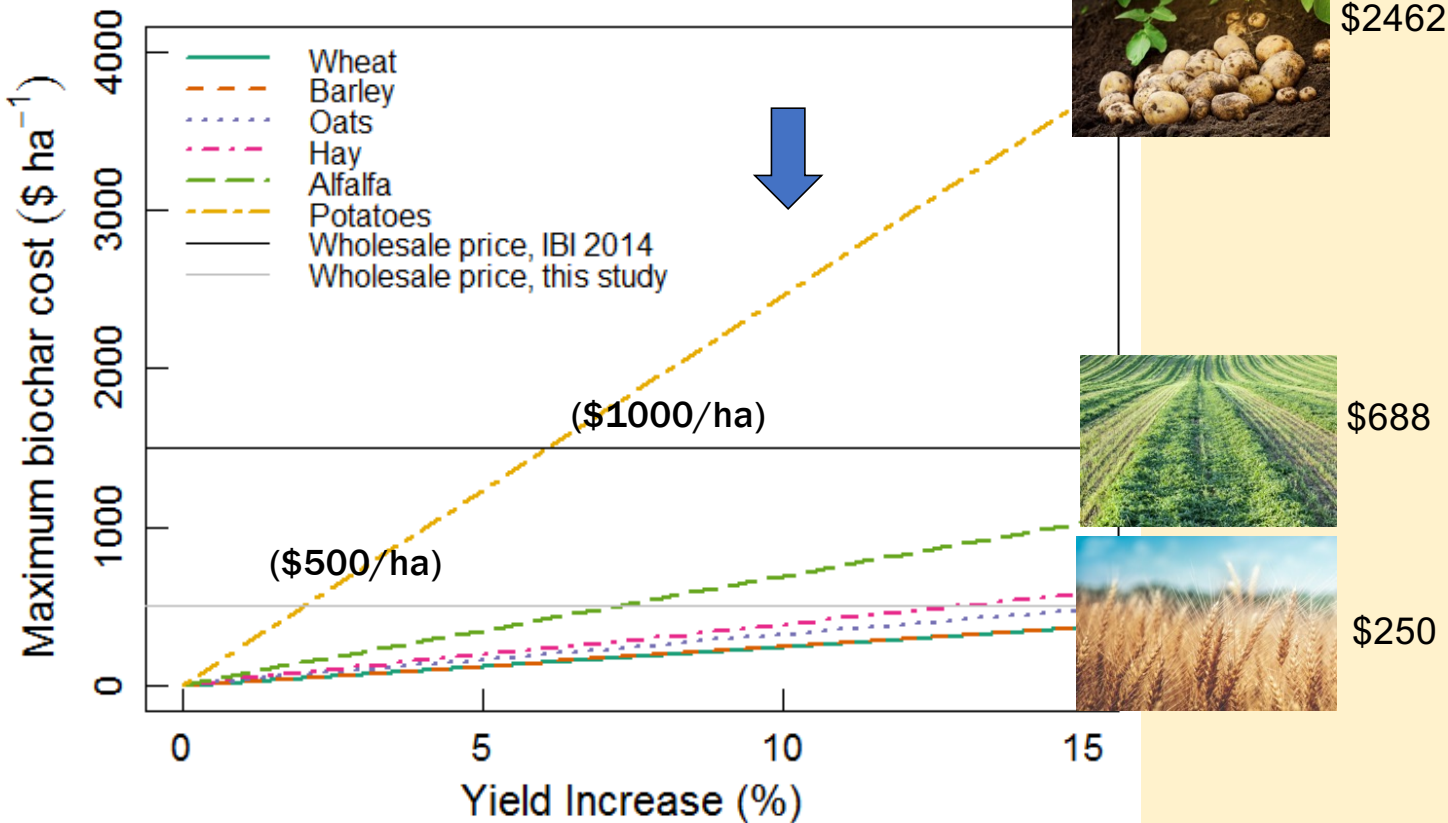
Jason Mauck, Constant Canopy [constantcanopy.com](http://constantcanopy.com)

Joe Basset, Underground Agriculture [undergroundagriculture.com](http://undergroundagriculture.com)



# Biochar Selection Tools: Cost benefit analysis

If biochar increased yield by 10%...



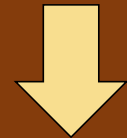
IDENTIFY  
CROP SPECIFIC  
SOIL DEFICIENCIES



DETERMINE GOALS



FIND A BIOCHAR

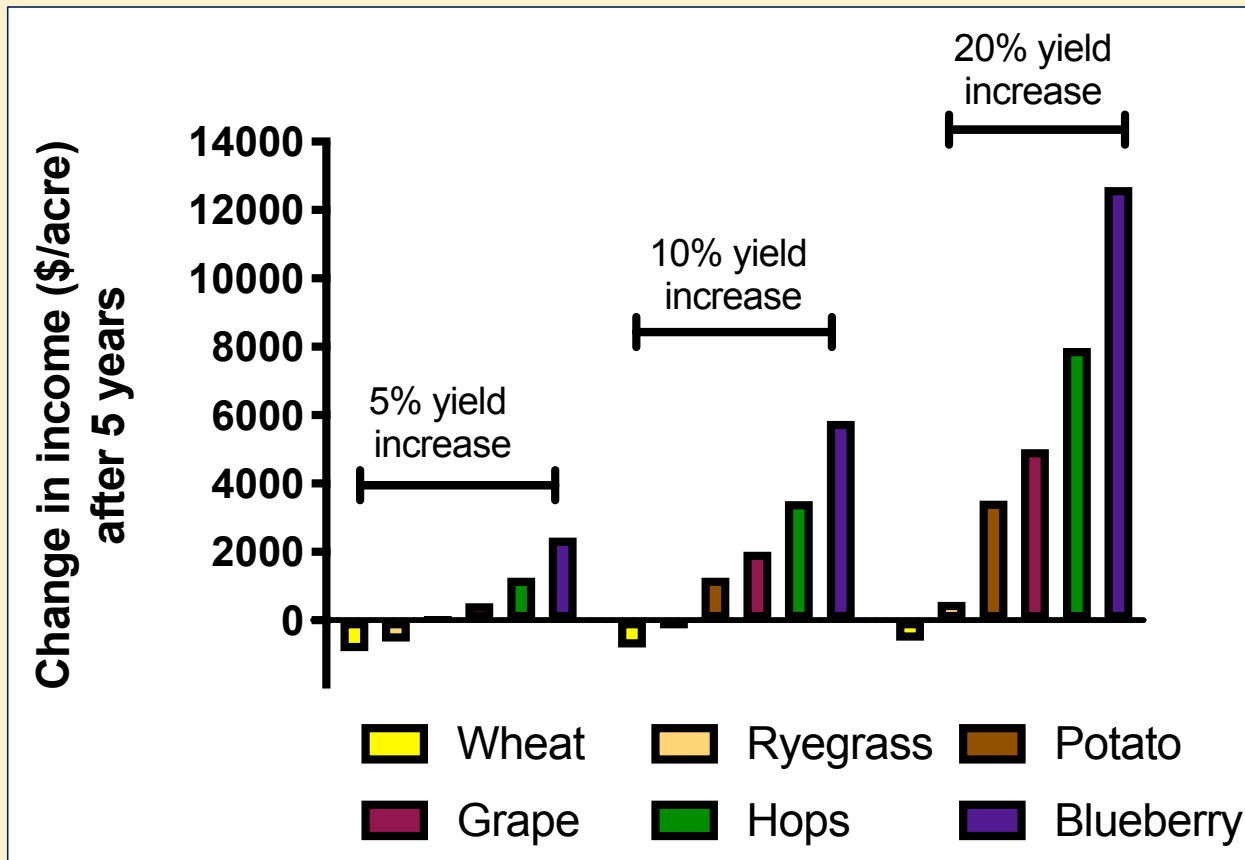


IS IT  
ECONOMICALLY  
SUSTAINABLE?

Take home: Only high-value crops can bear the cost of biochar amendments



# Biochar Selection Tools: Cost benefit analysis



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IDENTIFY  
CROP SPECIFIC  
SOIL DEFICIENCIES



DETERMINE GOALS



FIND A BIOCHAR



IS IT  
ECONOMICALLY  
SUSTAINABLE?



# Tomato Economics with Biochar - San Joaquin Valley

	Base	Biochar	Notes
Revenue/acre <sup>1</sup>	\$10,086	\$12,103	+20%
Base cost to farm <sup>2</sup>	-\$5,478	-\$5,478	
Water savings	-	+\$60	50%
Fertilizer savings	-	+\$33	30%
Hand Weed	-	-\$140	2 times
<b>Operating Profit per growing season</b>	<b>\$4,608/acre</b>	<b>\$6,578/acre</b>	<b>2 tons per acre</b>

Improved Economics = \$1,970/2 tons = \$985/metric ton

Marginal Land Value = \$6,578/2 tons = \$3,289/metric ton

Question: How much value does the Biochar Producer keep (1/3?)

<sup>1</sup> Revenues from USDA Economic Research Service for CA tomato farming in 2009

<sup>2</sup> Costs from UC Davis 2007 Tomatoes Cost and Returns – San Joaquin

# Applications

## Viticulture

- Large improvement in vineyards with soil challenges (Cd, Mg)
- 3 cubic yards per acre, mixed with compost at planting



## Strawberries

- 25-56% yield improvement with same watering and 40% less fertilizer
- 5 cubic yards per acre drop spread prior to bed creation
- Reduction in pathogenic fungi



## Turf

- Broadcast spread after aeration, 6 cubic yards per acre / 275 sq ft per 1 CF
- Reduces water use 30-50%, big value in SW United States
- City of Thousand Oaks first adopter



## Horticulture

- 15-40% yield improvement and increase in growth speed
- 20 - 40% reduction in fertilizer use



# Application Observations

## High Value Row Crops (Tomatoes, Bell Peppers, etc.)

- 15 – 75% yield improvement
- 20-40% less fertilizer use



## Orchards & Nut Trees

- Visual signs of improvement in new plantings with lower water use
- Remediates root rot
- Return to profitability



## Composting

- Reduces odors and VOC's, Increases soluble nitrates
- Enables composting of organic wastes
- Higher quality compost, enhanced water retention, better growth
- Possible elimination of CASP system for Windrow



# Strawberry Economics Case Study

	Control	Biochar
Strawberry Returns	6000 trays	7,500 trays
<b>REVENUE – per acre</b>	<b>\$49,800</b>	<b>\$62,250</b>
Water	1,000	1,000
Fertilizer	1,150	690
Biochar	0	1,600
Plants and Trays	14,120	16,640
Labor	17,744	20,251
Fungicide and Fumigation	6,100	6,100
Cooling	3,000	3,750
Machinery Op Costs	458	458
Miscellaneous	2,105	2,376
<b>TOTAL OPERATING COSTS/ACRE</b>	<b>\$45,677</b>	<b>\$53,175</b>
<b>NET RETURNS ABOVE OPERATING</b>	<b>\$4,123</b>	<b>\$9,075</b>
<b>ROI</b>		<b>66%</b>

- 25% Yield Increase
- \$8.30/Tray Sales Price
- 40% Less Fertilizer
- 5 cubic yards per acre
- Fumigation (may not be needed)



**66% Return on Investment**

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# *US Biochar Initiative*

## *Q&A*



### *Exploring Biochar In Crops*



<https://biochar-us.org> [info@biochar-us.org](mailto:info@biochar-us.org)



# *THANK YOU!*

## **US Biochar Initiative**

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*john@biochar-us.org*

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*instagram.com/usbiochar*

*twitter.com/usbiochar*

*linkedin.com/company/us-biochar-initiative*

*facebook.com/Usbiochar*

*biochar.groups.io*

*Youtube.com/@USBiocharInitiative*



**#biocharcode336**

**#biochar #pyccs**

**#biocharsaveswater**

**#biocharfixescarbon**

**#biochar2024**