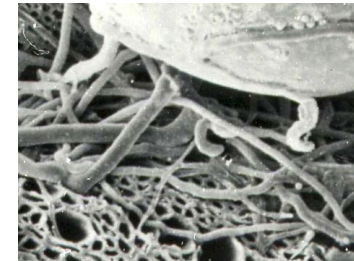


Using Biochar Technologies to Improve Soil Productivity and Soil Health at the Farm Scale

*Tom Miles
Executive Director
US Biochar Initiative*



Climate Mitigation & Adaptation: Climate-Smart Forest-Related Practices
USDA 99th Annual Agricultural Outlook Forum
February 23-24, 2023



Improve
compost
and save
money

Factsheet



Producers Directory



Equipment & Technology Development

ABOUT USBI

Established 2009

USBI is a not-for-profit organization promoting the sustainable production and use of biochar through research, policy, technology

Activities:

North America Conferences, Workshops, Research, Factsheets, Newsletter, Website, Provider Directory, Social Media, Advocacy, Referrals, Technical Advisory Team, Demos, Forestry Partner, biochar.groups.io forum, Outreach & Education

info@biochar-us.org

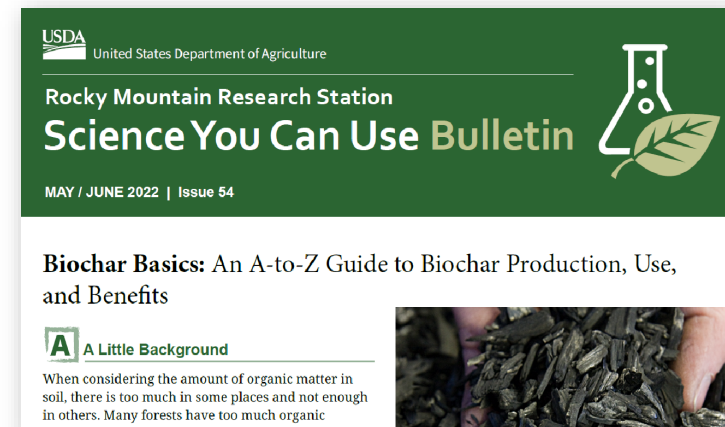
Climate-Smart Forest-Related Practices: Biochar



In-field Workshops



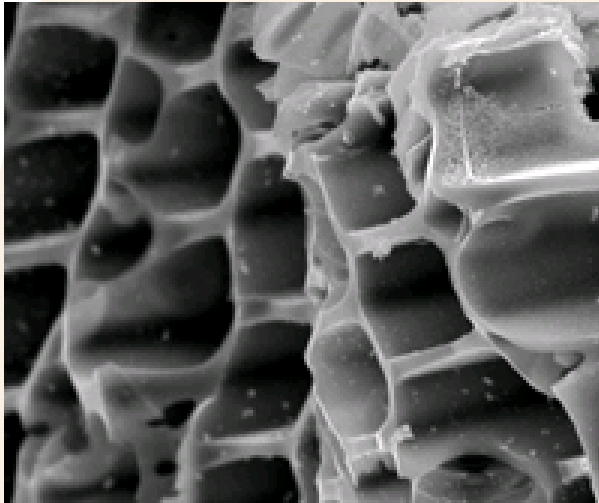
Trade shows & Conferences



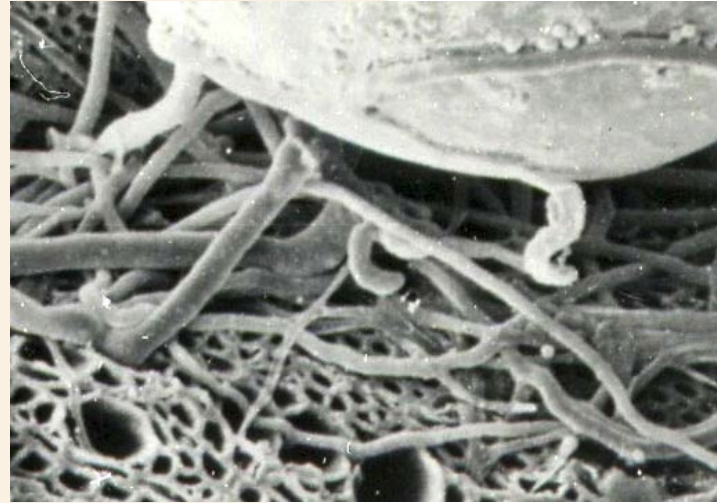
USFS Biochar Basics bit.ly/3Nctv78

Biochars are Processed So That Physical, Chemical, and Biological Properties Improve Soil Health and Hydrology

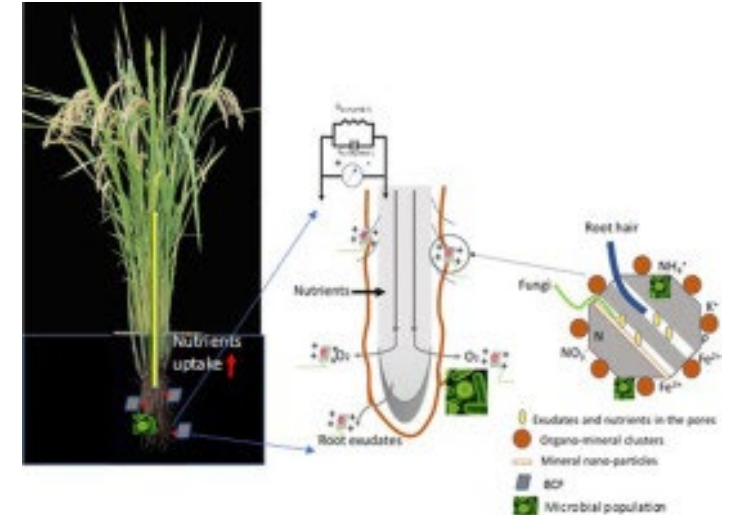
Biochars are fine-grained, highly porous charcoals that help soils retain nutrients and water. International Biochar Initiative



Collins 2009



Mycorrhizal fungal hyphae growing from spore base invade large charcoal pores Ogawa 2004

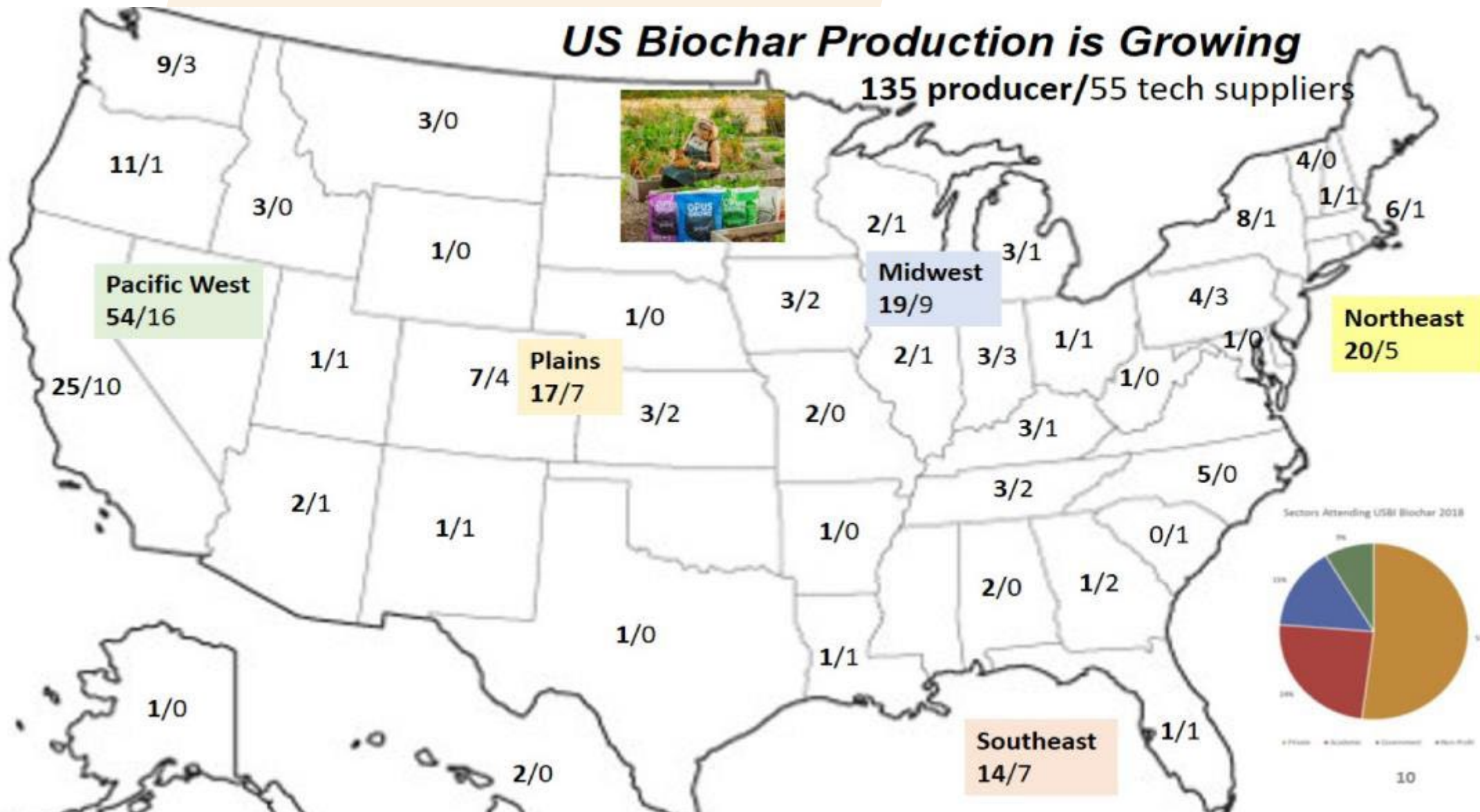


Biochar-based fertilizer redox potential, eH

Chew et al. 2020 bit.ly/30TQnIB

US Biochar Production is Growing

135 producer/55 tech suppliers



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, 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

- functionalized chars, 3d aerogels, antibiotics



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



Biochars are Ingredients in Agriculture, Retail Garden, Horticulture, Turf, Tree, and Landscape Applications



Rexius/OpusGrows, US
www.opusgrows.com



Carbon Gold, UK
www.carbongold.com



G&B Organics Eden Valley
Blend Potting Soil
with **BiocharMax™**
www.kelloggsgarden.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

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





Adding biochar can enhance the composting process:

- Reduces odor
- Reduces ammonia loss
- Increases nitrogen retention
- Accelerates the composting process
- Enhances the beneficial biological populations in compost !



char-grow.com



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



Green Frontier Compost



Yates Curly Kale

Missouri Organic Recycling
www.missouriorganic.com/compost

Biochars Complement Beneficial Supplements



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

ambiochar.com/products



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

andersonshumates.com/products/#HumicDG



IN CALIFORNIA'S SAN JOAQUIN VALLEY, WHERE WATER IS BOTH EXPENSIVE AND PRECIOUS, WATER CONSERVATION STUDIES USING BIOCHAR ARE ALSO CURRENTLY UNDERWAY*.



(tomatoes)



(harvest)

* (working with the California Department of Water Resources)

AGRICULTURAL USES FOR BIOCHAR

Biochar can be used as a soil amendment to build healthy soil in a variety of applications



LEARN MORE AT
www.biochar-us.org

Animals Inoculate, Distribute, and Mix Biochars in Soil, Improve Forage, Animal Health, Soil Health



- Deer, elk, cattle, pigs, chickens, goats, sheep feed on char which improves health and increases egg, milk, and meat production. Enriched biochar is passed out in the dung. Chars absorb nutrients from manures and reduce odors.
- Dung Beetles mix and inoculate biochars into soil, improving forage quality and production.
- Worms ingest biochar to form inoculated micro and nanocarbons

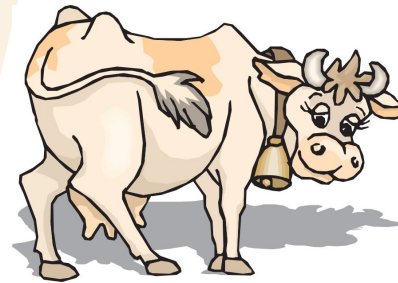
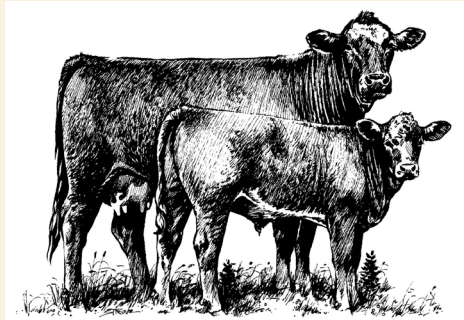
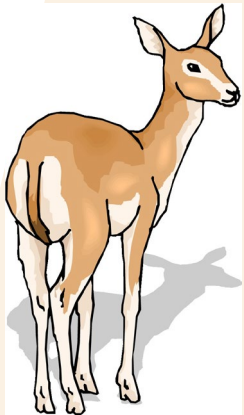


Photo: Sr. Miriam Paulette



Photo: Kathy Dawson

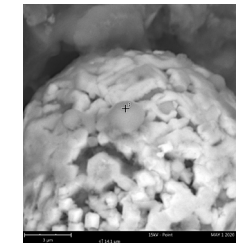
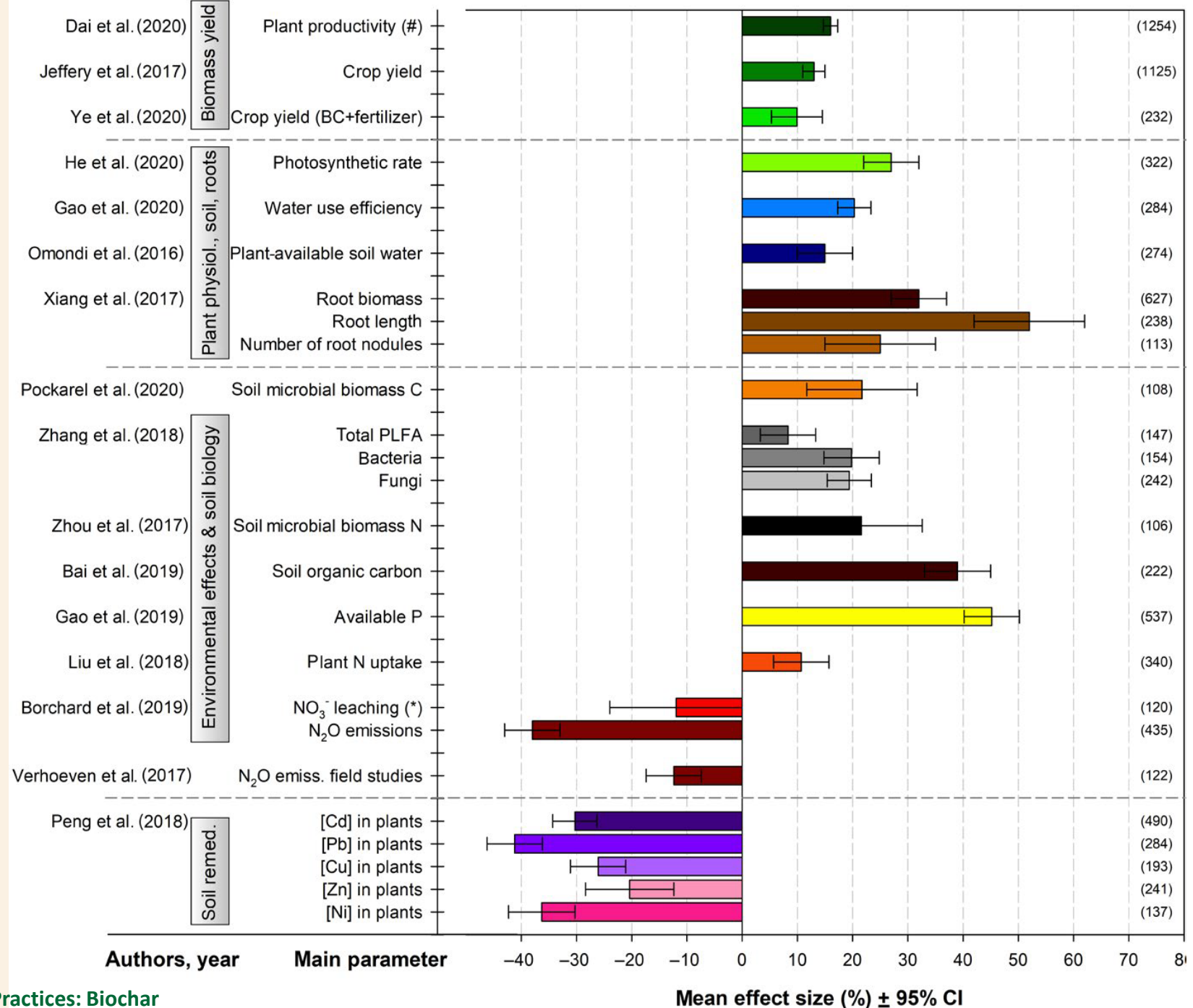


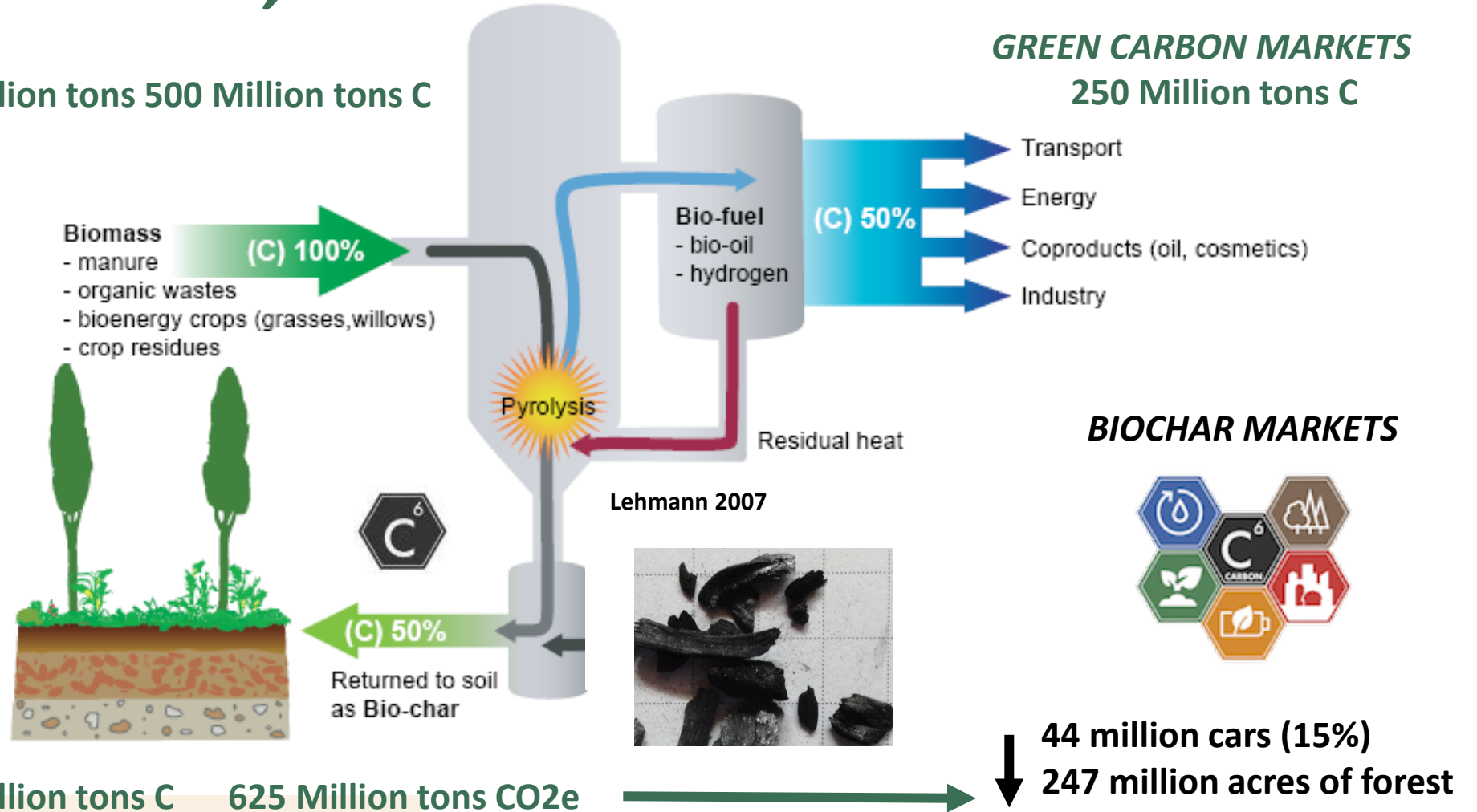
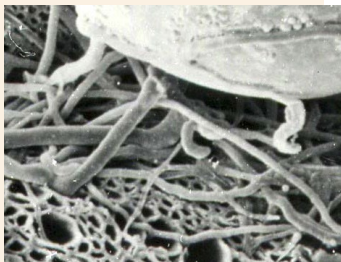
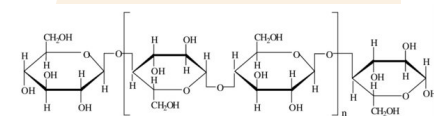
Photo: Stephen Joseph

Biochar Benefits: 26 Reviewed Meta- Analyses (Schmidt et. al. 2021)



Climate Markets: Make Renewable Energy, Sequester Carbon, Increase Soil Carbon

Sustainable Biomass 1 Billion tons 500 Million tons C



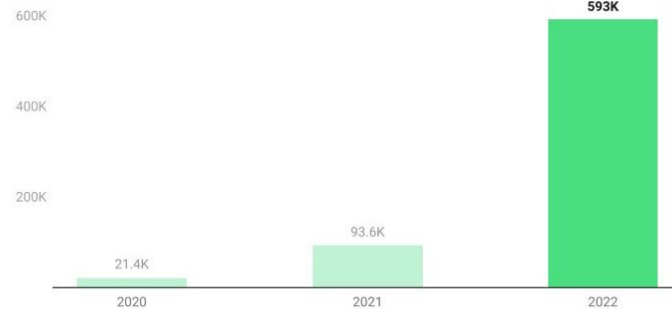
1 mt CO₂e = 1 Carbon Dioxide Removal Certificate (CDR or CORC™) 2.0-3.2 CDRs/mt Biochar

Carbon Removal Markets Fund Biochar Production



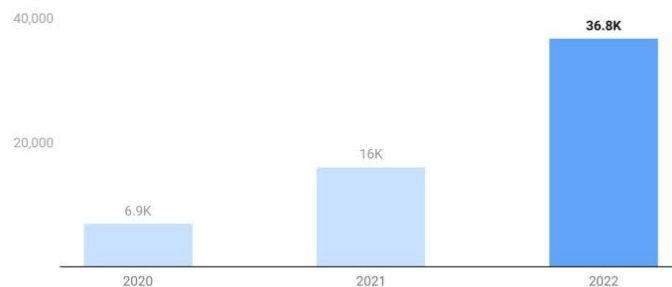
Carbon Removal Purchases

Total annual tonnes of carbon removal purchased

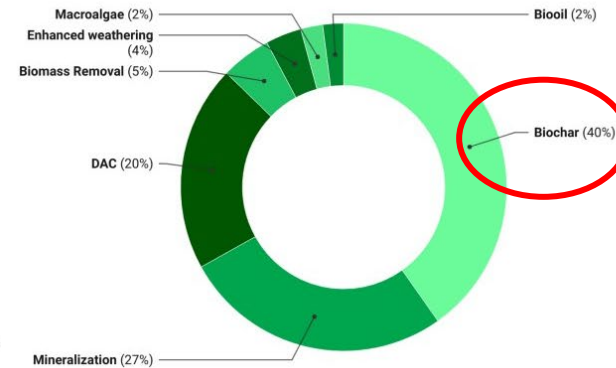


Carbon Removal Delivery

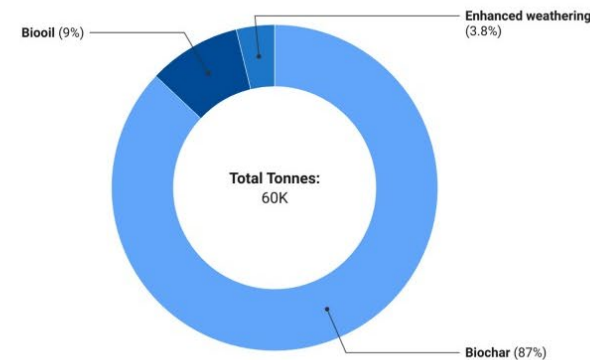
Total annual tonnes of carbon removal delivered



2022 CDR Purchases by Method

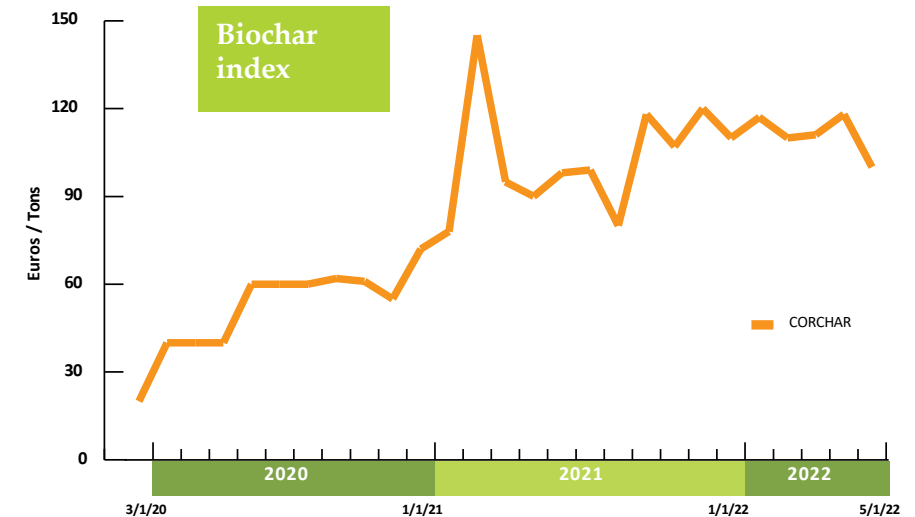


All-Time CDR Delivery by Method



Biochar CDR 40% of Purchases

Biochar CO2e Credits Offset Production Costs, Enable Finance



biochar-us.org/biochar-removes-carbon

CDR.fyi



Forest Resources Provide Carbon for Forestry and Agriculture

FOREST TO FOREST

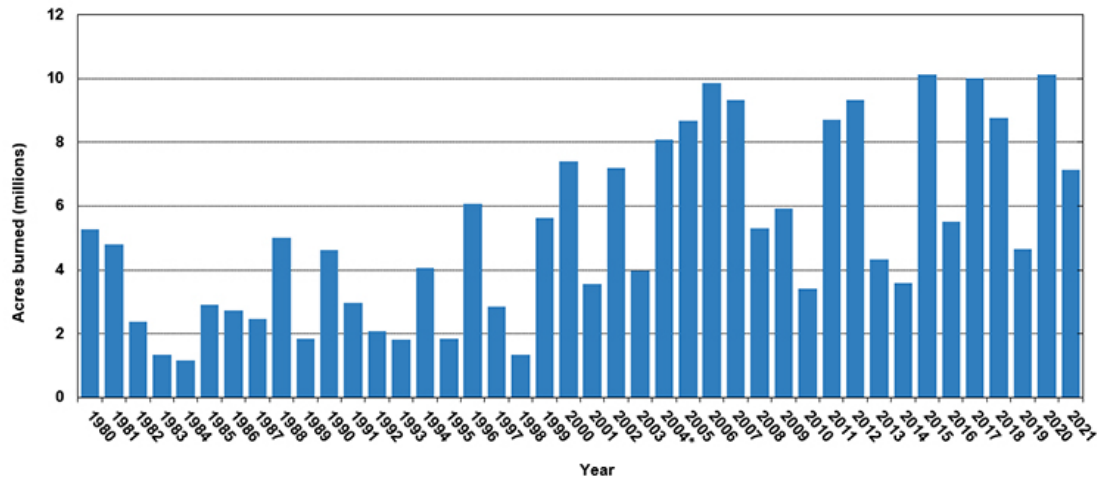


GREENHOUSE ENERGY & BIOCHAR
Excess forest fuels and salvage wood create energy and help build healthy soils



LEARN MORE AT
www.biochar-us.org

Biochar From Hazardous Forest Fuels Removed To Prevent Wildfires



Insurance Information Institute
[iii.org/fact-statistic/facts-statistics-wildfires](https://www.iii.org/fact-statistic/facts-statistics-wildfires)

Year	Wildfires #	Acres Burned Million
2022	66,255	7,5
2021	58,733	7.1
2020	58258	10.3
2019	49,786	4.6
2018	55,911	8.6

Highest Risk: CA, TX, CO, AZ, ID, WA, OK, OR, MT, UT



USFS Biochar Development

bit.ly/3NCtv78



FORESTERS CAN ALSO REMOVE FOREST FUELS USING PORTABLE WOOD GRINDING EQUIPMENT. THESE PRODUCE WOOD CHIPS THAT CAN BE LOADED INTO CHIP VANS FOR TRANSPORT TO NEARBY BIOMASS POWERPLANTS, WHERE THEY ARE CONVERTED INTO ENERGY AND BIOCHAR.



FORESTS AND BIOCHAR
Excess forest fuels can create energy and help build healthy soils



LEARN MORE AT
www.biochar-us.org

Integrated Modular Pyrolysis Systems: Heat and Biochar – BET, ARTiChar,



BET

biomassenergytechniques.com



ARTi

ARTi.com



Climate-Smart Forest-Related Practices: Biochar



Small Industrial Gasifiers Produce Heat and Biochar



Earthcare LLC

earthcarellc.com

2.5 tph fuel

Wood, Manure, Litters, Gasification, Heat



Ecoremedy

Fluid Lift Gasification

ecoremedyllc.com

Wood, Manure, Digestate, Biosolids,
Heat



Green Sawdust Gasifier Chars Enhance Turf and Trees

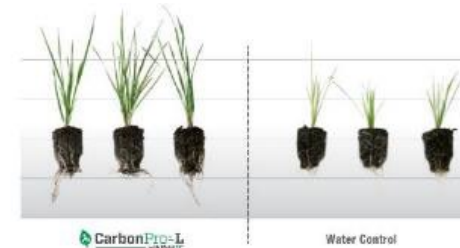


KDS Systems Green Sawdust Gasifier heats Lumber Dry Kilns www.kdskilns.com
3-5 tph fuel input, .25-0.4 t/hr biochar

Biochar co-product refined for landscaping



Liquid or granular biotic soil amendment for golf and turf (LESCO CarbonPro lesco.com)



CarbonPro
www.lesco.com/products/carbonpro

Deeper stronger roots
Improved greening
Improved Soil and Seed Establishment
Increased Nutrient Uptake and Efficiency
Reduced Water Requirements
Targeted Benefits



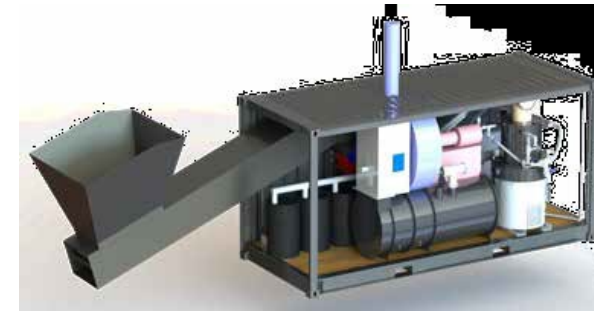
Small Scale Gasifiers for Combined Heat and Biochar



Phoenix Energy
California
2 MWe + Biochar
Eqtec.com gasifier
phoenixenergy.net



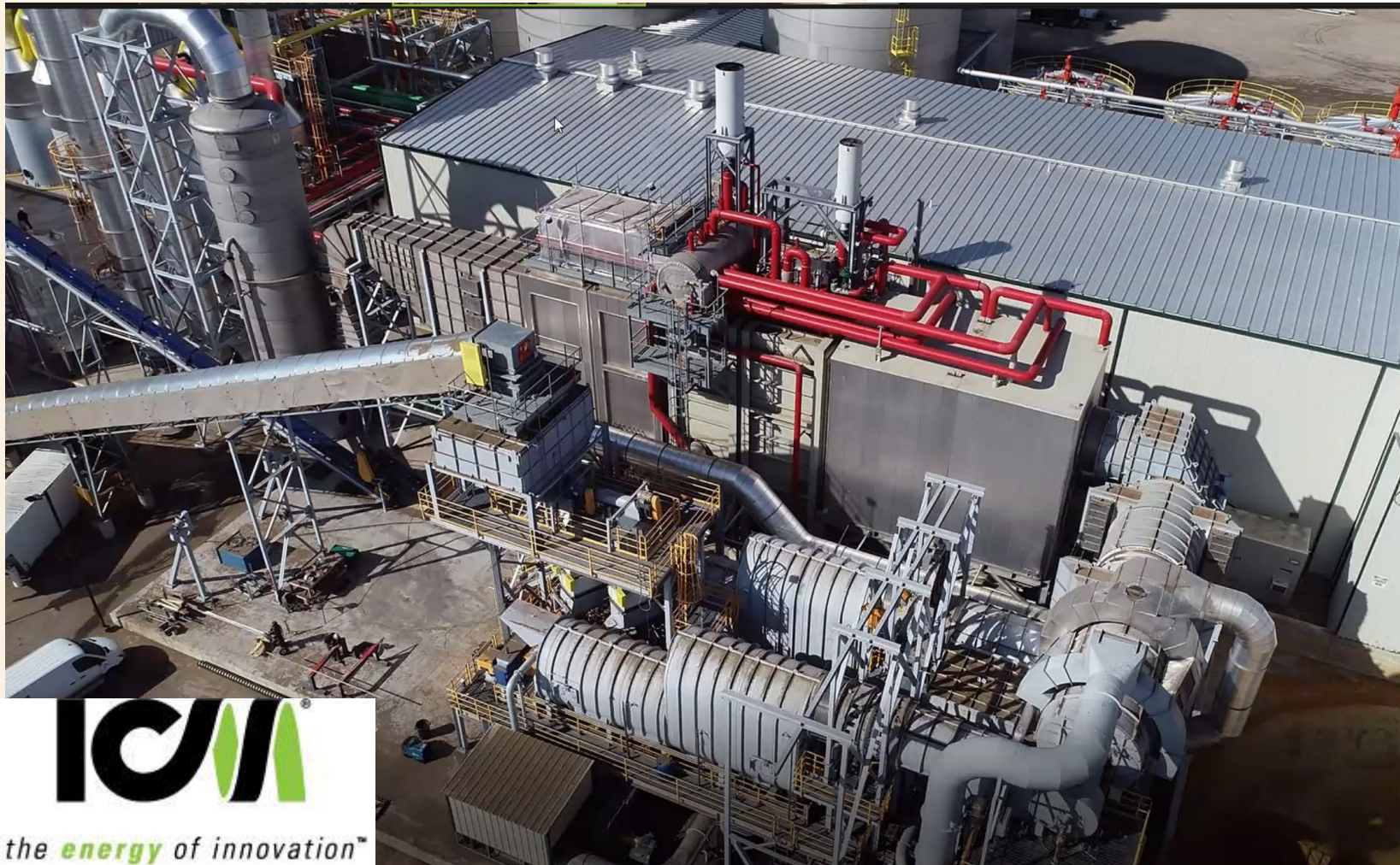
Qualterra
Heat +Biochar
www.qualterraag.com



All Power Labs
Chartainer 150 kWe+biochar
(Under development)
www.allpowerlabs.com



Wood Gasifier: Biochar, Steam and Power (10 MWe)



Waste Wood Heats Kansas Ethanol Plant ICMinc.com



Biochars are Delivered in Bulk



2 CY 400 lb dry

- High carbon
- Low Volatiles
- Low Ash
- Low Fines
- Good Flowability

Oregon Biochar Solutions
www.chardirect.com

80 CY 8-10 t



From Factory to Field



 **PACIFIC
BIOCHAR**
[Pacificbiochar.com](https://pacificbiochar.com)



Blending into windrows at a compost yard



Climate-Smart Forest-Related Practices: Biochar



Pacific Biochar

Field Application Example: applied down planting row, then ripped into soil profile



Field Application Example: BROADCAST (Add Water!)



Add Water to Reduce Dust

Wet Biochar Spreads Like Manure

(these images are captured from internet)



Progressive Farms Incorporate Biochars and Blends



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

Natural Plant Solutions, WA naturalplantsolutions.com

Biochar

Biochar-organic fertilizer

Biochar-based fertilizer

Liquid suspension



“Biochar Is A Change Agent”

Jason Mauck, Constant Canopy constantcanopy.com



Biochar Improves Fertilizer Use in Row Crops



David Yarrow, Down the Wormhole, 2016

terra-char.com/jr-bollingers-corn

J.R. Bollinger

Sikeston, Missouri

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

David Yarrow, Down the
Wormhole, 2016
Terra-char.com



terra-char.com/jr-bollingers-corn

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



INCREASING SOIL ORGANIC MATTER AND REDUCING INPUT COSTS ON AN OLD NORTHERN CALIFORNIA VINEYARD BY USING BIOCHAR-AMENDED COMPOST.



COVER CROP
(compost with biochar)

COVER CROP
(compost without biochar)

AGRICULTURAL USES FOR BIOCHAR

Biochar can be used as a soil amendment to build healthy soil in a variety of applications



LEARN MORE AT
www.biochar-us.org

Liquid Biochars Are Sized, Diluted 1:5, Applied 1:20



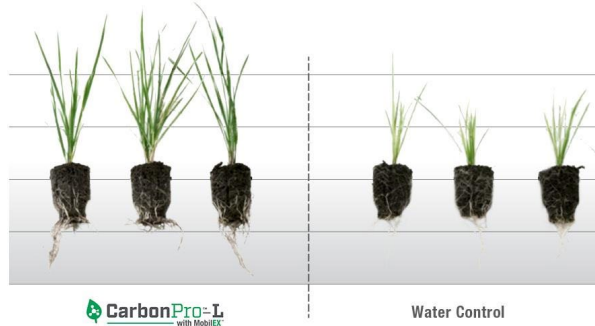
**Biochar Slurry Fed in No Till
Cross Slot (Don Graves, NZ)**



**LET YOUR PLANTS
EAT ORGANIC.**

LESCO® CarbonPro™ delivers natural
optimizing technology to soil and plants.

Liquid or granular biotic soil amendment for golf and turf
(LESCO CarbonPro lesco.com)



**Deeper stronger roots
Improved greening
Improved Soil and Seed Establishment
Increased Nutrient Uptake and Efficiency
Reduced Water Requirements
Targeted Benefits**

Biochar Seedballs Aid Aerial Seeding



Airseed Technologies

airseedtech.com



USDA Biochar Atlas: Match Biochar With Soil and Crops Needs

www.pnwbiochar.org

BIOCHAR PRODUCERS

DIRECT OUTREACH
FACTSHEETS
WEBINARS
FEEDBACK



FARMERS



USDA ARS PNW Biochar Atlas + USDA NRCS Soil Health Program

BIOCHAR LIBRARY

COLLECT &
CHARACTERIZE
BIOCHARS



INREACH NRCS

TRAININGS
WORKSHOPS



MODEL IMPLEMENTATION

WEB DEVELOPMENT

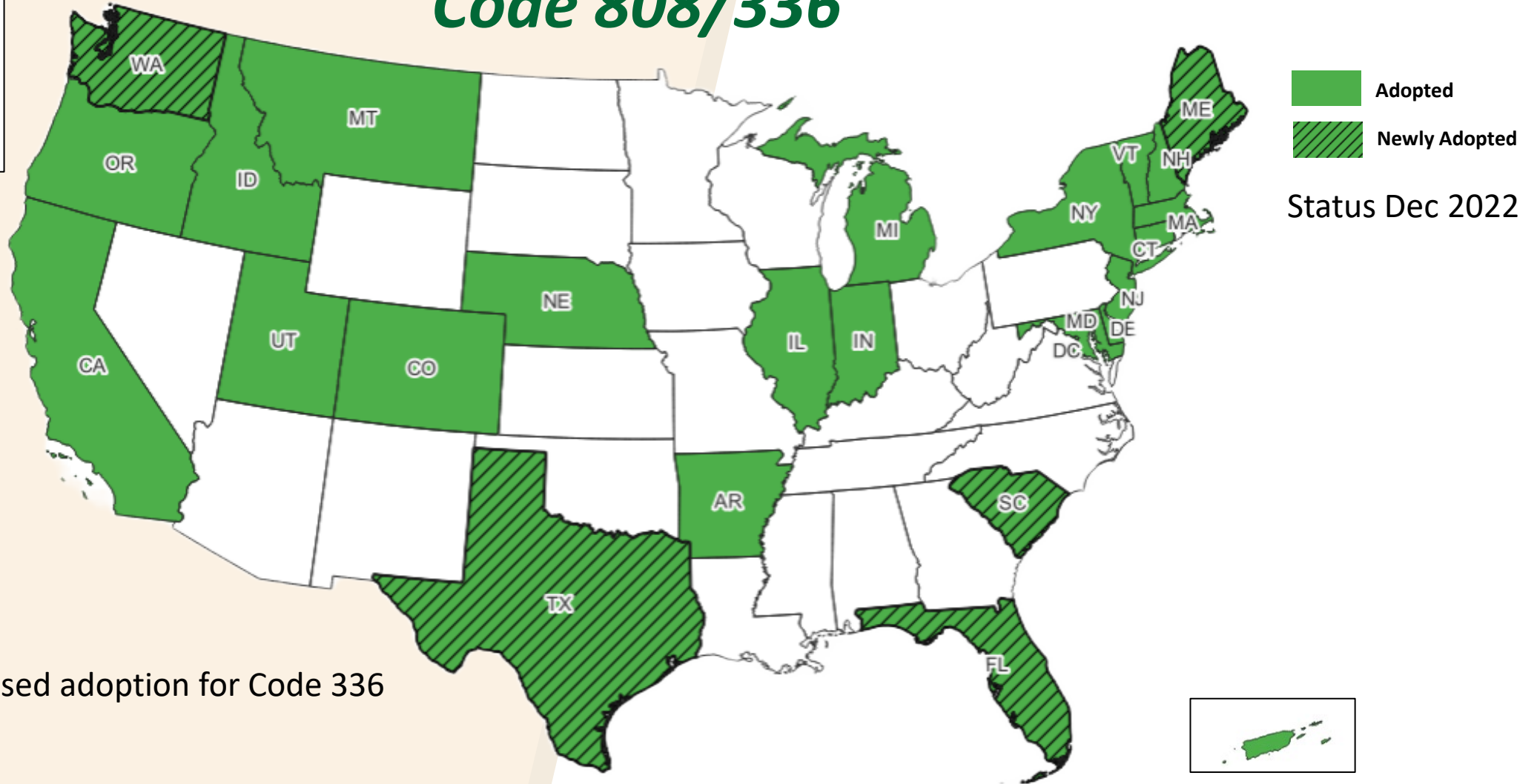
Climate-Smart Forest-Related Practices: Biochar

MODEL DEVELOPMENT

ADD GHG AND C
SEQUESTRATION
ESTIMATES



Boost Biochar With USDA NRCS Soil Carbon Amendment Code 808/336



Anticipate increased adoption for Code 336

**New climate friendly technologies
convert low-value wood waste to biochar
reduce wildfire risk and
facilitate biochar application on farmlands.**



**Carbon Markets fund increased biochar production
reduce costs**



**USDA creates tools and opportunities to
increase Soil Carbon and
improve Soil Health**



**Biochars and biochar amended products from wood residues
help improve food production and climate resilience.**

Just Add Biochar!



Thank you!

US Biochar Initiative

USBiochar@gmail.com

www.biochar-us.org



Photo: Josiah Hunt