Coupling Biochar with NRCS Practices

To Enhance & Maximize Water Quality Benefits

ALLIED SOIL HEALTH

Brandon R. Smith, Ph.D.

In collaboration with the US Biochar Initiative and the Center for Watershed Protection

USBI Building the future from the ground up.™

CENTER FOR WATERSHED PROTECTION

ALLIED
SOIL HEALTH

Started ASH in fall of 2022

National consulting company focuses on using biochar to amplify soil health practices.

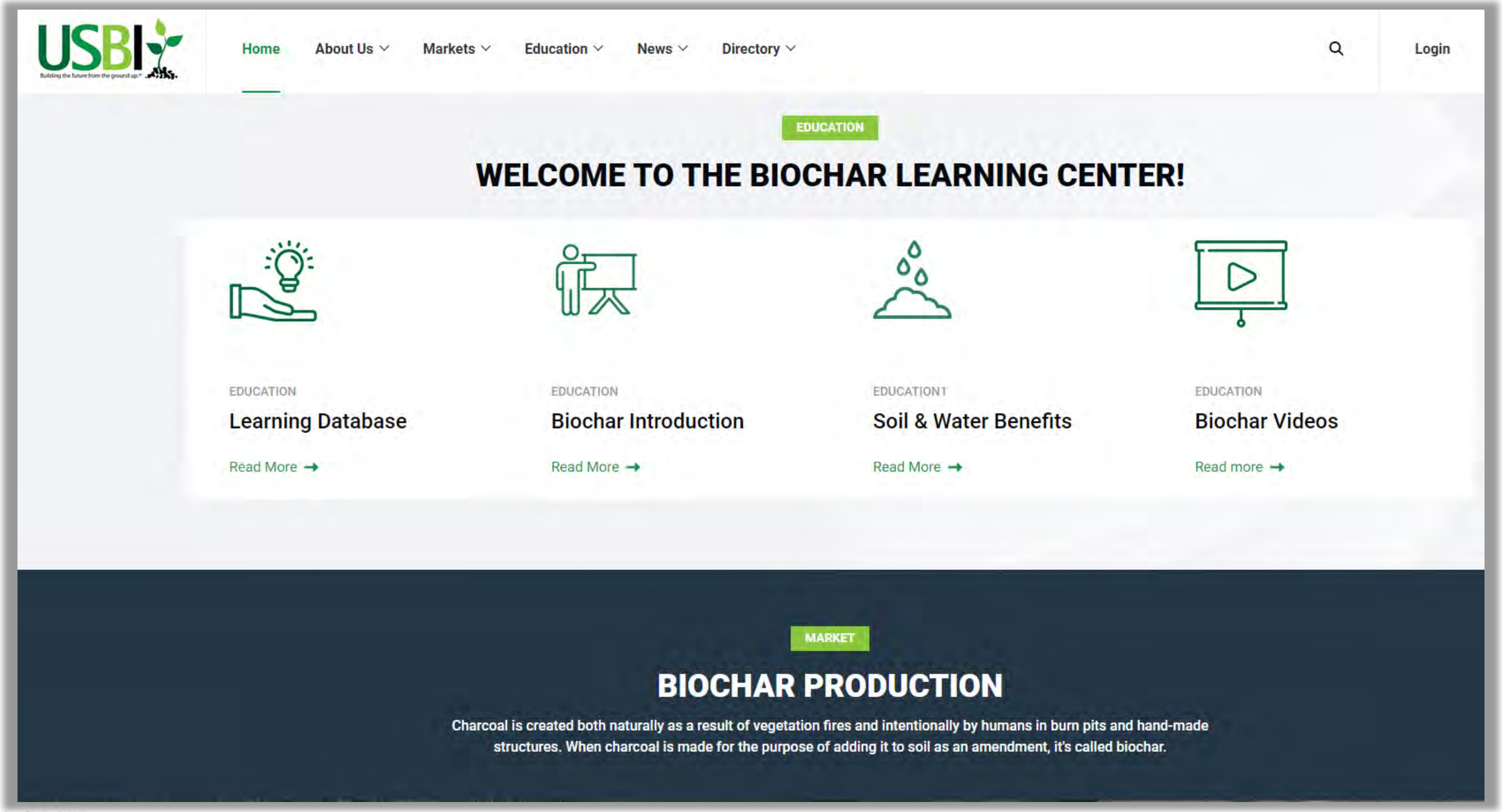
14 Years with NRCS at State, Regional & National Level
- Developed soil health practices and plans
- Best known for 808/336 Soil Carbon Amendment

Research professor of organic production a UT
Research technician at UNH

B.S., M.S., and Ph.D. in Horticulture & Agronomy from UNH and Cornell

Information and views presented here independent are <u>not</u> representative of the USDA

US Biochar Initiative: biochar-us.org



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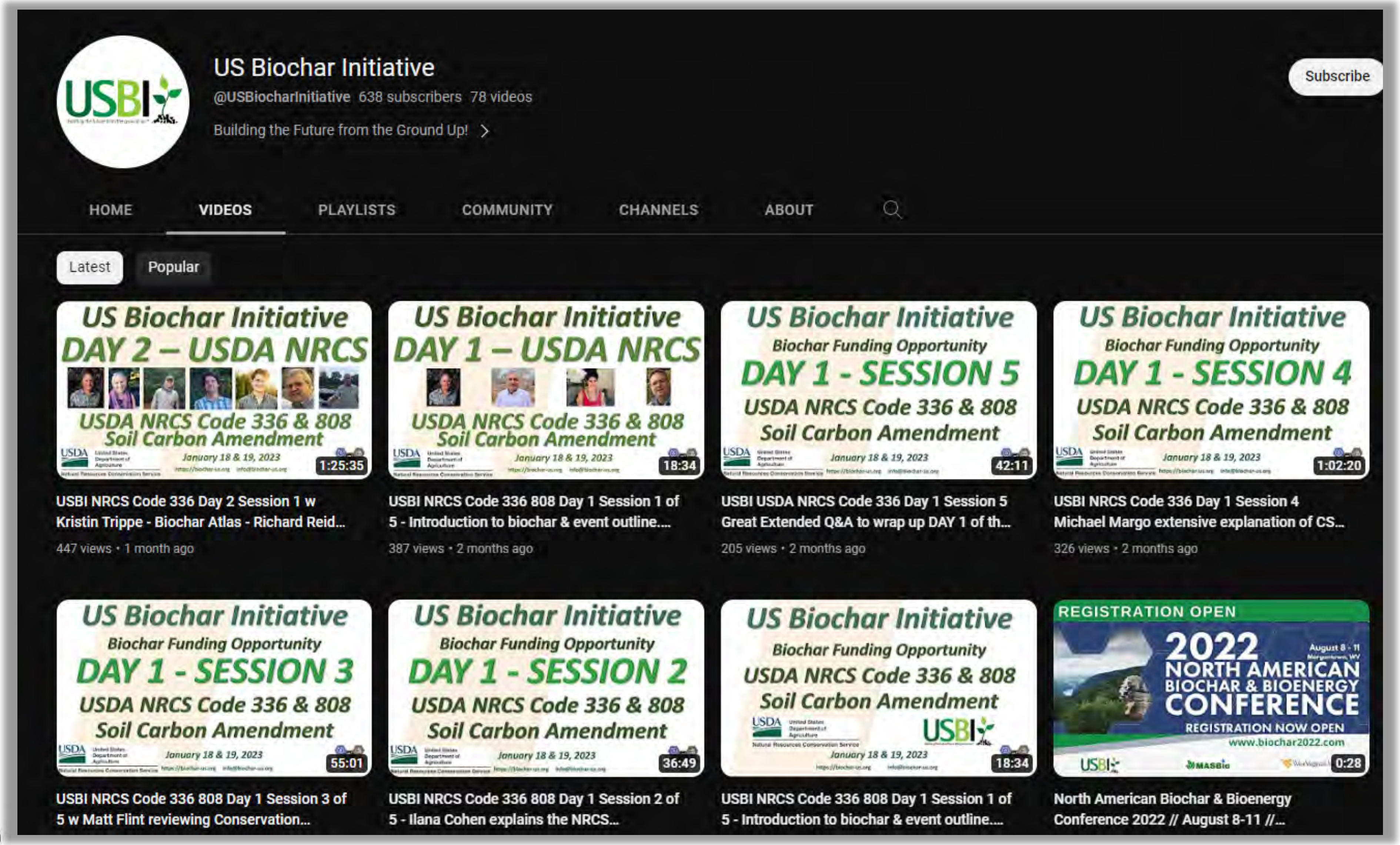
youtube.com/@USBiocharInitiative/videos



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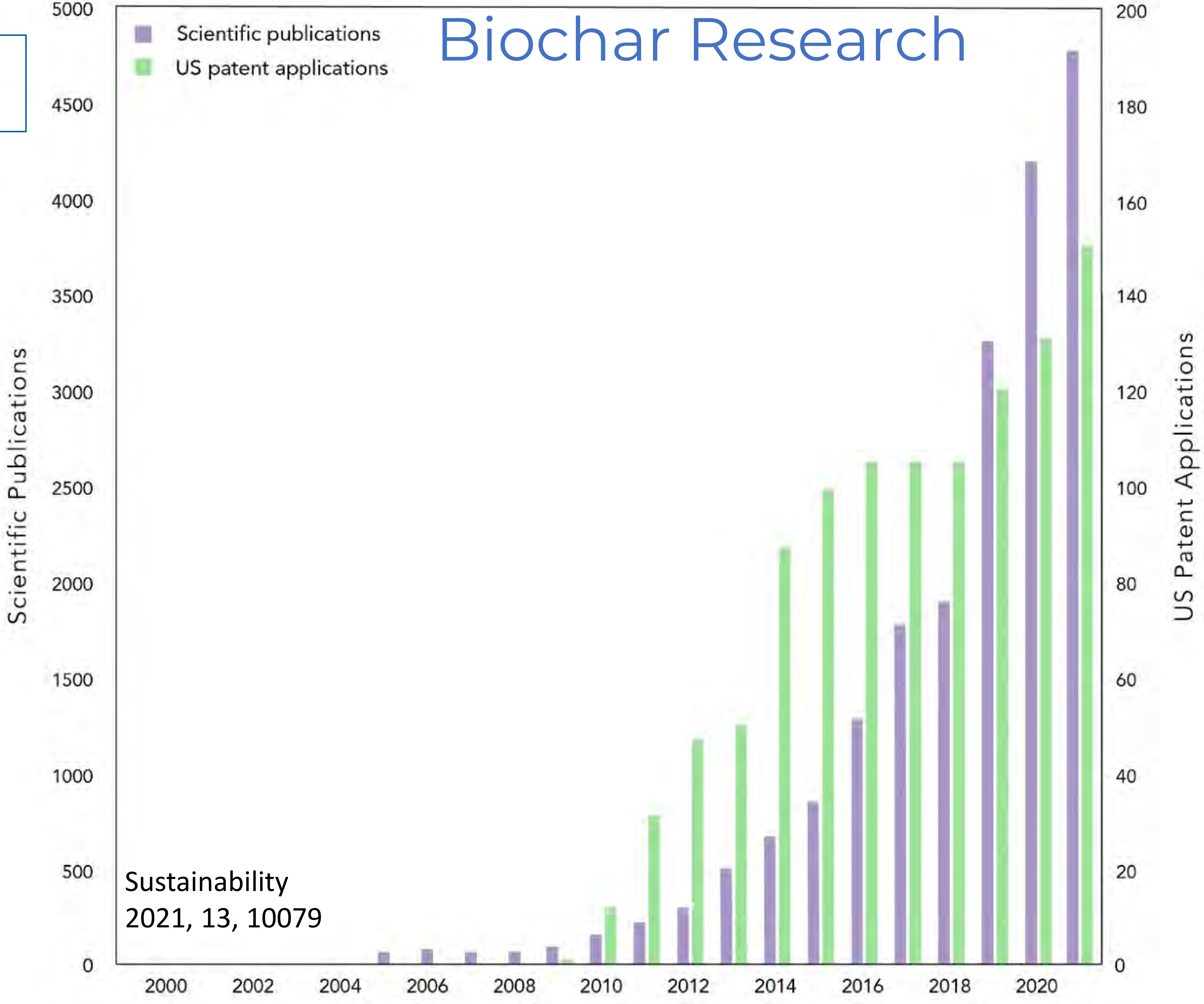
Biochar Research

8 National CIG's
10 State CIG's



Sustainability
2021, 13, 10079

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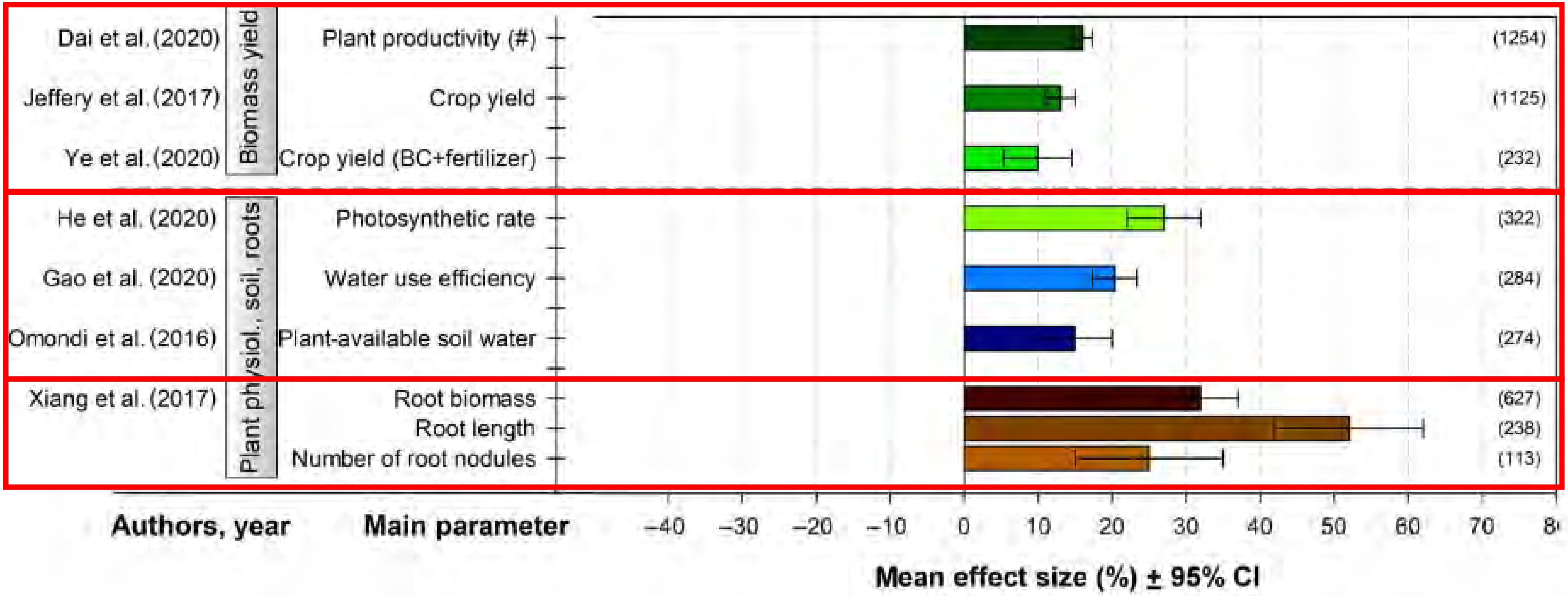
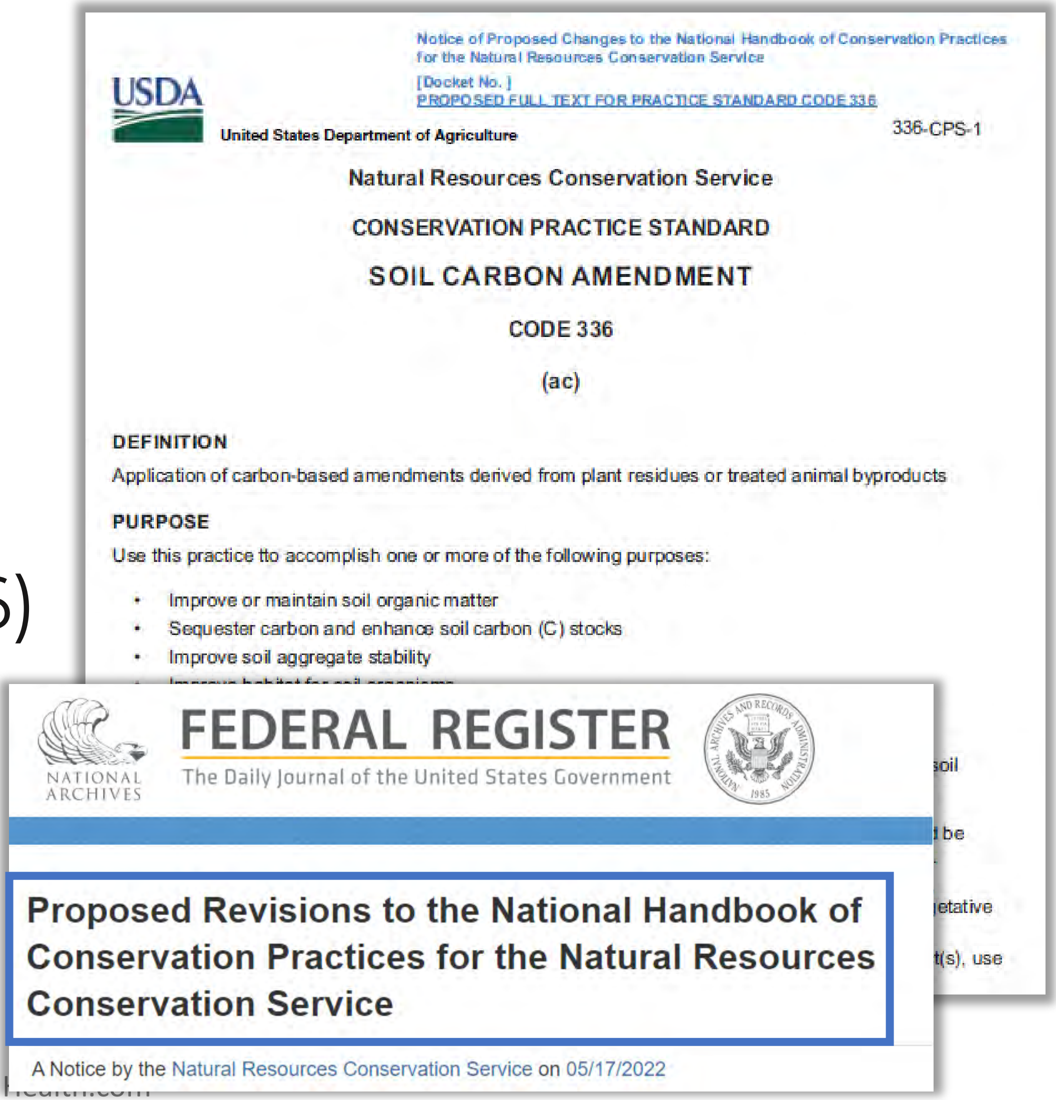
Biochar Impact on Plant Growth & Yield



Schmidt, H.-P., C. Kammann, N. Hagemann, J. Leifeld, T.D. Bucheli, et al. 2021. Biochar in agriculture – A systematic review of 26 global meta-analyses. GCB Bioenergy 13(11): 1708–1730. doi: 10.1111/gcbb.12889.

Soil Carbon Amendment Practice Standard

- Application of C-based Amendments
  - Biochar
  - Compost
- Interim Practice (808)
  - Created in 2018
  - Evaluation & Refinement
- Transitioned to National Practice (336)
  - Nov 2023 Release
  - States can use either for a 1-year period


Notice of Proposed Changes to the National Handbook of Conservation Practices for the Natural Resources Conservation Service
[Docket No.]
PROPOSED FULL TEXT FOR PRACTICE STANDARD CODE 336

USDA 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 residues or treated animal byproducts

PURPOSE

Use this practice tto accomplish one or more of the following purposes:

- Improve or maintain soil organic matter
- Sequester carbon and enhance soil carbon (C) stocks
- Improve soil aggregate stability

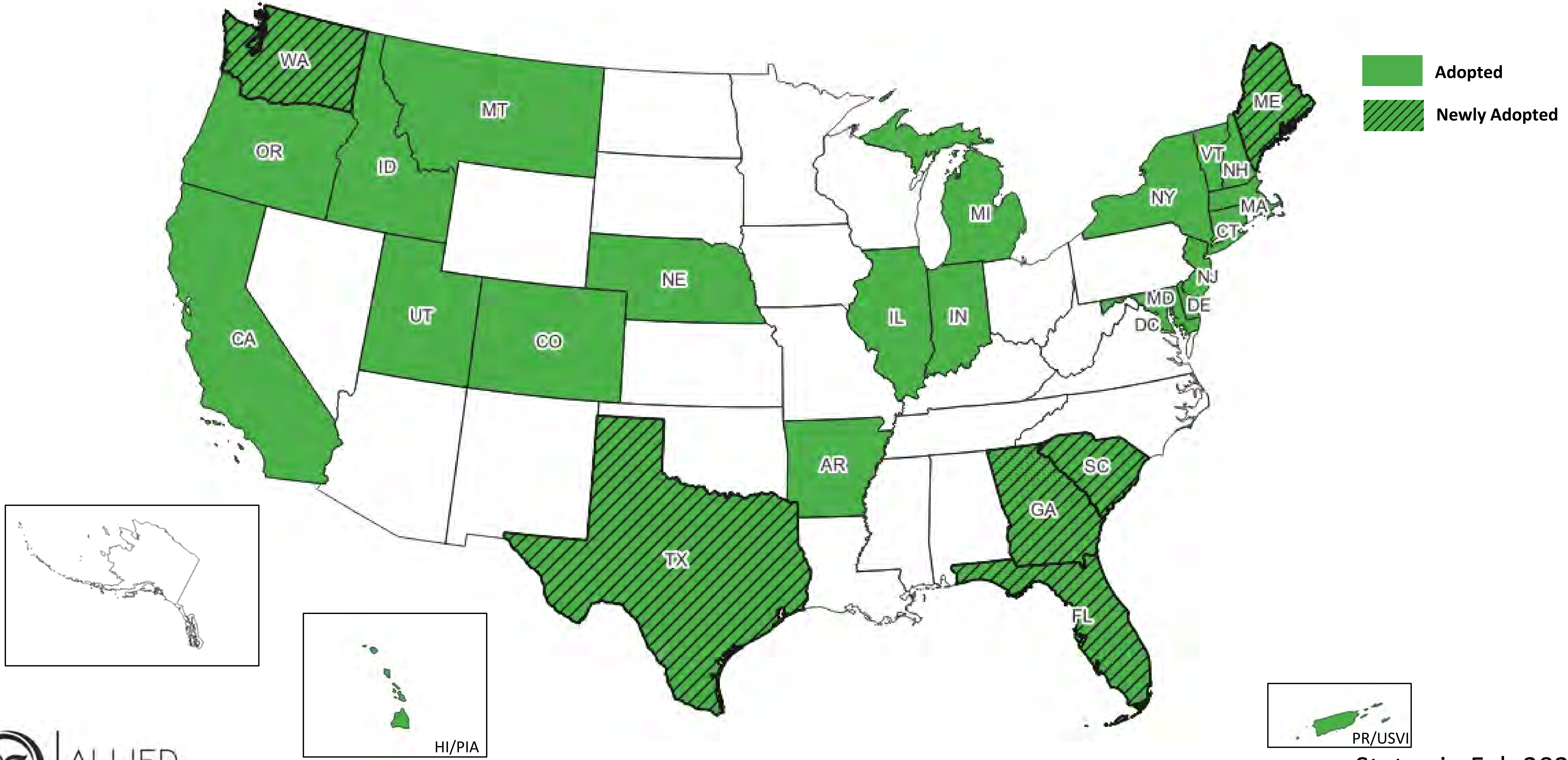
FEDERAL REGISTER
The Daily Journal of the United States Government

NATIONAL ARCHIVES

Proposed Revisions to the National Handbook of Conservation Practices for the Natural Resources Conservation Service

A Notice by the Natural Resources Conservation Service on 05/17/2022

State Adoption of 808



Status in Feb 2023

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USDA 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.

PURPOSE

Use this practice to accomplish one or more of the following purposes:

- Improve or maintain soil organic matter.
- Sequester carbon and enhance soil carbon (C) stocks.
- Improve soil aggregate stability.
- Improve habitat for soil organisms.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions.

States may add a purpose by requesting a variance as outlined in Title 450, General Manual, Part 401, Subpart B, "Variances" (450-GM-401-B). States may delete any purpose that addresses a resource concern that has not been identified in that State.

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Table 1. Parameters for All Carbon Amendments

Parameter	Range	Unit
Feedstock	Report[1]	Type by %
pH	Report	pH units
Electrical Conductivity (EC)	Report	dS/m
Moisture	Report	%
Organic Matter/Carbon	Report	% DW[2]
Total Nitrogen	Report	% DW
Particle Size	Report	% per size class
Phosphorus	Report	mg/kg[4] DW
Potassium	Report	mg/kg DW
Calcium	Report	mg/kg DW
Magnesium	Report	mg/kg DW
Arsenic[3]	<41	mg/kg DW
Cadmium	<39	mg/kg DW
Copper	<1500	mg/kg DW
Lead	<300	mg/kg DW
Mercury	<17	mg/kg DW
Nickel	<420	mg/kg DW
Selenium	<100	mg/kg DW
Zinc	<2800	mg/kg DW

[1]Report results, also see criteria under amendment type.

[2]DW = Dry weight.

[3]Pollutant concentration limit values from US EPA Title 40 Part 503 STANDARDS FOR THE USE OR DISPOSAL OF SEWAGE SLUDGE. Follow State and local laws and regulations.

[4]milligrams per kilogram (mg/kg) = parts per million (ppm) = grams per ton ($g\ t^{-1}$)

Biochar

Use biochar that is produced by heating biomass to a temperature in excess of 350 °C under conditions of controlled and limited oxygen concentrations to prevent combustion (i.e., pyrolysis or gasification). Use biochar with the International Biochar Initiative (IBI) Certified biochar seal or that meets the criteria in table 3 as determined by the methods in IBI Standards (version 2.1), or by LGU recognized methods.

Document:

- Origin of biochar and production method (e.g., verification of temperature and limited oxygen conditions).
- Parameters for All Carbon Amendments in table 1.
- Parameters for Biochar Amendments in table 3.

Table 3. Parameters for Biochar Amendments

Parameter	Range	Unit
Total Ash	Report[1]	% of total mass, dry basis
Liming equivalent	Report	% $CaCO_3$
Organic Carbon (C_{org})	>10	% DW
$H:C_{org}$	<0.7	Molar ratio
Chromium	<1200	mg per kg DW
[1]Report = Required results only, no threshold or range needs to be met		

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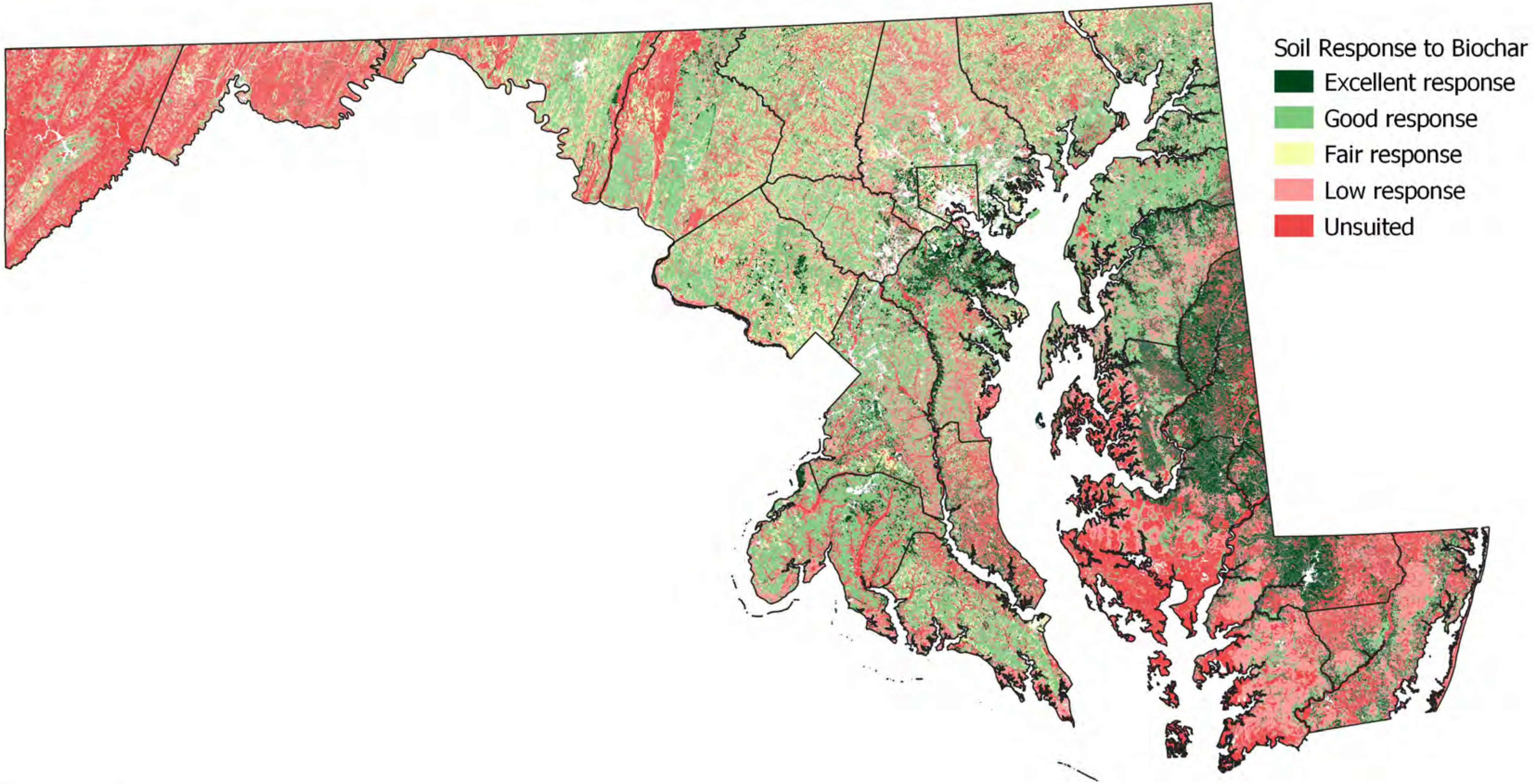
Dynamic Soil Properties Response to Biochar Application



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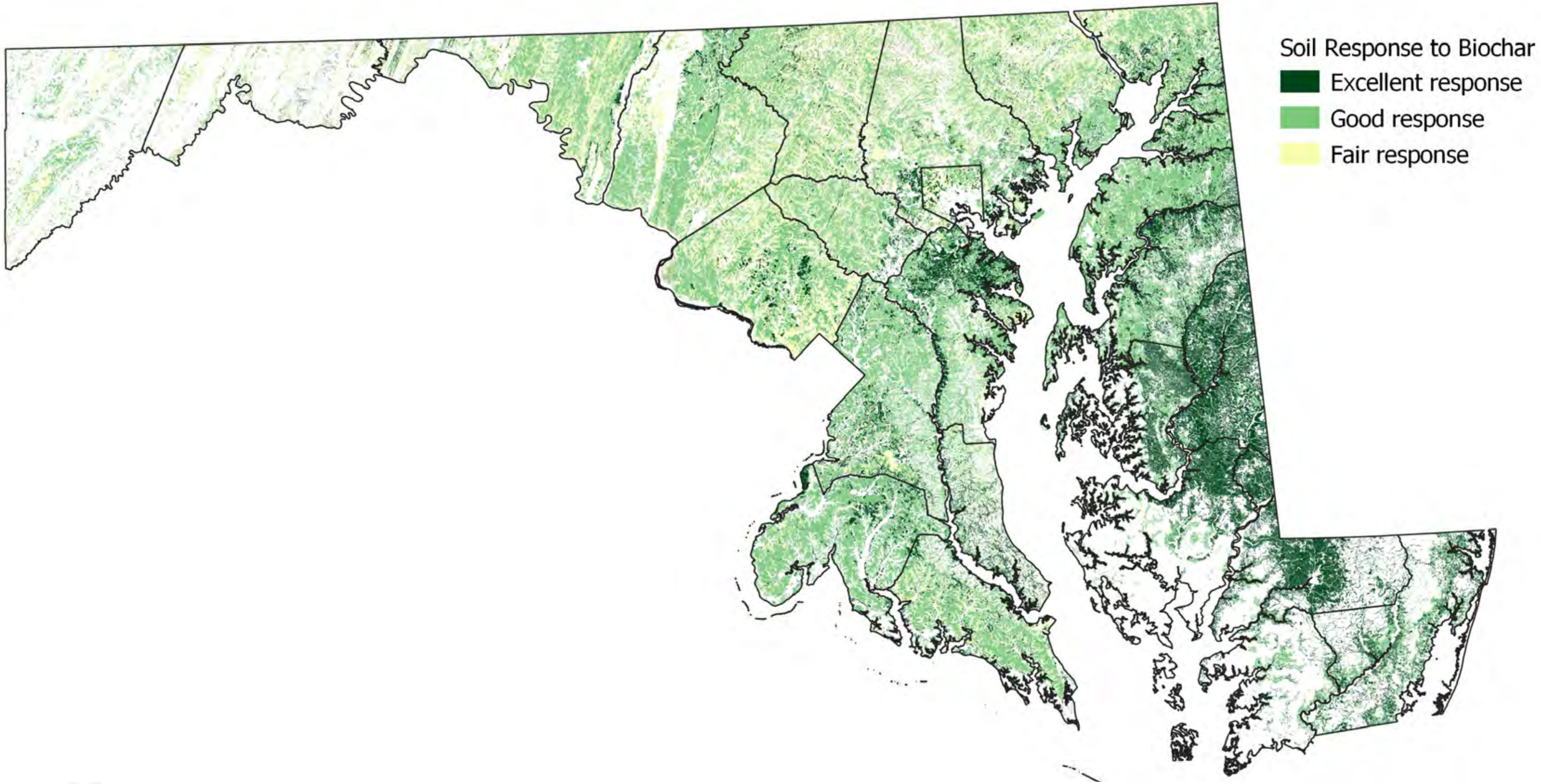
Dynamic Soil Properties Response to Biochar Application



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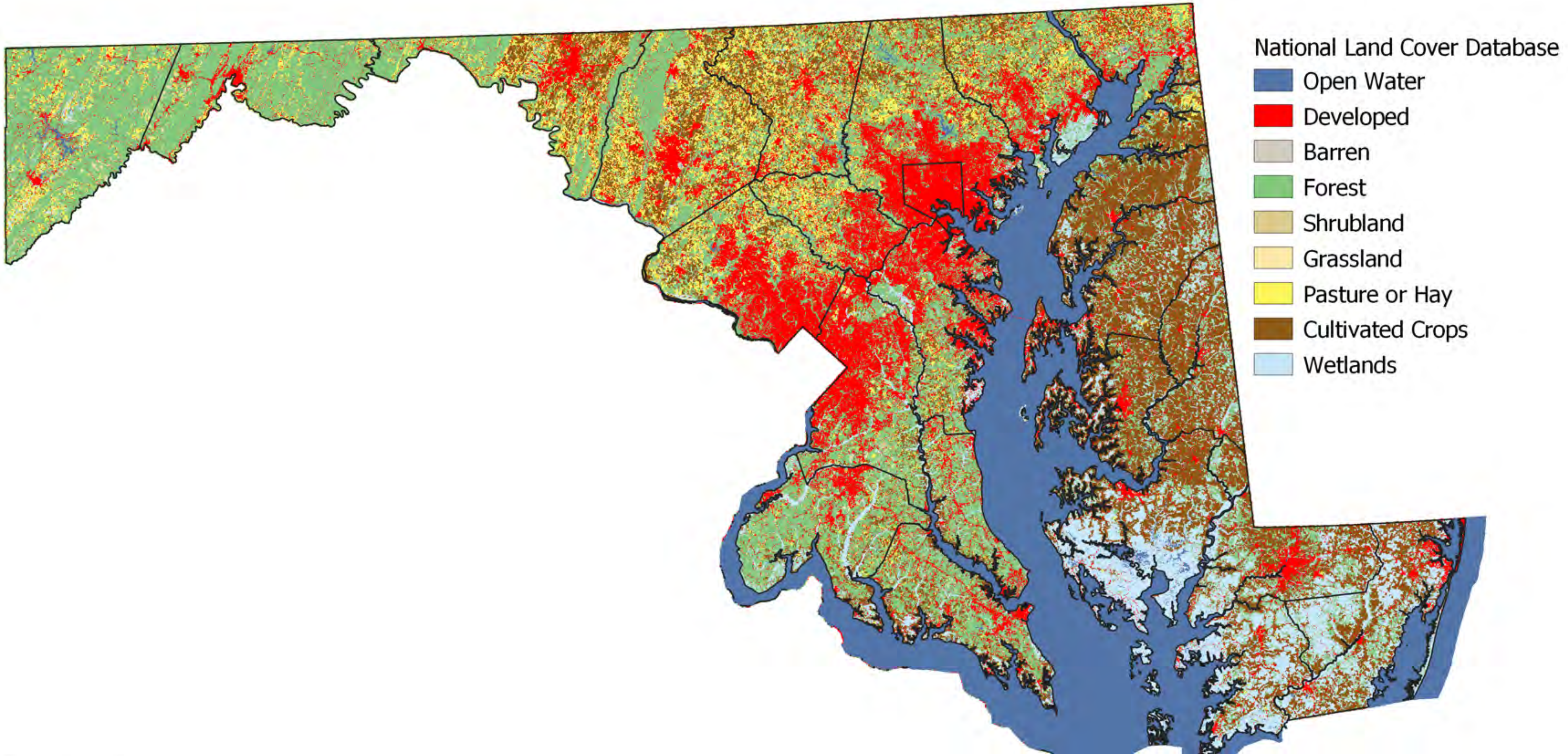
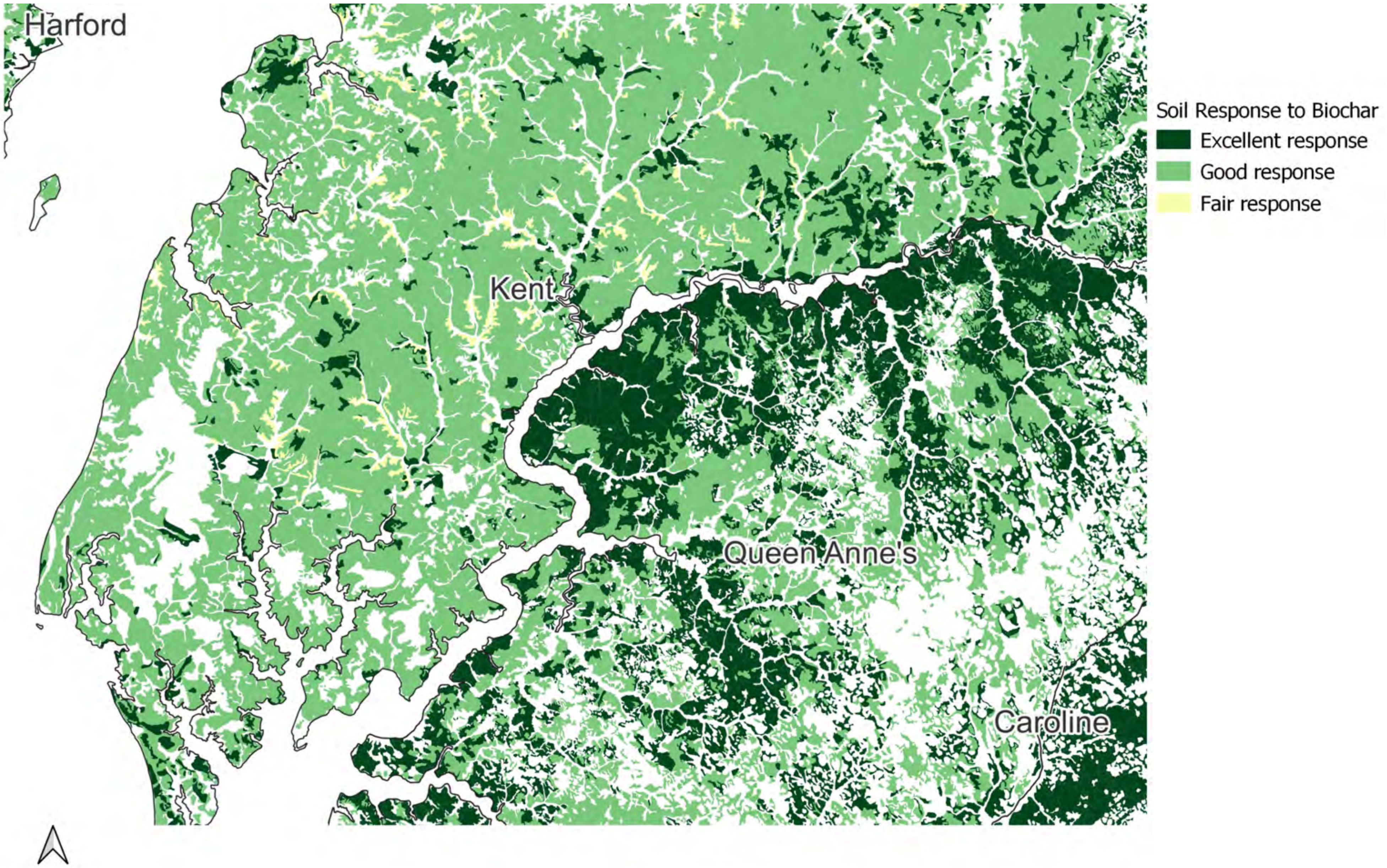
Land Cover

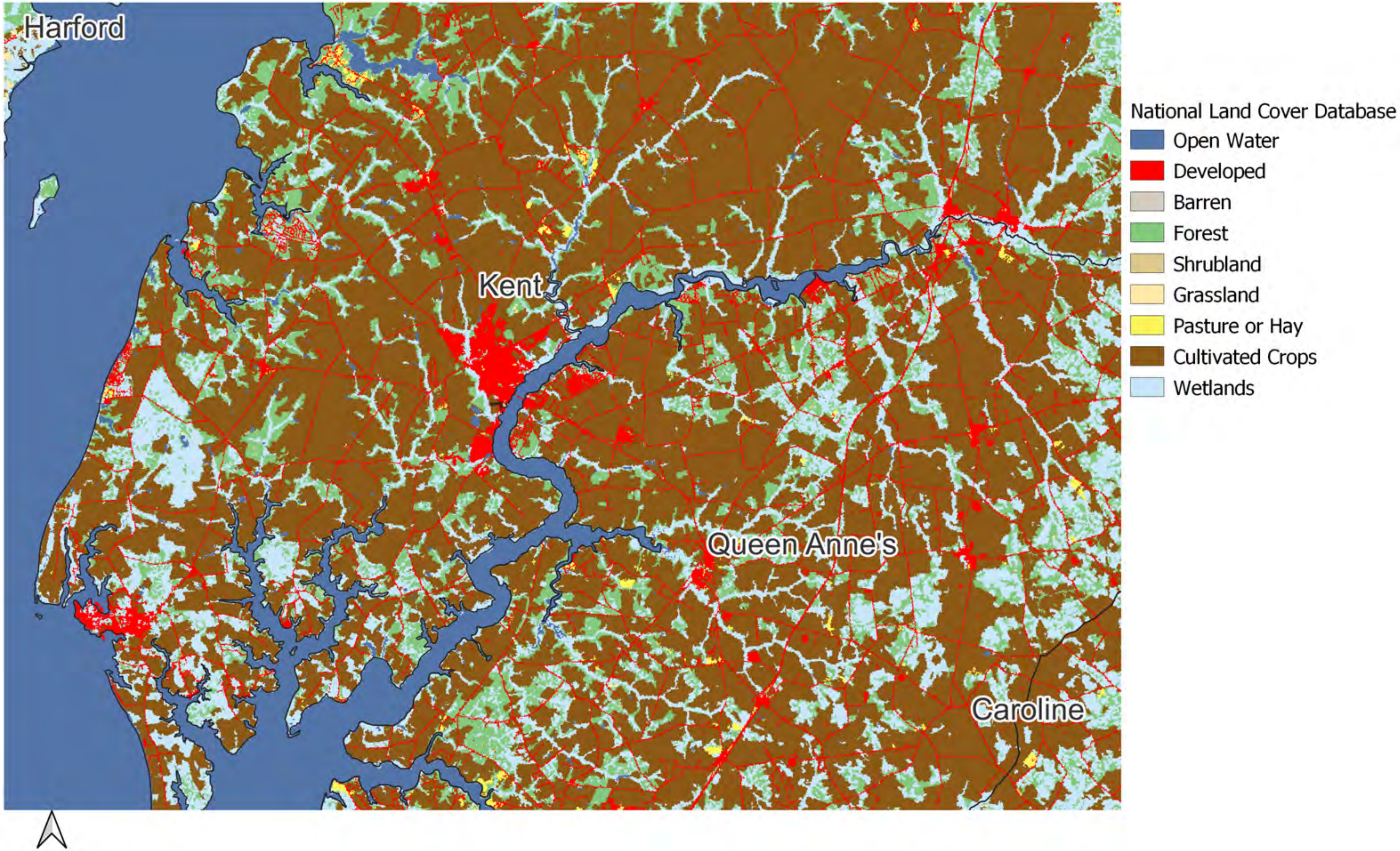

National Land Cover Database
Open Water
Developed
Barren
Forest
Shrubland
Grassland
Pasture or Hay
Cultivated Crops
Wetlands

Dynamic Soil Properties Response to Biochar Application



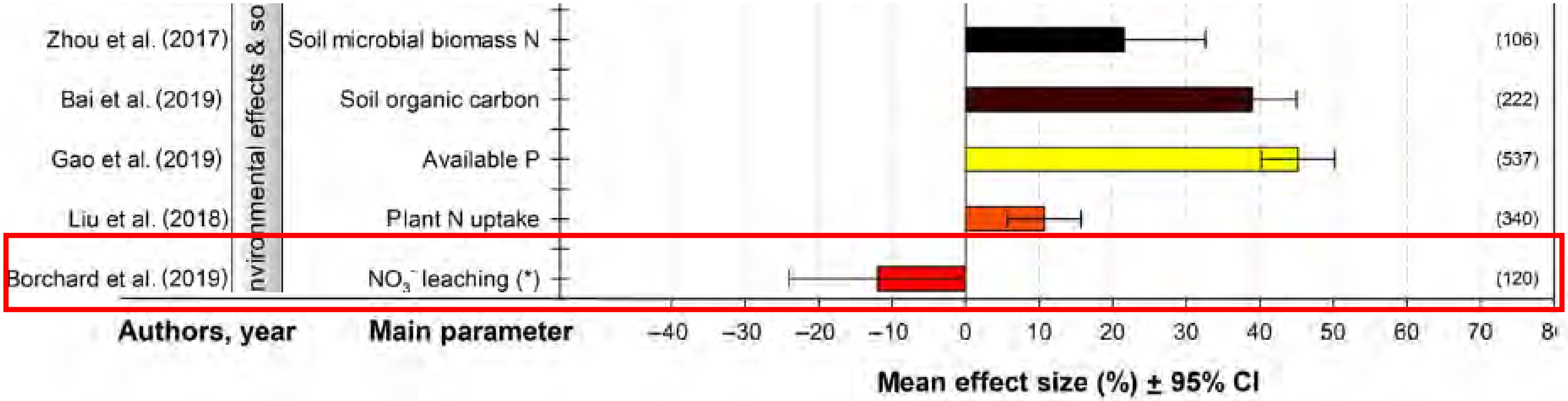
ALLIED SOIL HEALTH

Land Cover



Harford
Kent
Queen Anne's
Caroline
National Land Cover Database
Open Water
Developed
Barren
Forest
Shrubland
Grassland
Pasture or Hay
Cultivated Crops
Wetlands

Biochar Impact on Nutrients



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Biochar and N Utilization

- Biochar **Reduces Short-Term Nitrate Leaching** from a Horizon in an Apple Orchard
- Biochar **Reduced Nitrate Leaching** and Improved Soil Moisture Content without Yield Improvements in a Four-Year Field Study
- Over 20 studies revealed a **15-69% delay in N release** and **25-65% improvement in fertilizer use efficiency**
- Biochar coated urea **increased N use efficiency** for oilseed rape by 20%
- A ^{15}N study with biochar made from sewage sludge found that **N use efficiency from both soil N and fertilizer N was higher** in biochar treated soils compared to control

- Ventura, Maurizio, Giovambattista Sorrenti, Pietro Panzacchi, E. George, and Giustino Tonon. "Biochar Reduces Short-Term Nitrate Leaching from a Horizon in an Apple Orchard." *Journal of Environmental Quality* 42 1 (n.d.): 76–82.
- Haider, Ghulam, Diedrich Steffens, Gerald Moser, Christoph Müller, and Claudia I. Kammann. "Biochar Reduced Nitrate Leaching and Improved Soil Moisture Content without Yield Improvements in a Four-Year Field Study." *Agriculture, Ecosystems & Environment* 237 (January 2017): 80–94. https://doi.org/10.1016/j.agee.2016.12.019.
- Gao, Yurong, Zheng Fang, Lukas Van Zwieten, Nanthi Bolan, Da Dong, Bert F. Quin, Jun Meng, et al. "A Critical Review of Biochar-Based Nitrogen Fertilizers and Their Effects on Crop Production and the Environment." Biochar 4, no. 1 (June 13, 2022): 36. https://doi.org/10.1007/s42773-022-00160-3.
- Jia, Yiman, Zhengyi Hu, Yuxin Ba, and Wenfang Qi. "Application of Biochar-Coated Urea Controlled Loss of Fertilizer Nitrogen and Increased Nitrogen Use Efficiency." *Chemical and Biological Technologies in Agriculture* 8, no. 1 (January 8, 2021): 3. https://doi.org/10.1186/s40538-020-00205-4.
- Figueiredo, Cícero Célio de, Éllen Griza Wickert, Helen Cristina Vieira Neves, Thais Rodrigues Coser, and Jorge Paz-Ferreiro. "Sewage Sludge Biochar Increases Nitrogen Fertilizer Recovery: Evidence from a ^{15}N Tracer Field Study." *Soil Use and Management* 37, no. 4 (October 2021): 689–97. https://doi.org/10.1111/sum.12672.

NWQI projects focus on reducing nutrient, sediment, and bacteria runoff to surface waters through a variety of practices that **avoid, control**, or **trap** these pollutants to reduce their contribution to water quality impairment. This may involve (Figure 1):

- *Avoiding runoff of pollutants*
  - Nutrient management plans and activities.
  - Addressing the rate, timing, form, and method of nutrient application.
- *Controlling runoff of pollutants*
  - Residue and tillage management.
  - Drainage water management.
- *Trapping pollutants*
  - Vegetated waterbody buffers.
  - Wetlands designed for nutrient removal.

NWQI Practices				
Core Practices	**Code**	**Avoiding**	**Controlling**	**Trapping**
Waste Storage Facility	313	X	X	
Animal Mortality Facility	316		X	
Composting Facility	317	X	X	
Conservation Cover	327	X		X
Conservation Crop Rotation	328	X		
No-Till	329		X	X
Contour Farming	330		X	X
Contour Orchard…	331		X	X
Contour Buffer Strips	332			X
Cover Crop	340	X		X
Critical Area Planting	342		X	X
Reduced Till	345		X	X
Well Water Testing	355	X		
Waste Treatment Lagoon	359		X	
Waste Facility Closure	360	X		
Anaerobic Digester	366		X	

NWQI Avoiding Practices

Core Practices	Code	Avoiding
Conservation Cover	327	X
Cover Crop	340	X
Tree/Shrub Establishment	612	X
Nutrient Management	590	X
Prescribed Grazing	528	X
Conservation Crop Rotation	328	X
Well Water Testing	355	X
Waste Facility Closure	360	X
Stream Habitat Improvement and Management	395	X
Access Control	472	X
Heavy Use Area Protection	561	X
Streambank and Shoreline Protection	580	X
Waste Storage Facility	313	X
Composting Facility	317	X
Waste Transfer	634	X

+BIOCHAR (Conservation Cover, Cover Crop, Tree/Shrub Establishment)

= Higher Level of Conservation

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+BIOCHAR (applies to Composting Facility, Field Border, Filter Strip, Grassed Waterway, Critical Area Planting)

NWQI Controlling Practices		
Core Practices	**Code**	**Controlling**
Composting Facility	317	X
Field Border	386	X
Filter Strip	393	X
Grassed Waterway	412	X
Critical Area Planting	342	X
Contour Farming	330	X
Contour Orchard and Other Perennial Crops	331	X
Anaerobic Digester	366	X
Animal Mortality Facility	316	X
Drainage Water Management	554	X
Grade Stabilization Structure	410	X
Irrigation Reservoir	436	X
Irrigation Water Management	449	X
Residue and Tillage Management, No Till/Strip Till/Di	329	X
Residue and Tillage Management, Reduced Till	345	X

= Higher Level of Conservation

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NWQI Trapping Practices

Core Practices	Code	Trapping
Conservation Cover	327	X
Cover Crop	340	X
Field Border	386	X
Filter Strip	393	X
Riparian Forest Buffer	391	X
Riparian Herbaceous Cover	390	X
Tree/Shrub Establishment	612	X
Critical Area Planting	342	X
Denitrifying Bioreactor	605	X
Contour Buffer Strips	332	X
Contour Farming	330	X
Contour Orchard and Other Perennial Crops	331	X
Residue and Tillage Management, No Till/Strip Till/Di	329	X
Residue and Tillage Management, Reduced Till	345	X
Constructed Wetland	656	X

+BIOCHAR

= Higher Level of Conservation

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Key Biochar-Coupled WQ Practices

- Vegetative
  - Conservation Cover, Cover Crop, Tree/Shrub Establishment
  - Field Border, Grassed Waterway, Filter Strip, Critical Area Planting
  - Riparian Herbaceous Cover or Forest Buffer
- Structural
  - Composting Facility
  - Denitrifying Bioreactor
- Highlight
  - Amendments for Treatment of Agricultural Waste

Vegetative: How to Make it Work

- 336 as an Associated Practice
  - Planned with Core Practices
  - Needs WQ Purpose?

GRASSED WATERWAY

CODE 412

(ac)

DEFINITION

A shaped or graded channel that is established with suitable vegetation to convey surface water at a nonerosive velocity using a broad and shallow cross section to a stable outlet.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- Prevent gully formation
- Protect/improve water quality

SOIL CARBON AMENDMENT

CODE 336

(ac)

DEFINITION

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

PURPOSE

Use this practice to accomplish one or more of the following purposes:

- Improve or maintain soil organic matter.
- Sequester carbon and enhance soil carbon (C) stocks.
- Improve soil aggregate stability.
- Improve habitat for soil organisms.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to areas of Crop, Pasture, Range, Forest, Associated Agriculture Lands, Developed Land, and Farmstead where organic carbon amendment applications will improve soil conditions.

States may add a purpose by requesting a variance as outlined in Title 450, General Manual, Part 401, Subpart B, "Variances" (450-GM-401-B). States may delete any purpose that addresses a resource concern that has not been identified in that State.

Vegetative: How to Make it Work

- Biochar as a Component
  - New payments for WQ practices to include biochar

USDA United States Department of Agriculture
Natural Resources Conservation Service

Maryland
Practice Scenarios - Fiscal Year 2023

Practice: 412 - Grassed Waterway

Scenario #2 - Waterway, small, 0.2 Acres or less

Scenario Description:
Typical practice is 200 ' long by 35' wide by 1.2' deep parabolic channel. The waterway is a shaped or graded channel and is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet. Establishment of vegetation is included. This practice addresses Concentrated Flow Erosion (Classic Gully & Ephemeral Erosion) and Excessive Sediment in surface waters. Waterway area measured from top of bank to top of bank. Costs include excavation and associated work to construct the overall shape and grade of the waterway. Associated Practices: Diversion (362), Critical Area Seeding (342), Mulching (484), Underground Outlet (620), Structure for Water Control (587), Subsurface Drainage (606), Water and Sediment Control Basin (638).

Before Situation:
The field has a small gulley which is cutting deeper into the field as time goes on, so it needs to be stopped or controlled. Excessive sedimentation and soil erosion as a result from ephemeral or classic gully erosion. Gully has formed in field as a result of excessive runoff and poor cropping techniques. Grassed waterway is also commonly installed to covey runoff from concentrated flows, terraces, diversions, or water control structures or similar practices to a suitable, stable outlet.

After Situation:
Installed grassed waterway is 200' long by 35' wide by 1.2' deep parabolic earthen channel. The practice is installed using a dozer. Topsoil stripped and replaced. Included is seed bed preperation, seeding, lime, fertillizer etc . for establishment of vegetation. If erosion control blankets or mulching for seedbed establishment/protection are needed, use conservation practice Mulching (484). Drainage tile, if needed, will be installed accoring to Subsurface Drain (606). Outlets, if needed will be installed using Structure for Water Control (587). If inlet Structures are needed with the drainage tile, then those will be installed using Underground Outlet (620).

Feature Measure: Area of Waterway

Scenario Unit: Square Feet

Scenario Typical Size: 6,970.00

Scenario Total Cost: $1,167.03

Scenario Cost/Unit: $0.17

Cost Details:

Component Name	ID	Description	Unit	Cost	QTY	Total
Equipment Installation						
Tillage, Light	945	Includes light disking (tandem) or field cultivator. Includes equipment, power unit and labor costs.	Acres	$13.21	0.16	$2.11
Fertilizer, ground application, dry bulk	950	Dry bulk fertilizer application performed by ground equipment. Includes equipment, power unit and labor costs.	Acres	$7.97	0.16	$1.28
Seeding Operation, No Till/Grass Drill	960	No Till drill or grass drill for seeding. Includes equipment, power unit and labor costs.	Acres	$22.25	0.16	$3.56
Stripping and stockpiling, topsoil	1199	Stripping and stockpiling of topsoil adjacent to stripping area. Includes equipment and labor	Cubic Yards	$0.82	260	$213.20

USDA United States Department of Agriculture
Natural Resources Conservation Service

Maryland
Practice Scenarios - Fiscal Year 2023

Practice: 808 - Soil Carbon Amendment

Scenario #12 - 40% Biochar-60% Compost

Scenario Description:
Apply a blend of >= 40% biochar and <= 60% compost (by volume) to sequester carbon, reduce nitrogen losses, and improve other soil health-related resource concerns. Biochar and compost has been tested, and is imported from an outside source. The blend contains at least 40% biochar and is applied at the recommended rate to treat the identified resource concerns.

Before Situation:
An appropriate assessment tool is used to determine that soil health resource concerns exist.

After Situation:
A blend of >= 40% biochar and <= 60% compost was applied at the recommended rate and ratio. Soil health resource concerns were treated. A follow up assessment is planned to determine the effect of the biochar application.

Feature Measure: Cubic Yards of Amendment per Acr

Scenario Unit: Cubic Yards

Scenario Typical Size: 4.00

Scenario Total Cost: $481.84

Scenario Cost/Unit: $120.46

Cost Details:

Component Name	ID	Description	Unit	Cost	QTY	Total
Equipment Installation						
Tillage, Light	945	Includes light disking (tandem) or field cultivator. Includes equipment, power unit and labor costs.	Acres	$13.21	1	$13.21
Manure, compost, application	955	Loading, hauling and spreading manure/compost by ground equipment. Includes equipment, power unit and labor costs.	Hours	$135.01	0.5	$67.51
Materials						
Compost	265	A mixture of decaying organic matter, as from leaves and manure, used to improve soil structure and provide nutrients	Ton	$42.88	2.4	$102.91
Biochar	2743	Solid material obtained from thermochemical conversion of biomass in an oxygen-limited environment (pyrolysis). Biochar is typically produced from woody biomass, but other carbon sources may be used. Materials only.	Cubic Yards	$163.26	1.6	$261.22
Mobilization						
Aggregate, Shipping, Cubic Yard-mile	2360	Mobilization of aggregate material beyond 20 miles of local delivery from quarry to construction site. Cubic Yard-mile (Cubic Yard * miles of haul).	Cubic Yard Mile	$0.37	100	$37.00

https://www.nrcs.usda.gov/getting-assistance/payment-schedules

Structural: How to Make it Work

- Compost Facility
  - Size facility to include biochar in co-composting

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

ELSEVIER

Review

Biochar increases nitrogen retention and lowers greenhouse gas emissions when added to composting poultry litter

Eunice Agyarko-Mintah [a,i], Annette Cowie [a,b,*], Bhupinder Pal Singh [a,c], Stephen Joseph [a,d,e,f], Lukas Van Zwieten [a,g], Alan Cowie [a], Steven Harden [h], Robert Smillie [a]

Received: 26 October 2022 | Accepted: 7 December 2022

DOI: 10.1111/gcbb.13028

GCB-BIOENERGY BIOPRODUCTS FOR A SUSTAINABLE BIOECONOMY

WILEY

RESEARCH ARTICLE

Biochar co-compost improves nitrogen retention and reduces carbon emissions in a winter wheat cropping system

Si Gao[1,2] | Brendan P. Harrison[3] | Touyee Thao[3] | Melinda L. Gonzales[3] | Di An[4] | Teamrat A. Ghezzehei[2] | Gerardo Diaz[5] | Rebecca A. Ryals[2]

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Structural: How to Make it Work

- Denitrifying Bioreactor
  - Include biochar as a component
- Spread charged biochar on fields
  - Better than woodchips

Virginia Cooperative Extension

PUBLICATION BSE-55P

Denitrifying Bioreactors: An Emerging Best Management Practice to Improve Water Quality

Emily Lassiter, Graduate Research Assistant, Biological Systems Engineering, Virginia Tech
Zachary M. Easton, Assistant Professor and Extension Specialist, Biological Systems Engineering, Virginia Tech.*

USDA United States Department of Agriculture
Natural Resources Conservation Service

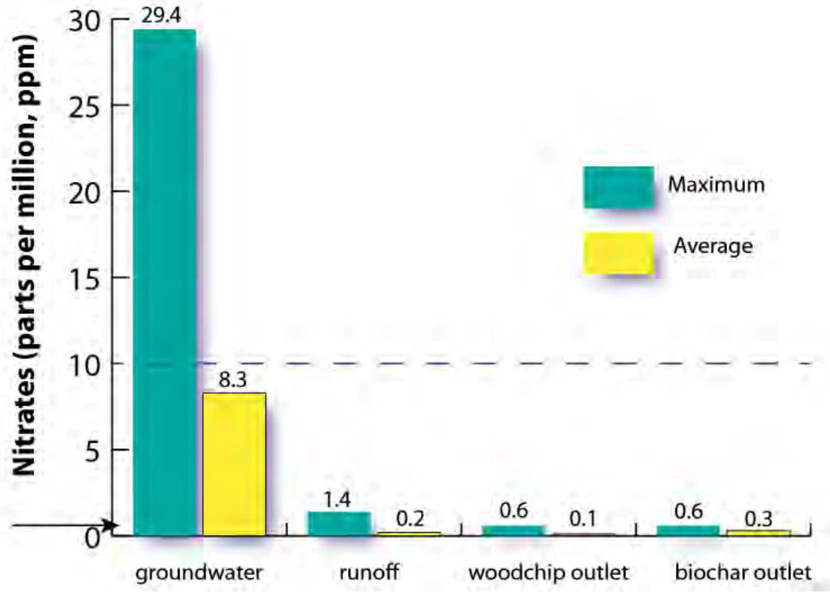
Maryland
Practice Scenarios - Fiscal Year 2023

Practice: 605 - Denitrifying Bioreactor

Scenario #7 - Denitrifying Bioreactor

Scenario Description:

"Scenario describes a structure containing a carbon source installed to intercept subsurface drain (tile) flow or ground water, and reduce the concentration of nitrate-nitrogen. Woodchips serve as the carbon source necessary to the denitrification process. This bioreactor has geotextile fabric (or polyethylene - PE) between the wood chips and the surrounding soil plus the following components: woodchip filled pit, two water control structures (to allow management of the flow rate and and free water elevation within the bioreactor), and piping to convey water to and from the bioreactor. Woodchips serve as the carbon source necessary to the denitrification process. Associated practices: Subsurface Drain (606), Structure for Water Control (587), Drainage Water Management (554). Resource concern: Water Quality Degradation -



Highlight Practice: Trapping N at the Source

United States Department of Agriculture

Conservation Practice Overview

September 2020

Amendments for Treatment of Agricultural Waste (Code 591)

The addition of chemical or biological additives to manure, process wastewater, contaminated storm water runoff, or other wastes to reduce adverse effects on air and/or water.

Practice Information

The purpose of this practice is to change the characteristics of the waste stream to facilitate waste handling and improve or protect air or water resources or animal health. The additives covered by this practice are commonly used for phosphorus binding, ammonia suppression, odor control, and solids separation enhancement.

The amendments are to be used in the implementation of a planned waste management system. The use of amendments can have ancillary production benefits for crops and livestock.

When handling chemicals or biological amendments you will need to follow all of the safety precautions recommended by the manufacturer.

There will also be a requirement for recordkeeping in sufficient detail to describe the amendment's use, actual application rates and timing, and any tests performed (including nutrient analysis).

Practice: 591 - Amendments for Treatment of Agricultural Waste

Scenario #10 - Zeolite for Ammonia Reduction

Scenario Description:

Application of bulk zeolite to a beef or dairy pen surface to reduce ammonia emissions.

Before Situation:

Zeolite is not added to a beef or dairy open lot pen surface, resulting in loss of nitrogen via ammonia volatilization.

After Situation:

Bulk zeolite with a minimum of 65% natural clinoptilolite zeolite, crushed to a size of not smaller than 14-30 mesh nor larger than 6-14 mesh, is added to a beef or dairy open lot pen surface. Zeolite is applied at a rate of 4-6% of the anticipated weight of manure produced over the period of time animals are housed in the pen. The zeolite will adsorb ammonia and other compounds, resulting in lower ammonia emissions and resultant air quality improvement.

Feature Measure: Area of Application

Scenario Unit: 1,000 Square Foot

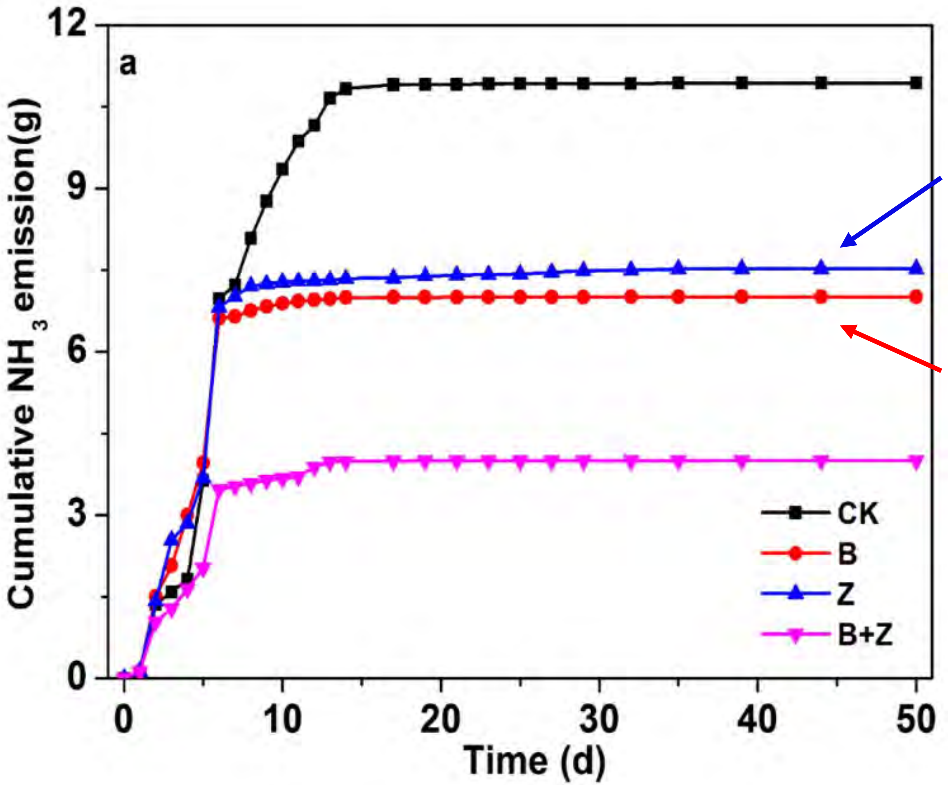
Scenario Typical Size: 30.00

Scenario Total Cost: $19,016.82

Scenario Cost/Unit: $633.89

Cost Details:

Component Name	ID	Description	Unit	Cost	QTY	Total
Equipment Installation						
Chemical, ground application	948	Chemical application performed by ground equipment. Includes equipment, power unit and labor costs.	Acres	$6.17	0.7	$4.32
Materials						
Zeolite, Bulk	2683	Zeolite applied as a pen surface amendment or used as a feed ingredient. Zeolite is added to feed as a nutrition-based strategies or applied to pen surface as an ammonia abatement measures in livestock production, means of reducing ammonia emissions from concentrated animal feeding operations.	Ton	$422.50	45	$19,012.50



Zeolite is mined

Biochar is made from renewable resources
Biochar is carbon-negative

Wang, Quan, Mukesh Kumar Awasthi, Xiuna Ren, Junchao Zhao, Ronghua Li, Zhen Wang, Hongyu Chen, Meijing Wang, and Zengqiang Zhang. "Comparison of Biochar, Zeolite and Their Mixture Amendment for Aiding Organic Matter Transformation and Nitrogen Conservation during Pig Manure Composting." *Bioresource Technology* 245 (December 2017): 300–308. https://doi.org/10.1016/j.biortech.2017.08.158.

USDA United States Department of Agriculture
Natural Resources Conservation Service

Arkansas
Practice Scenarios - Fiscal Year 2023

Practice: 591 - Amendments for Treatment of Agricultural Waste

Scenario #1 - Litter Amendments for Air Quality With Partially Treated Brood Chamber

Scenario Description:
This practice scenario includes the application of a litter treatment amendment that is approved by NRCS to the entire poultry house to reduce ammonia emissions from

Scenario Unit: 1,000 Square Foot

Scenario Typical Size: 84.00

Scenario Total Cost: $2,076.92

Scenario Cost/Unit: $24.73

Cost Details:

Component Name	ID	Description	Unit	Cost	QTY	Total
Equipment Installation						
Application of ag waste amendment for poultry litter	2020	Litter amendment application performed in house. Includes equipment, power unit and labor costs.	Ton	$59.20	3.4	$201.28
Materials						
Ag Waste Amendment, sodium bisulfate	1686	Sodium bisulfate poultry litter amendment. NRCS approved for air quality concerns to reduce ammonia emissions from the litter. Includes materials only.	Ton	$551.66	3.4	$1,875.64

Scenario Total Cost: $2,076.92

Scenario Cost/Unit: $24.73

Cost Details:

Component Name	ID	Description	Unit	Cost	QTY	Total
Equipment Installation						
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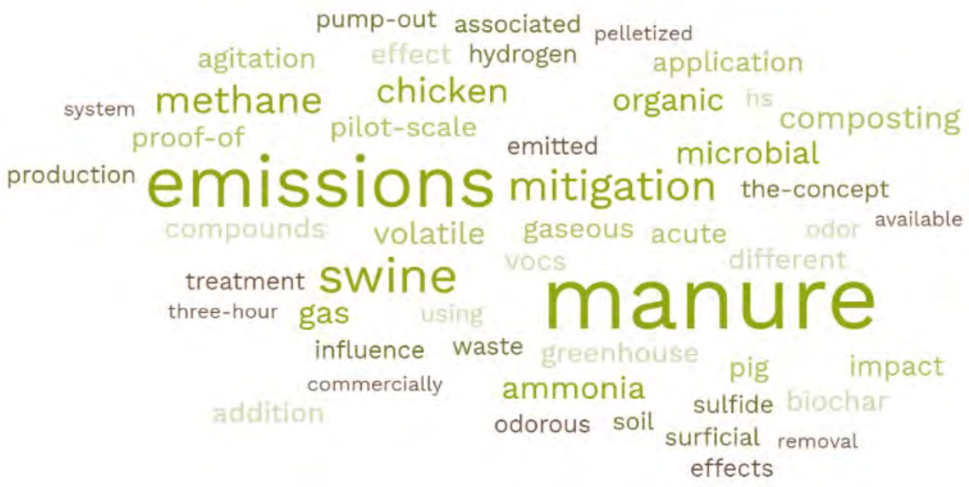
Manure Odor and Emissions



Biochar as a cover for dairy manure lagoons: reducing odor and gas emissions while capturing nutrients

Brian Dougherty, Myles Gray, Mark G. Johnson, Markus Kleber

- Pilot-Scale H2S and Swine Odor Removal System Using Commercially Available Biochar, AGRONOMY-BASEL, 2021
- Mitigation of Acute Hydrogen Sulfide and Ammonia Emissions from Swine Manure during Three-Hour Agitation Using Pelletized Biochar, ATMOSPHERE, 2021
- Impact of biochar application on gas emissions from liquid pig manure storage, SCIENCE OF THE TOTAL ENVIRONMENT, 2021
- Mitigation of Acute Ammonia Emissions With Biochar During Swine Manure Agitation Before Pump-Out: Proof-of-the-Concept, FRONTIERS IN ENVIRONMENTAL SCIENCE, 2021
- Mitigation of Gaseous Emissions from Stored Swine Manure with Biochar: Effect of Dose and Reapplication on a Pilot-Scale, ATMOSPHERE, 2021
- Methane production and characteristics of the microbial community in the co-digestion of potato pulp waste and dairy manure amended with biochar, RENEWABLE ENERGY, 2021
- Mitigation of Gaseous Emissions from Swine Manure with the Surficial Application of Biochars, ATMOSPHERE, 2020
- Effect of Biochar Diet Supplementation on Chicken Broilers Performance, NH(3)and Odor Emissions and Meat Consumer Acceptance, ANIMALS, 2020
- The Proof-of-the Concept of Biochar Floating Cover Influence on Swine Manure pH: Implications for Mitigation of Gaseous Emissions From Area Sources, FRONTIERS IN CHEMISTRY, 2020
- Methane emissions and associated microbial activities from paddy salt-affected soil as influenced by biochar and cow manure addition, APPLIED SOIL ECOLOGY, 2020
- The Impact of Surficial Biochar Treatment on Acute H2S Emissions during Swine Manure Agitation before Pump-Out: Proof-of-the-Concept, CATALYSTS, 2020
- Use of biochar for the sorption of volatile organic compounds (VOCs) emitted from cattle manure, ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH
- Effects of microbial culture and chicken manure biochar on compost maturity and greenhouse gas emissions during chicken manure composting, JOURNAL OF HAZARDOUS MATERIALS, 2020
- Response of bamboo biochar amendment on volatile fatty acids accumulation reduction and humification during chicken manure composting, BIORESOURCE TECHNOLOGY, 2019
- Efficacy of Different Biochars in Removing Odorous Volatile Organic Compounds (VOCs) Emitted from Swine Manure, ACS SUSTAINABLE CHEMISTRY & ENGINEERING, 2018
- Effect of different particle-size biochar on methane emissions during pig manure/wheat straw aerobic composting: Insights into pore characterization and microbial mechanisms, BIORESOURCE TECHNOLOGY, 2018

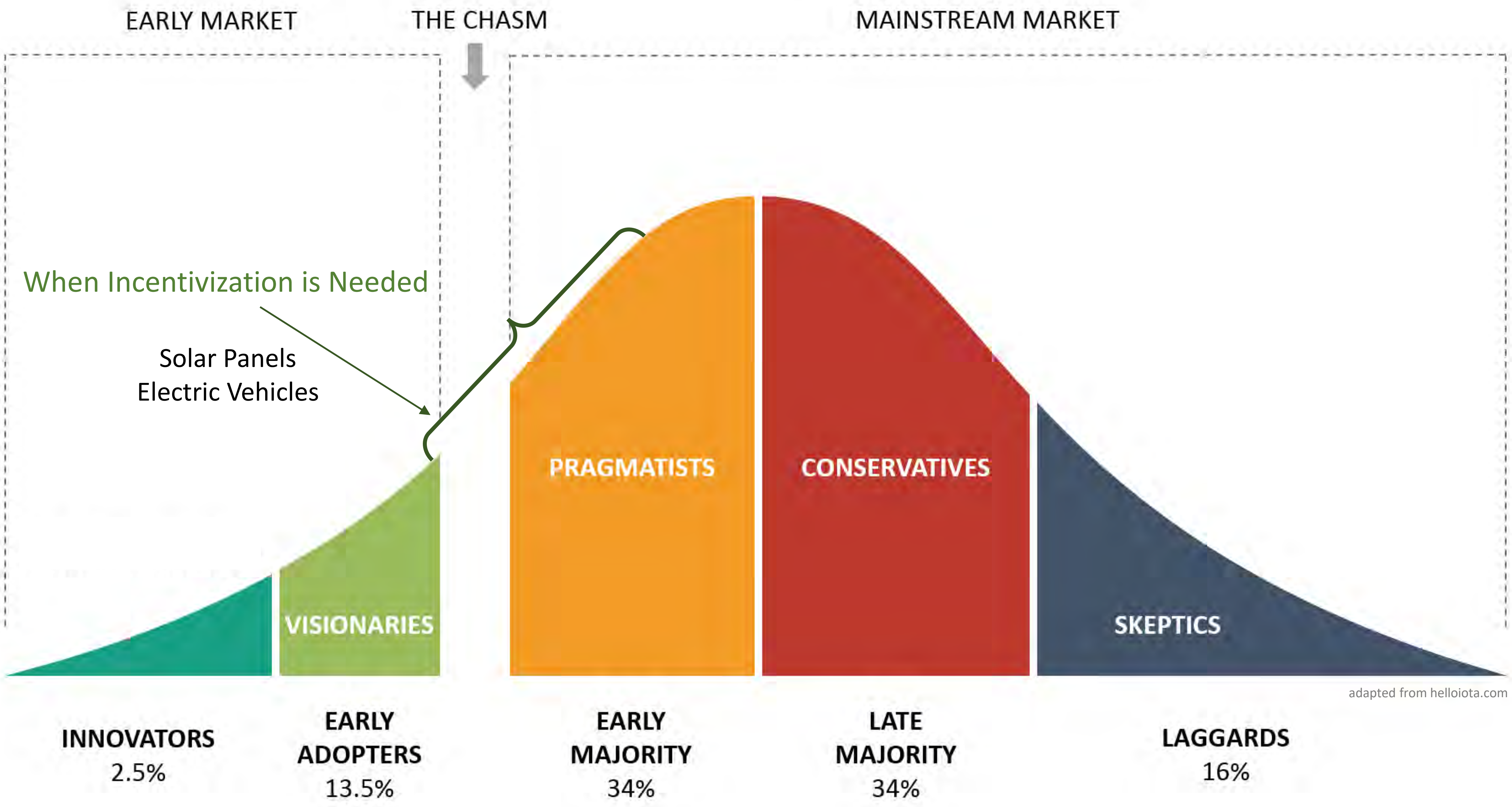
Action Items – Requests for States

- Adopt 336 for FY24
- Add WQ Purpose to 336
- Add Biochar Component to WQ Practice Payment Schedules
- Add Biochar to 591

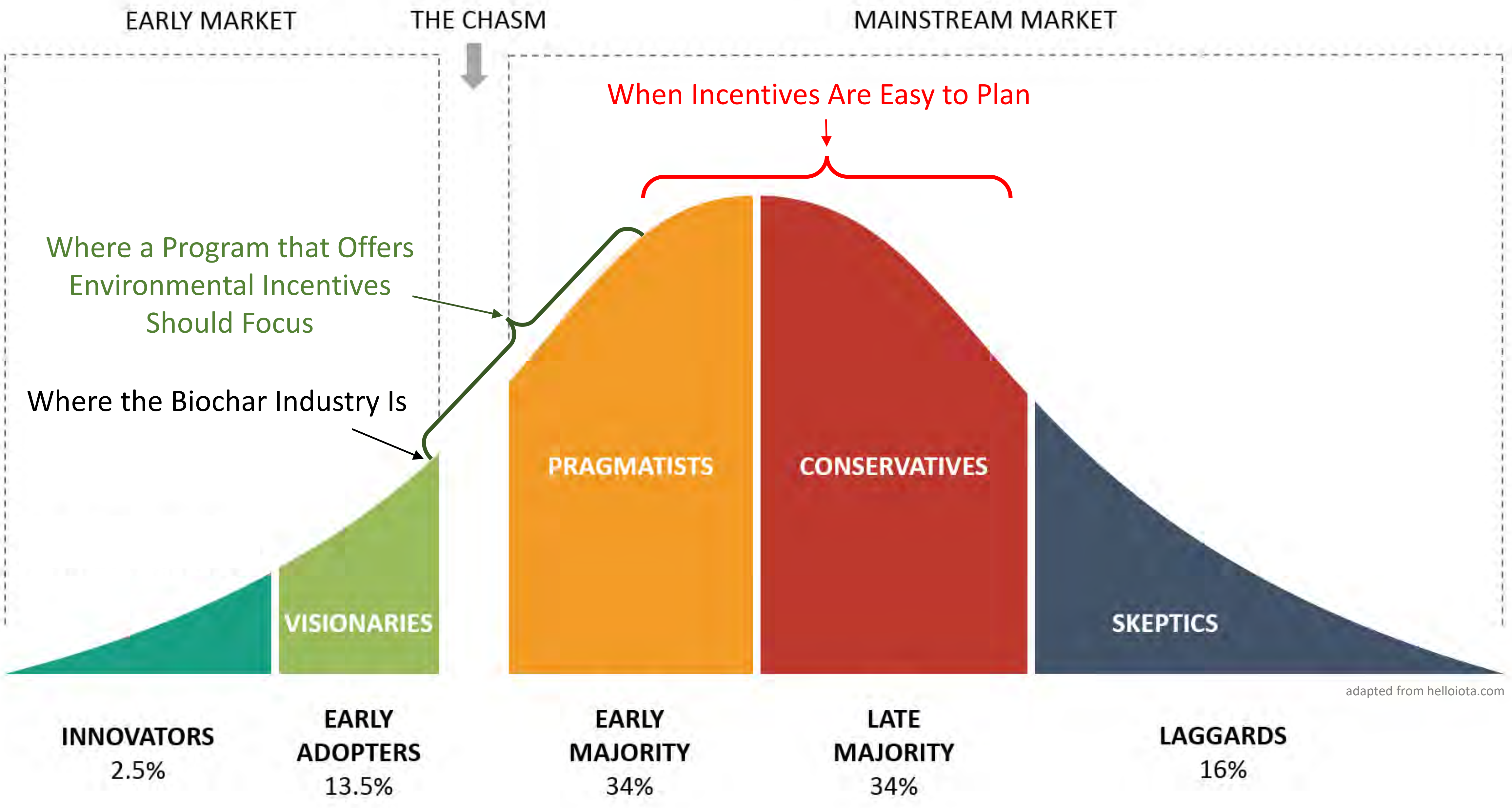
Send requests to the State Agronomist, State Resource Conservationist, or State Conservationist

Thank You

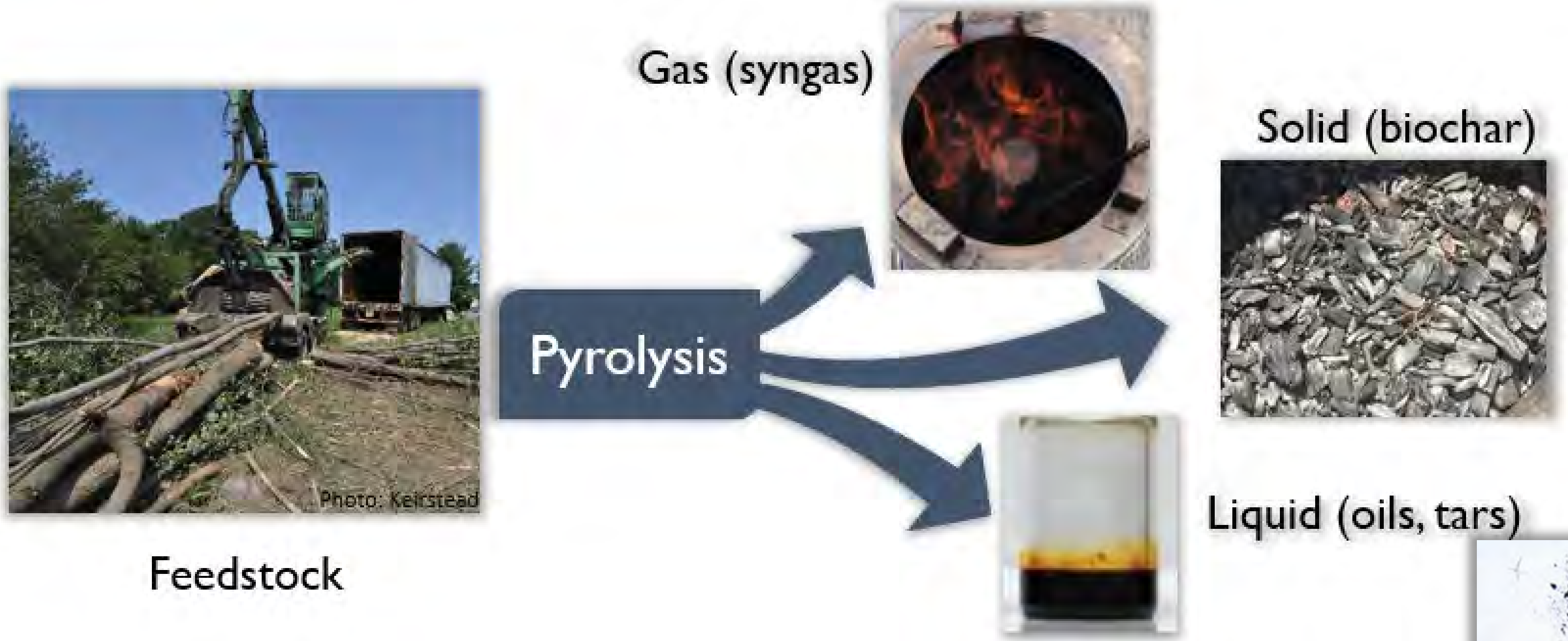
Technology Adoption Curve



Conservation Technology Adoption Curve

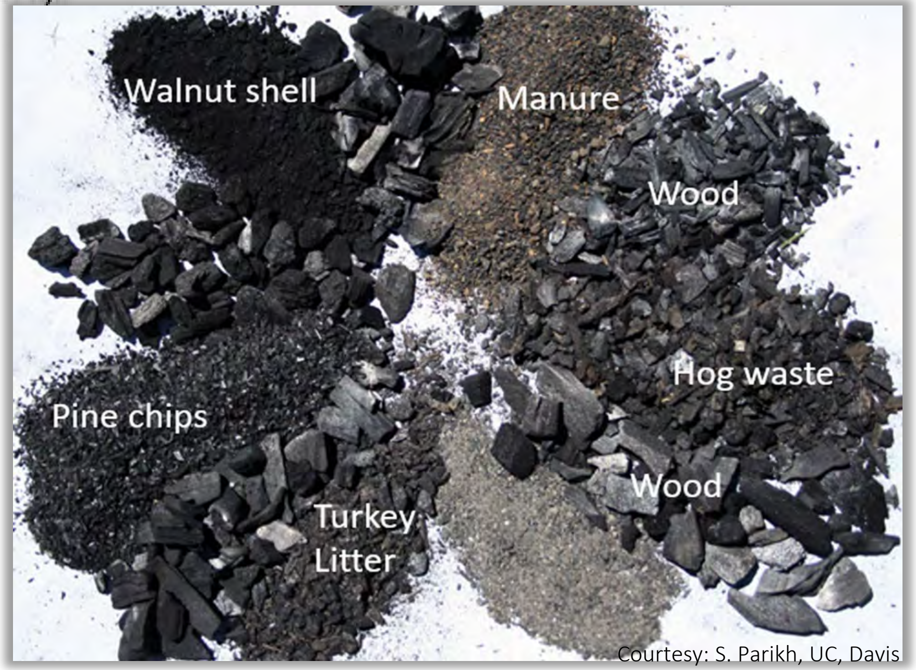


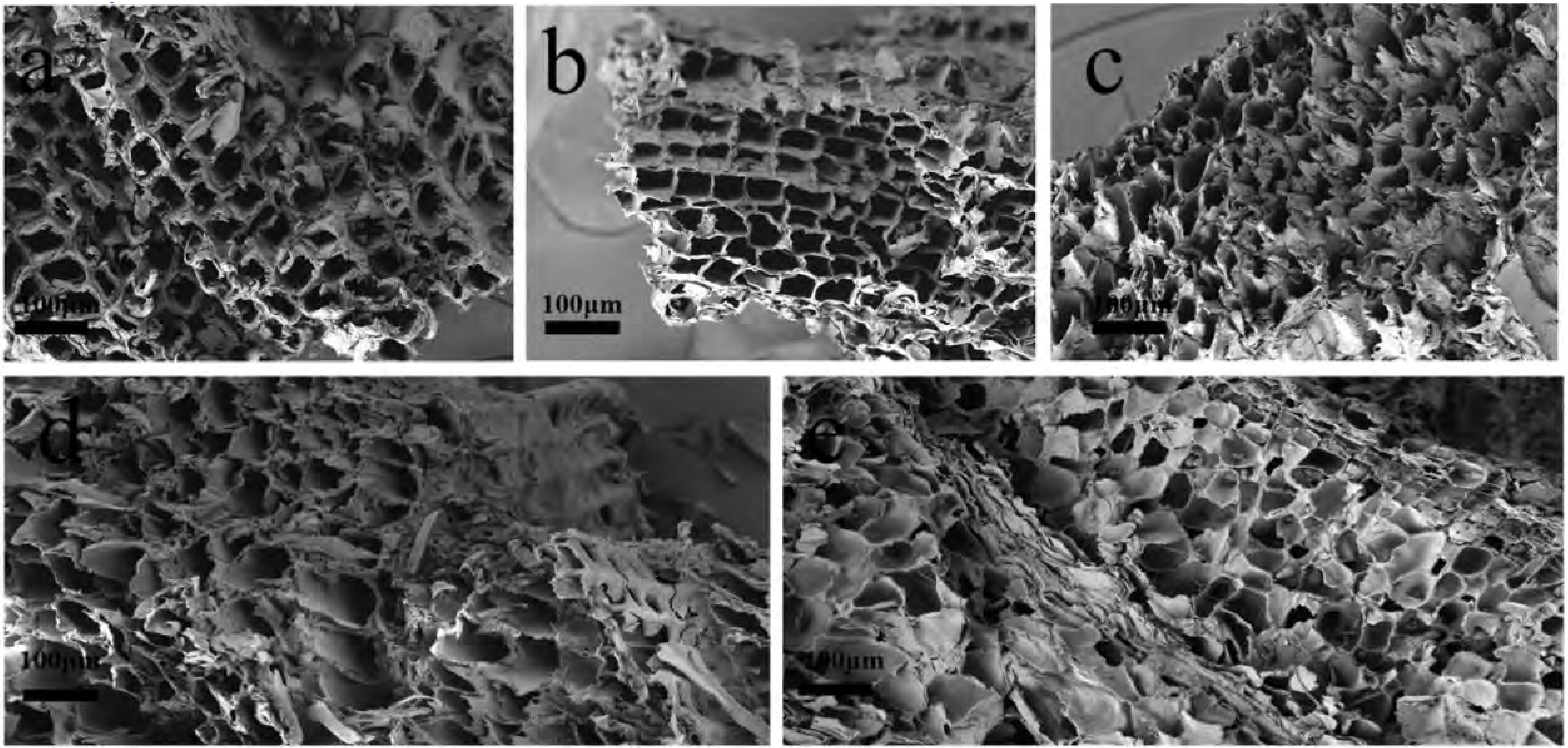
Biochar



Pyrolysis: thermochemical decomposition of biomass at high temps >350°C in limited oxygen environment

- Highly porous (sponge), charged, stable carbon (recalcitrant)
- Majority of biochar carbon persists >1000 years in soil
- Smaller fractions last 50 to 100 years





Surface morphology of five biochar samples obtained at different pyrolysis temperatures as made evident by scanning electron microscopy images: (**a**) PC300, (**b**) PC400, (c) PC500, (**d**) PC600, and (**e**) PC700.

Liu, L., Deng, G. & Shi, X. Adsorption characteristics and mechanism of p-nitrophenol by pine sawdust biochar samples produced at different pyrolysis temperatures. Sci Rep 10, 5149 (2020). https://doi.org/10.1038/s41598-020-62059-.

Application Methods


Dry Fertilizer – 2x2?
Fennigequipment.com


Lime Spreader or Chicken Litter Spreader?
David Laird

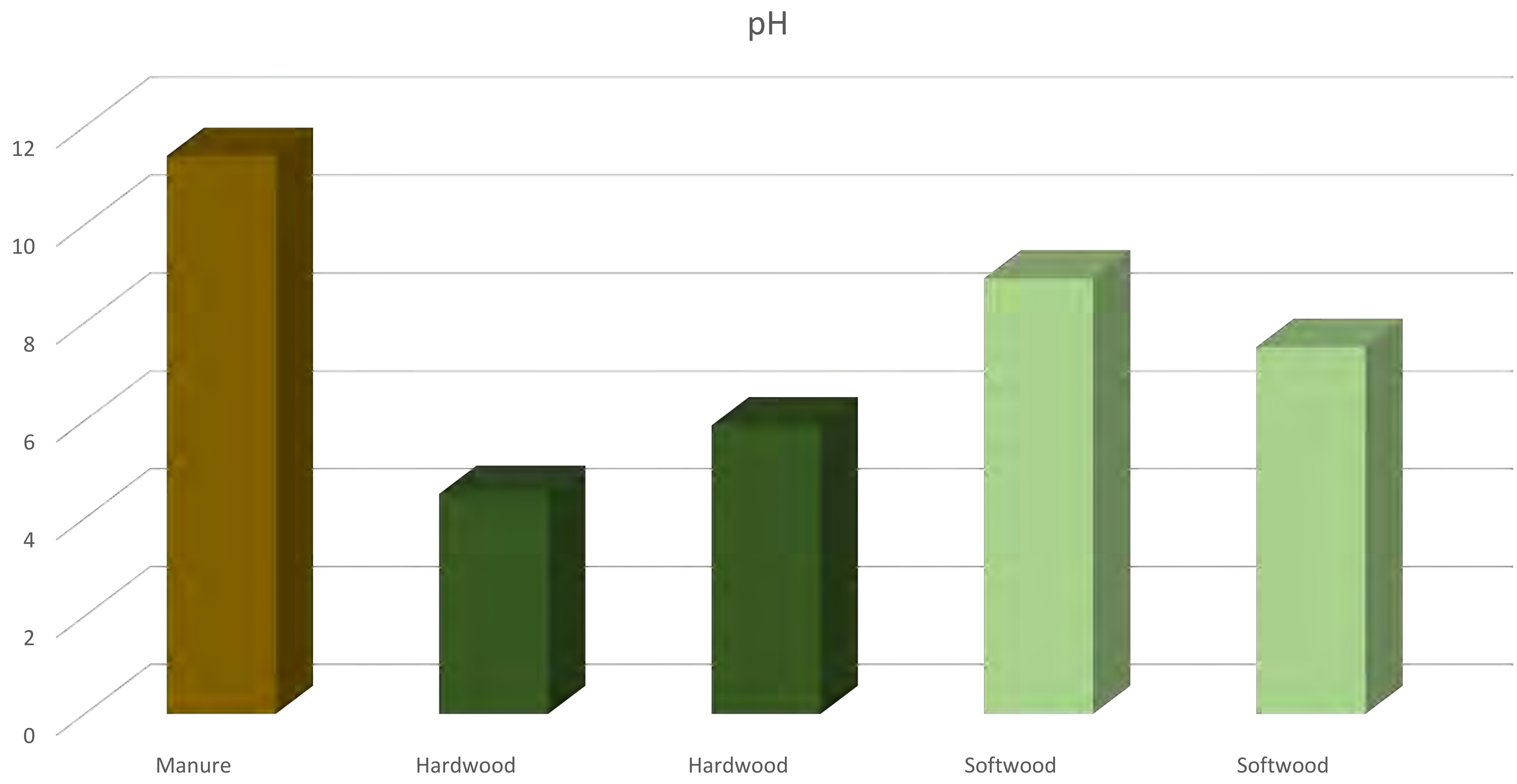

Surface Apply or Disc In?

Drill or Planter?

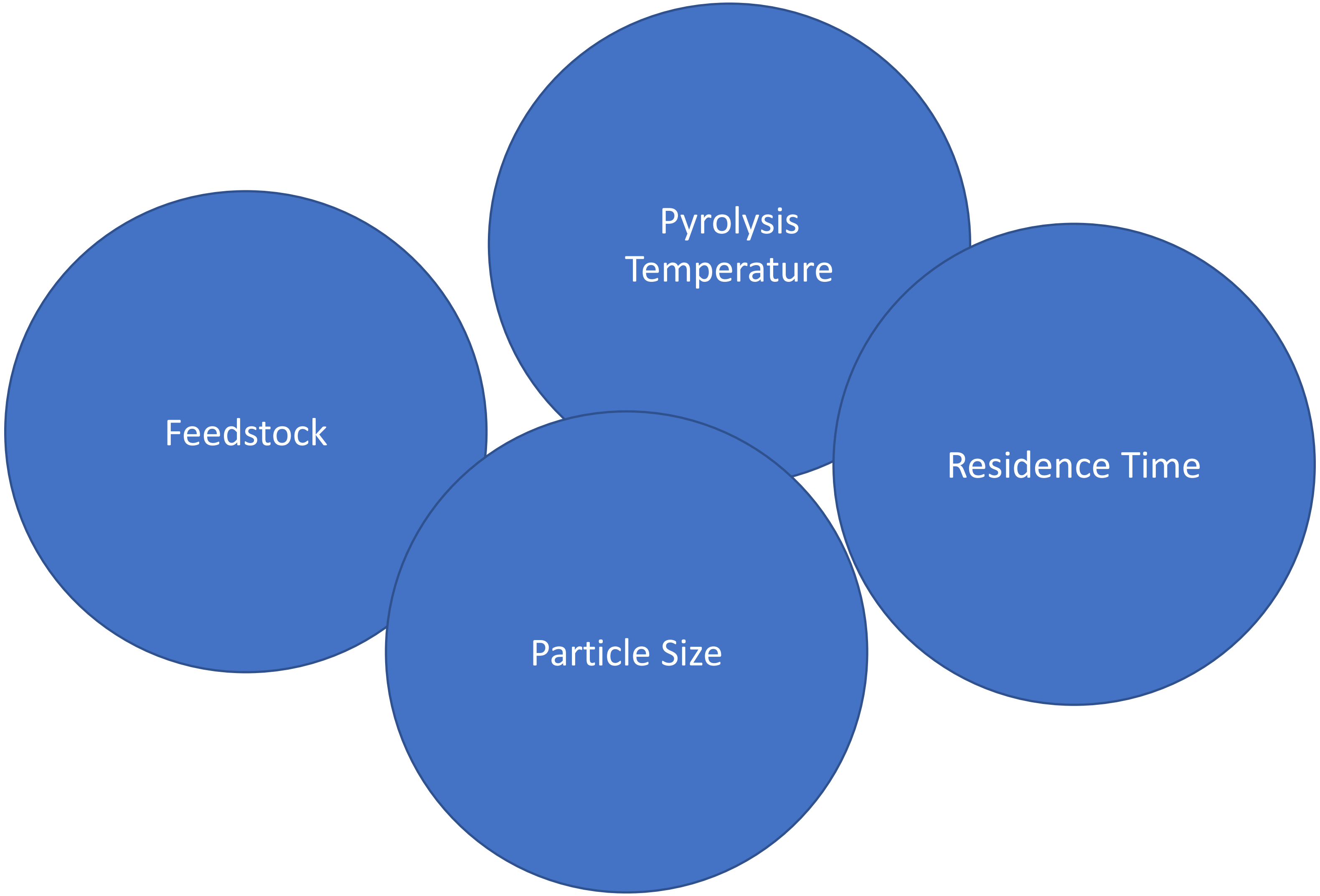
In Slurry?

ALLIED
SOIL HEALTH

Brandon R. Smith, Ph.D. | Brandon@AlliedSoilHealth.com



ALLIED SOIL HEALTH



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