

A scanning electron micrograph (SEM) showing the highly porous and irregular surface structure of biochar. The image displays a dense network of interconnected, rounded and elongated features, creating a complex, honeycomb-like texture. The lighting highlights the three-dimensional nature of the surface, with bright highlights on the raised edges and deep shadows in the pores.

Biochar Markets & Standards

**California Bioresources
Alliance Symposium**

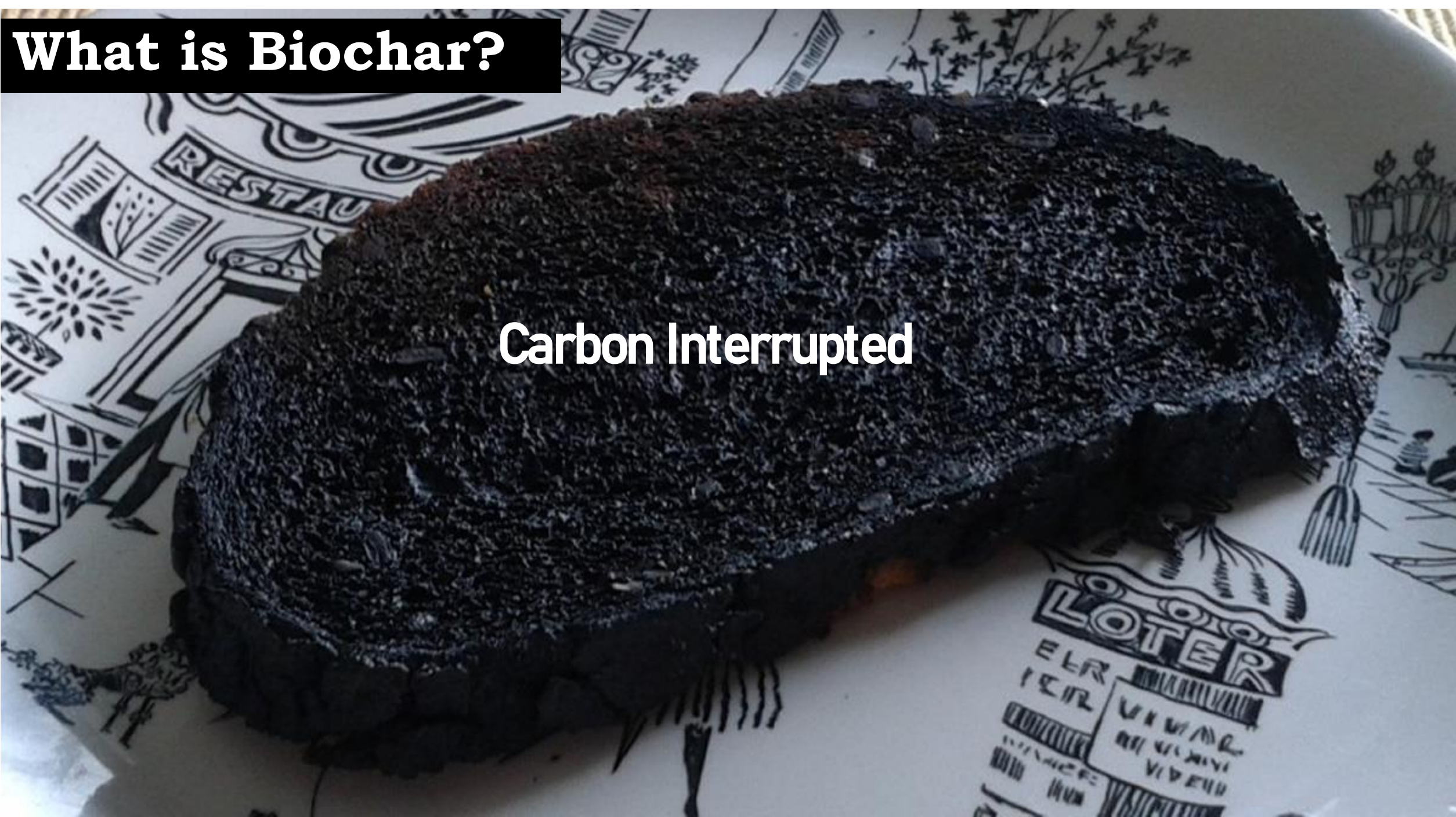
Kathleen Draper
November 18, 2021

Agenda

- **What is biochar?**
- **Markets for biochar**
- **Synergies with other bioresources:**
 - **Compost**
 - **Anaerobic digestion**
 - **WWTP**
 - **Landfills**
- **USDA NRCS - Code 808**
- **Standards**
- **Carbon Markets**

What is Biochar?

Carbon Interrupted



What is Biochar?



	Charcoal	Biochar	Activated Carbon
Feedstock	Hardwood, sawdust + Binding Agents	Ag, forestry & other organic materials/waste	Coconut shells, peat, coal, petroleum pitch
Common Uses	Fuel (Cooking)	Soil Amendment Remediation Filtration Binding Agent (livestock)	Filtration Odor Control Remediation Binding Agent (humans)
Relevant Qualities	Burnability Low smoke	Adsorption/Porosity CEC Sequestration	Adsorption
Cost	\$ - \$\$	\$\$	\$\$\$
Production	Slow Pyrolysis; Kiln	Slow Pyrolysis; Kiln; Gasification	Pyrolyzed at 600 – 900C + activated at 250C OR Chemically impregnated & cooked @ 450 – 900C
Carbon Footprint	Carbon Neutral: May lead to Deforestation	Carbon Negative (in many situations) ★	Carbon Positive

Additional:

Storm water management

Anaerobic Digestion

Bedding/Litter

Compost

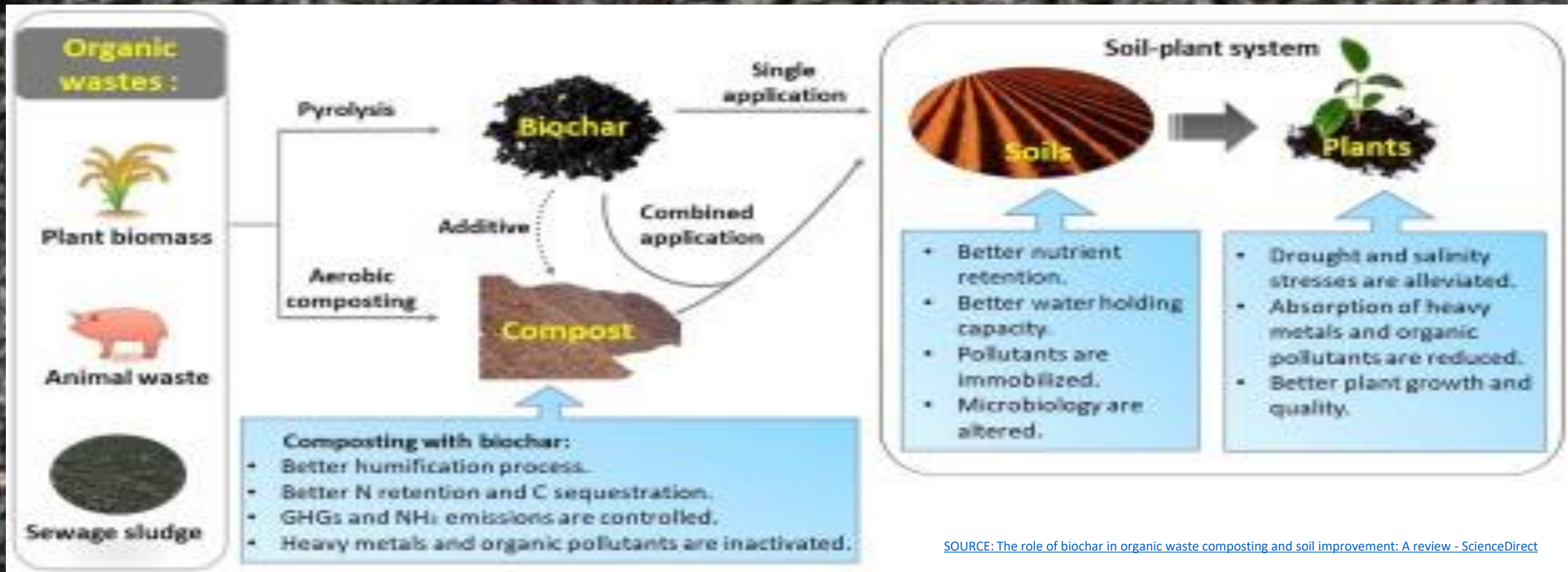
Cosmetics



Synergies: compost

Biochar & Compost

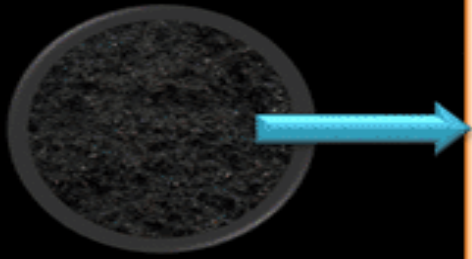
- Faster turnover
- Hotter temperatures
- Longer lasting carbon
- Immobilizes certain toxins
- GHG reductions



Synergies: anaerobic digestion

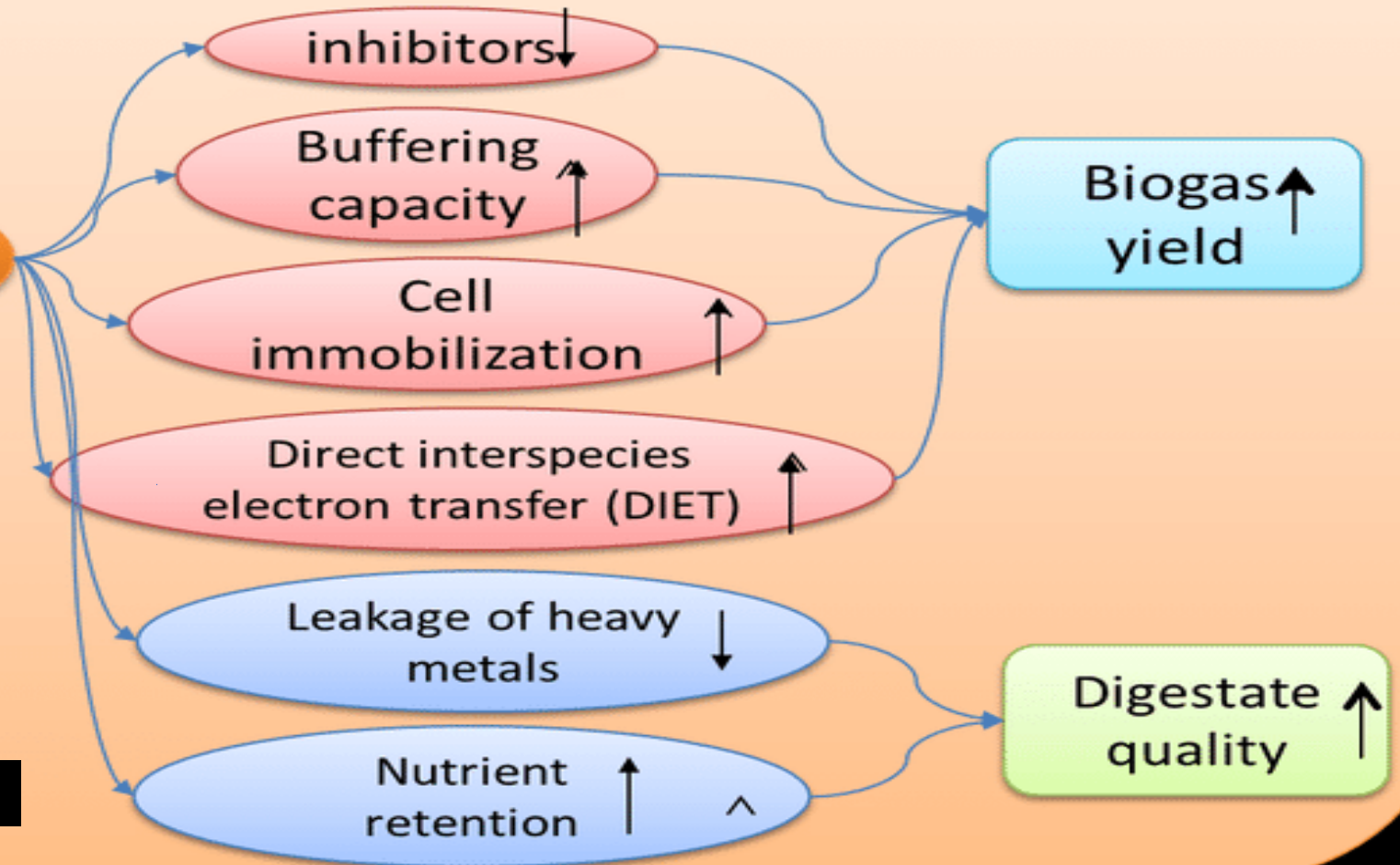
Biochar & AD

- Faster turnover
- Reduced H₂S
- Digestate can be carbonized
- Heat from pyrolysis can go into AD
- Effluent can be filter through biochar
- GHG reductions



Anaerobic Digestion

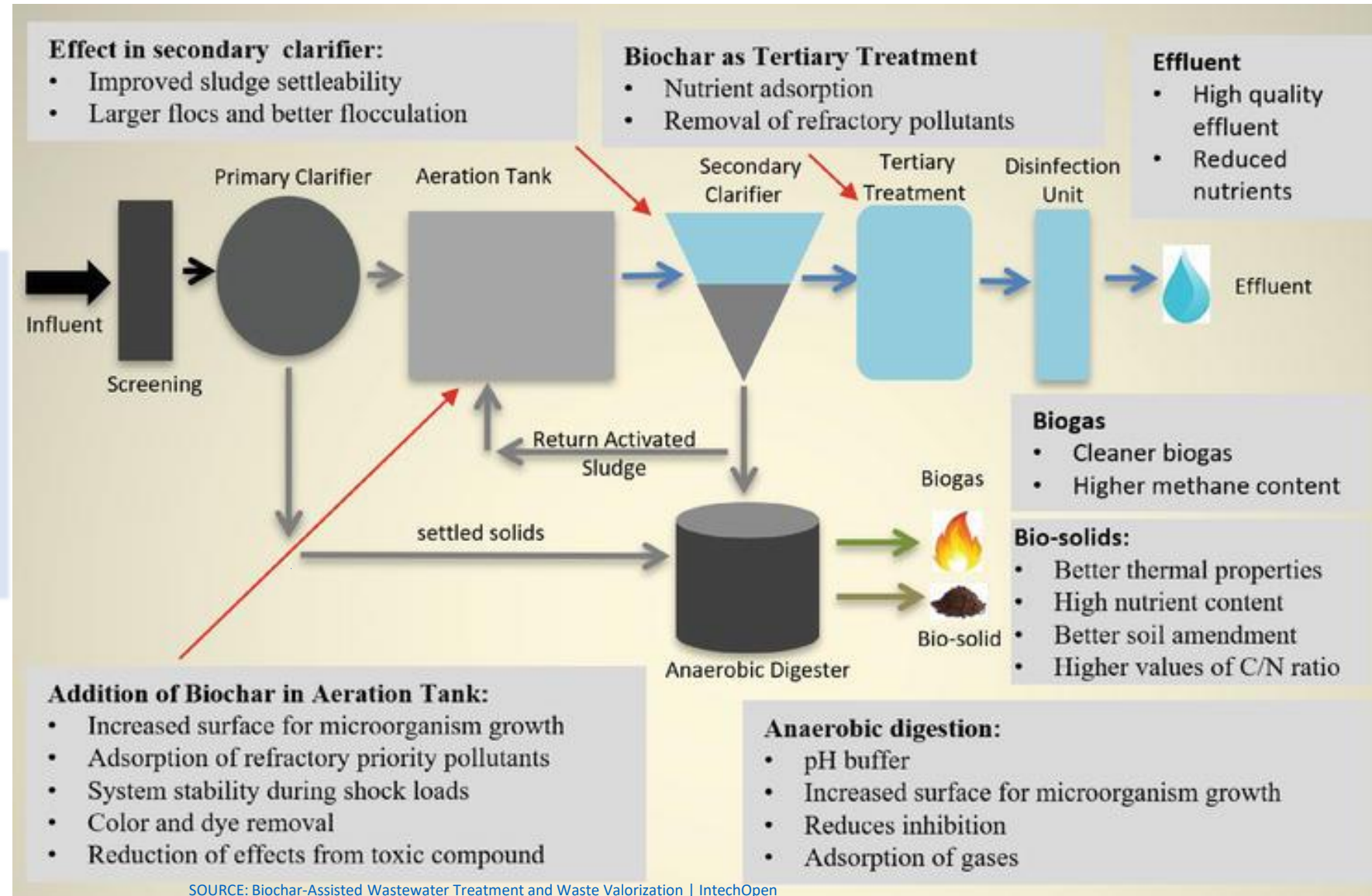
biochar



Synergies: wastewater treatment

Biochar & WWTP

- Sludge can be carbonized to minimize volume
- Effluent can be filtered using sludge biochar
- Immobilizes certain toxins
- GHG reductions



SOURCE: Biochar-Assisted Wastewater Treatment and Waste Valorization | IntechOpen

Synergies: landfills

A photograph of a landfill site. In the foreground, there are large piles of waste and debris. In the middle ground, several trucks are visible, some with their rear ends raised, dumping waste into large metal chutes or containers. The background shows a vast, hilly landscape covered in dense green vegetation under a clear sky.

Waste Management

- **Waste reduction – extend life of landfills**
- **Methane reduction**
- **Leachate remediation**
- **Daily cover: odor reduction**
- **Capping material**
- **Renewable Energy**
- **Reduced transportation when carbonization happens at point of production**

Standards

- All biochars are not the same! There is a lot of biochar coming into the marketplace of varying quality.
- Standards & Certifications:
 - IBI: soils
 - EBC: soils, feed & composite biochar
 - Organic
- Focused on:
 - Safety
 - Sequestration & Stability
 - H:C ratio <.7



Standards

Test Category A: Basic Utility Properties (Required for All Biochars)			
Parameter	Criteria ¹	Unit	Test Method ²
Moisture	Declaration	% of total mass, dry basis	ASTM D1762-84 Standard Test Method for Chemical Analysis of Wood Charcoal (specify measurement date with respect to time from production)
Organic Carbon (C _{org})	10% Minimum Class 1: ≥60% Class 2: ≥30% and <60% Class 3: ≥10% and <30%	% of total mass, dry basis	Total C and H analysis by dry combustion-elemental analyzer. Inorganic C analysis by determination of CO ₂ -C content with 1N HCl, as outlined in ASTM D4373 Standard Test Method for Rapid Determination of Carbonate Content of Soils. Organic C calculated as Total C – Inorganic C. See Appendix 7 for H:C _{org} discussion.
H:C _{org}	0.7 Maximum	Molar ratio	
Total Ash	Declaration	% of total mass, dry basis	ASTM D1762-84 Standard Test Method for Chemical Analysis of Wood Charcoal
Total Nitrogen	Declaration	% of total mass, dry basis	Dry combustion-elemental analyzer following the same procedure for total C and H above.
pH	Declaration	pH	pH analysis procedures as outlined in section 04.11 of TMECC (2001) using modified dilution of 1:20 biochar:deionized H ₂ O (w:v) and equilibration at 90 minutes on the shaker, according to Rajkovich et al. (2011). See Appendix 5 for further information.
Electrical Conductivity	Declaration	dS/m	EC analysis procedures as outlined in section 04.10 of TMECC (2001) using modified dilution of 1:20 biochar:deionized H ₂ O (w:v) and equilibration at 90 minutes on the shaker, according to Rajkovich et al. (2011). See Appendix 5 for further information.
Liming (if pH is above 7)	Declaration	% CaCO ₃	AOAC 955.01 potentiometric titration on "as received" (i.e., wet) samples. Use dry weight to calculate % CaCO ₃ and report "per dry sample weight".
Particle size distribution	Declaration	% <0.5 mm; % 0.5-1 mm; % 1-2 mm; % 2-4 mm; % 4-8 mm; % 8-16 mm; % 16-25 mm; % 25-50 mm; % >50 mm	Progressive dry sieving with 50 mm, 25 mm, 16 mm, 8mm, 4mm, 2 mm, 1 mm, and 0.5 mm sieves.

¹ All values will be reported to one decimal place significant digit (0.1), unless otherwise indicated within the criteria for any reporting requirement (e.g., if the analysis is 0.73, it can be reported as 0.7).

² See Section 8 – References for complete citations

ANALYTICAL CHEMISTS and BACTERIOLOGISTS <i>Approved by State of California</i> SOIL CONTROL LAB 42 HANGAR WAY Watsonville CA 95076 www.compostlab.com			
Kathleen Draper Finger Lakes Biochar 142 County Road #9 Victor NY 14564		Account No.: 2050820 01 7519 Batch: Apr. - May 2012 33 CODE: BioChar IBI	
Date Received: 05/31/12 Sample Id.: Cherry Pit Biochar Sample Id. Number: 01 2050820		International BioChar Initiative (IBI) Level I Wet Dry	
Moisture	5.1	0.0 percent	Declaration ASTM D1762-84 (105c)
Total Ash	5.6	5.9 percent	50% Max. ASTM D 1762-84 (750c)
Organic Carbon	80.2	84.5 percent	Declaration CHN by dry combustion
Inorganic Carbon	0.14	0.15 percent	Declaration HCl treated
Hydrogen/Carbon (H:C)	0.25	0.25 molar ratio	0.7 Max
Hydrogen	1.6	1.7 percent	Declaration CHN by dry combustion
Total Nitrogen	1.4	1.4 percent	Declaration CHN by dry combustion
Total Oxygen	6.0	6.3 percent	Declaration by difference
pH value	8.52	NA units	Declaration Ahmedna et al (2002) (1997)
Liming (neut. value)	2.9	3.0 % CaCO ₃	Declaration Rayment & Higginson
Liming (carbonate value)	1.2	1.2 % CaCO ₃	Declaration ASTM D 4373
Activity (Butane)*	6.9	7.3 g/100 g	Declaration ASTM D 5742 (butane)
Bulk Density	17.55	16.66 lb/cu ft	Declaration
Sulfur	0.0131	0.0138 percent	Declaration
Energy (HHV)		13234 (Btu/lb)	
Particle Size Distribution ASTM D2862 granular			
MM	Inch	% Retained	Fraction %
> 19	0.750	0.0	0.0
16 to 19	0.625	0.0	0.0
9.5 to 16	0.375	0.0	0.0
6.3 to 9.5	0.250	0.0	0.0
4.0 to 6.3	0.158	0.0	0.0
2.0 to 4.0	0.079	45.4	45.4
1.0 to 2.0	0.039	80.1	34.7
0.425 to 1.0	0.017	89.7	9.5
< 0.425	0.017	100	10.3
		Sum	100.0

Standards

Table 2 (continued). Test Category B Parameters, Maximum Allowed Thresholds and Test Methods.

Parameter	Range of Maximum Allowed Thresholds		Test Method
Polycyclic Aromatic Hydrocarbons (PAHs), total (sum of 16 US EPA PAHs) ⁷	6 – 300	mg/kg ⁸ dry wt	US EPA 8270 (2007) using Soxhlet extraction (US EPA 3540) and 100% toluene as the extracting solvent
Dioxins/Furans (PCDD/Fs) ⁹	17	ng/kg WHO-TEQ ¹⁰ dry wt	US EPA 8290 (2007)
Polychlorinated Biphenyls (PCBs) ¹¹	0.2 – 1	mg/kg dry wt	US EPA 8082 (2007) or US EPA 8275 (1996)
Arsenic	13 – 100	mg/kg dry wt	TMECC (2001)
Cadmium	1.4 – 39	mg/kg dry wt	TMECC (2001)
Chromium	93 – 1200	mg/kg dry wt	TMECC (2001)
Cobalt	34 – 100	mg/kg dry wt	TMECC (2001)
Copper	143 – 6000	mg/kg dry wt	TMECC (2001)
Lead	121 – 300	mg/kg dry wt	TMECC (2001)
Mercury	1 – 17	mg/kg dry wt	US EPA 7471 (2007)
Molybdenum	5 – 75	mg/kg dry wt	TMECC (2001)
Nickel	47 – 420	mg/kg dry wt	TMECC (2001)
Selenium	2 – 200	mg/kg dry wt	TMECC (2001)
Zinc	416 – 7400	mg/kg dry wt	TMECC (2001)
Boron	Declaration	mg/kg dry wt	TMECC (2001)
Chlorine	Declaration	mg/kg dry wt	TMECC (2001)
Sodium	Declaration	mg/kg dry wt	TMECC (2001)

⁷ For a list of the required PAH compounds to be tested see Appendix 2.

⁸ PAHs must also be reported on a B(a)P toxic equivalency basis with a maximum level of 3 mg/kg B(a)P-TEQ dry weight. See Appendix 3 for further information on TEF values for PAHs.

⁹ For a list of the required PCDD/F compounds to be tested see Appendix 2.

¹⁰ See Appendix 3 for further information on the WHO 2005 TEF values for PCDD/Fs.

¹¹ For a list of the required PCB compounds to be tested see Appendix 2.

SOIL CONTROL LAB

TPAC 001 7.2M12100

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Watsonville CA 95076
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42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076

2050820 01 7519
Batch
Apr. - May 2012 33
CODE:
BioChar (BI)

Kathleen Draper
Finger Lakes Biochar
142 County Road #9
Victor NY 14564

Date Received: 05/31/12
Sample Id.: Cherry Pit Biochar
Sample Id. Number 01 2050820

International BioChar Initiative (IBI) Level II

		Results		Maximum	Units	Method
		Wet Basis	Dry Basis	Allowed		
Arsenic (As)		0.17	0.18	13	mg/kg	B
Cadmium (Cd)		< 0.2	< 0.2	1.4	mg/kg	A
Chromium (Cr)		10	11	93	mg/kg	A
Cobalt (Co)		0.11	0.12	34	mg/kg	B
Copper (Cu)		2.1	2.2	143	mg/kg	A
Lead (Pb)		1.1	1.1	121	mg/kg	A
Molybdenum (Mo)		0.13	0.14	5.0	mg/kg	B
Mercury (Hg)		< 0.2	< 0.2	1.0	mg/kg	A
Nickel (Ni)		1.2	1.2	47	mg/kg	A
Selenium (Se)		< 0.2	< 0.2	2.0	mg/kg	B
Zinc (Zn)		301	318	416	mg/kg	A
Boron (B)		27	28	Declaration	mg/kg	TMECC
Chlorine (Cl)		864	910	Declaration	mg/kg	TMECC
Sodium (Na)		171	180	Declaration	mg/kg	TMECC
Basic Soil Enhancement Properties						
Potassium (K)	Total and available	0.91	0.95	Declaration	percent	E
Phosphorus (P)	Total	0.43	0.45	Declaration	percent	E
Ammonia (NH4-N)	Mineral	16	17	Declaration	mg/kg	R
Nitrate (NO3-N)	Mineral	5.9	6.2	Declaration	mg/kg	R
Phosphorus (P)	Available	575	605	Declaration	mg/kg	F
Electrical Conductivity	EC 1:5 w/w	10.340	NA	Declaration	Sm	R
Moisture		5.1	0.0	Declaration	percent	TMECC
pH value		8.52	NA	Declaration	units	TMECC
Methods		Method E Enders and Lehmann (2011)				
Method A	Amlinger, Farino and Pollack (2004)	Method R Rayment and Higginson (1992)				
Method B	Bureau de normalisation du Quebec (2005)	Method F Formic Acid procedure				
TMECC	Test Methods for the Examination of Compost and Composting (2001)					

Analyst: Frank Shields

Frank Shields

Standards

IBI Assists in Definitions Standards and Certifications

- **US, Canada, Puerto Rico**
 - AAPFCO Association of American Plant Food Control Officials biochar definition (2016)
 - USDA Natural Resource Conservation Service (NRCS) Conservation Stewardship Program, **Conservation Enhancement Activity E384135Z** Biochar production from woody residue(2016) Conservation Practice 384: Woody Residue Treatment
 - **California Air Pollution Control Officers Association** (CAPCOA) Biochar Protocol (2015) or carbon sequestration.

Carbon Markets





Biochar: **Safe, scalable & shovel-ready**

Any questions?

IBI Assisted Official of Biochar for Labelling Biochar in the US, Canada, and Puerto Rico

Biochar - is a solid material obtained from thermochemical conversion of biomass in an oxygen-limited environment (pyrolysis) containing at least 60% carbon. Feedstocks may be composed of crop residue, wood or other forest waste, and animal manures. Materials transported in salt water, painted, or treated with preservatives are not permitted. When listing biochar in an ingredient statement, the feedstock shall be designated by prefixing the term biochar with the feedstock from which it was produced; i.e. poultry litter biochar, green waste biochar, papermill biochar, etc. When more than one feedstock is involved, all feedstocks greater than 10% of the total volume are to be listed by decreasing volume. Their uses include soil amendments (*Official 2016 WA*) Pg 74 OP69

Approved at *Association of American Plant Food Control Officials AAPFCO*
Winter Meeting, February 22, 2016 www.aapfco.org