



Advances in Biochar Products, Systems, and Processes



Tom Miles
US Biochar Initiative
International Biochar Initiative



Biocycle West Coast 18
San Diego, March 28, 2018



Topics

- Biochars



- Products



- Systems

- Processes



Biochars are made in Different Forms and Qualities for Different Uses



**Char Composted in Soil –
Terra Preta 3,500 yrs**

**Charred
Branches**

Charred Chips



**Horticultural
Charcoal
6 mm/0.25 in**



**Biochar
Pellets**



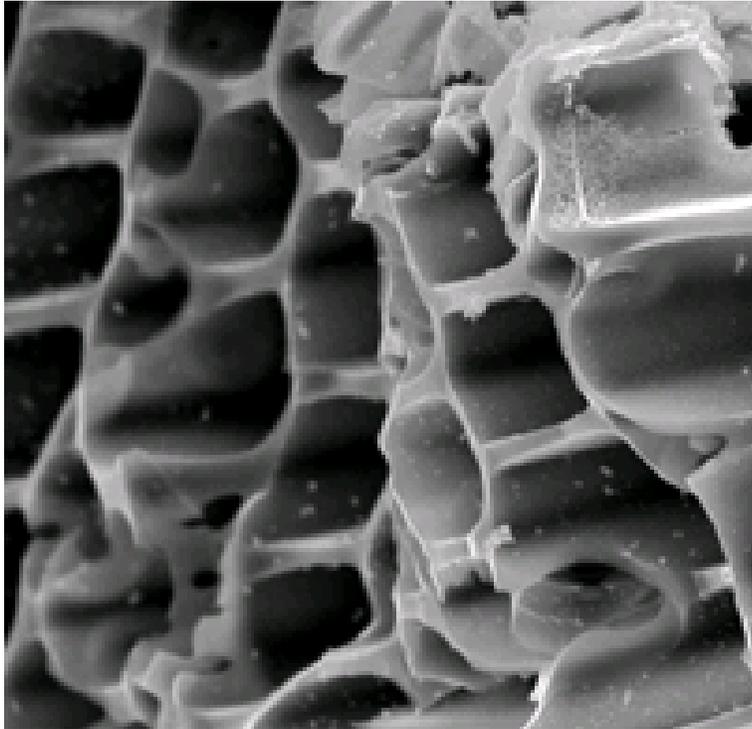
**Prills
Biochar+Minerals**



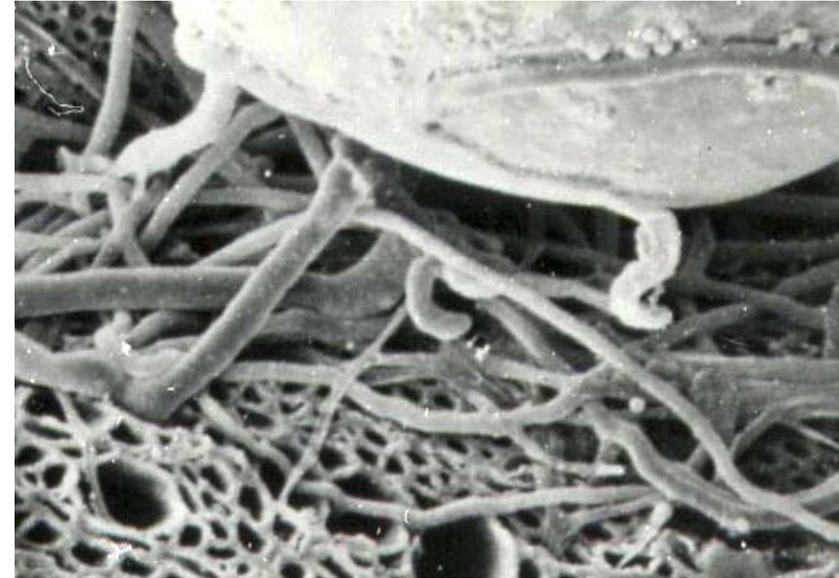
**Biochar+ Fiber+Bio
Biotic Soil
Amendment**

What are Biochars?

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



Collins 2009



**Mycorrhizal fungal hyphae
growing from spore base invade
large charcoal pores**

Ogawa 2004

Origins: Amazonian Dark Earth (Terra Preta)



No Char
Ferralsol
Hi Iron,
Al
pH 3.6



Terra Preta Ingredients:
charcoal, fish bones,
food waste, excrement,
soil

Soil: 30 in pH 5-6;

P 100-300x; Zn 10 x;
high base sat; low Fe sat



Char Only
Terra Mulata
pH 4.4



Cacao Pod
and Bean

- Heavy clay soils on high bluffs above Amazon river
- Low pH (3.5-4), high iron, high alumina, high leaching

EMBRAPA Caldeirão, Amazonas, BR



Char + Waste
Terra Preta de
Indio
pH 5.3-5.7



Manioc
(Cassava)
root

Biochar as an Ingredient of Retail Garden, Horticultural, and Landscape Products



Rexius/OpusGrows
www.opusgrows.com

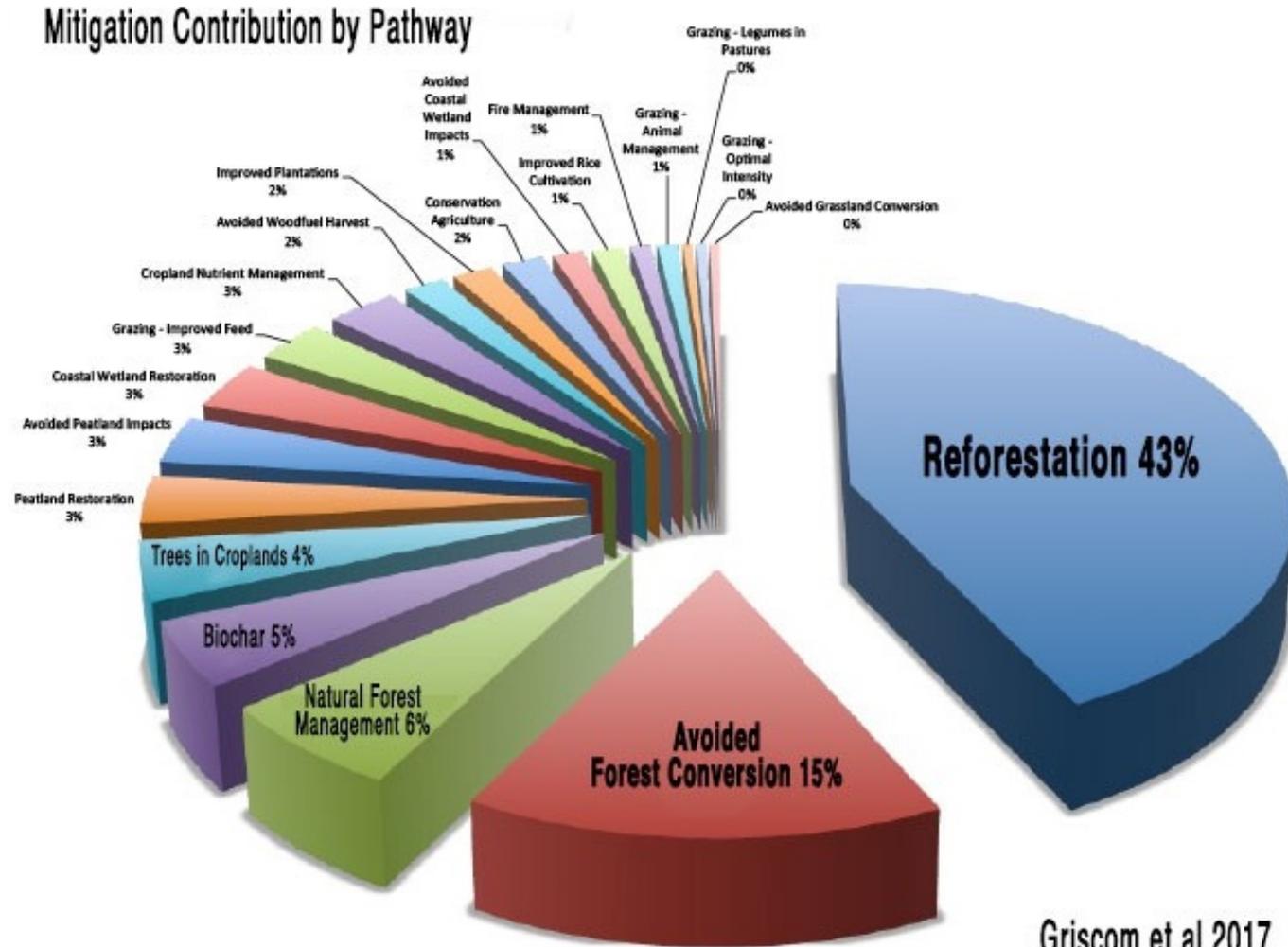


Kellogg Garden Products
www.kelloggarden.com

Others: Sustane Organic + Biochar, Mirimichi Green CarbonizPn Turf Enhancer, Cool Terra Engineered Biocarbon, Wakefield Biochar Soil Conditioner . . .

See: Role of biochar as an additive in organic waste composting. Miguel A. Sanchez-Monedero, Cayulela, M.L. Roig, A., Jindo, K. , Mondini, C & Bolan, N. (2018) Bioresource Technology, 247-1155-164

Biochar is Among Top 4 Natural Cause Pathways to Carbon Sequestration



Griscom et al 2017

Albert Bates

US Biochar Initiative - International Biochar Initiative Network – Education - Demonstration



**2009-
North America
Conferences - 2009 - 2018
Announcements, Newsletter
Website, Social Media
Education and Outreach**

**www.biochar-us.org
USBiochar@gmail.com**



**2008-
International
Members (Professional, Business, Organizations)
Newsletters
White Papers (Science Committee)
Webinars
Study tours
Website, Social Media
Education and Outreach**

**www.biochar-international.org
info@biochar-international.org**

Biochar uses, from Food Security to Multiple Markets

Manaus, Brazil – Terra preta

- Soil Amendment – food security



Biochar (Terra Preta 2.0)

- Advanced Biochar Products- food security
- Horticulture, Special Crops, Trees and Turf
- Environment – remediation, water quality, odor control, nutrient management
- Livestock Feed – animal health, food security
- Climate Resilience, Pollution Reduction
- Other carbon products: Building Products



Biochar Research, Production, and Use Advances From Terra Preta to Biochar Compound Fertilizers



- Accelerated Research
- Improved Chemistry and Biology – carbon interactions
- Improved Technologies for biochar and co-products
- More Sectors are Engaged in Biochar Development
- Early adoption by Retail Garden, Landscape, Slow Adoption by Ag
- Many Different Markets and Uses e.g. Livestock Feed
- Emerging uses complement use in soils e.g. Stormwater
- Opportunities for Climate Change Resilience – resistance to drought and disease
- Limited but growing supply of biochar products

Some Current Uses of Biochar from Wastes and Residues

Organic Recycling

- Volume reduction – crop residues, bedding, manures, biosolids, land clearing
- Odor control – Ammonia, H₂S filters

Urban Forestry

- Tree Health – road salt, carrier for micro organisms, water holding and infiltration
- Drought resistance – urban plant survival

Bioenergy and Waste Disposal

- Anaerobic Digestion – digester and digestate, increased gas, reduced CO₂, ammonia control

Soil Amendment

- Compost amendment – air and water, specialty products, leachate control
- Horticulture – growing media vermiculite substitute
- Turf and Tree – water conservation, growing media

Stormwater

- Contaminant filtration, metals

Biochars are finding value in diverse markets

- **Retail Garden and Landscaping**
 - Packaged consumer products
 - Biochar, Compost
 - Composted biochar (5%-20% biochar)
 - Biotic Soil Amendments (biochar + organics minerals and biologicals)
 - Biochar Compound Fertilizers (25% biochar)
- **Wholesale to**
 - Landscape services – tree service
 - Specialty Crops, Horticulture, and Turf
- **Environment, Remediation, Erosion Control**
 - Sewage Treatment, Biosolids and Odor
 - Stormwater filtration
 - Mine reclamation
 - Granulated products for hydro-seeding, turf
 - Oilfield remediation, Filtration
- Non-soil carbon products– building products, odor control, feed (“Cool Fauna”)



www.biocharsupreme.com



www.kelloggarden.com



Biochars are sized, formulated, and packaged for specific uses



Biochar Size Selection Table

	Chip	Medium	Small	Powder
Particle sizes (based on screen sizes)	1" to 3mm	3mm to 26 mesh	26 mesh to 50 mesh	50 mesh and under
Applications				
Direct placement into soil	X	X	X	X
Top-dressed on soil or grass		X		
Air seeder insertion into soil			X	
Suspended in water spray				X
Drip irrigation systems				X
Ag irrigation systems			X	X
Suspended in water for soil injection			X	X
Biofilter for air or water	X	X	X	X
Biofiller		X	X	X
Microbe carriers	X	X	X	X

Abundant Crop Research Continues

Most early field studies used biochar for water infiltration and retention. Current research is on enriched products, disease resistance, contamination, etc .



Dryland Wheat -Kristin Trippe, USDA-ARS, Oregon State University



Biochar for Coffee Production and Disease Resistance - Tanzania

Systems: Converting slash to biochar for forest management

US Forest Service Biochar Spreader



USFS Spreader –
D Page-Dumroese

Systems: Biochar added to Dry Ingredients for Strip Tillage



David Yarrow, Down the Wormhole, 2016

Systems: Liquid Biochar Injection to Offset No-till Acid Toxicity



**Biochar Slurry Fed in Cross Slot
Don Graves, NZ**

Processes: Large Scale Production of Granulated Biochar Enhanced Compound Fertilizer from Crop Residues in China



Beijing Sanju Crop Residue to Biochar Fertilizer Production Facility
2.5 mt/hr, gas+pyrogas

China: Biochar Fertilizers Approved for Recycling Agricultural Residues (2017) and Carbon Trading (2018)

2017: 800,000 tons crop straw converted to biochar fertilizers.



50 plants
300 test farms

Beijing Sanju Environmental Protections & New Material Co. Ltd., Nanjing Agricultural University, IBI Asia
www.biochar-international.org/node/8858 www.sanju.cn/Home/nav/154.html

Processes: High Carbon Biochar Delivered in Bulk as a byproduct of Biomass Plants or Gasifiers in Sawmills for Drying Lumber



2 CY 400 lb



80 CY 8-10 t

Oregon Biochar Solutions
www.chardirect.com



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

Processes: Phoenix Energy Gasifier Engine Systems: 500 kWe, 1000 kWe, 2,000 kWe + Biochar



www.phoenixenergy.net

Processes: Urban Residues to Heat and Biochar for Carbon Reduction



Pilot plant
ÅVC 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

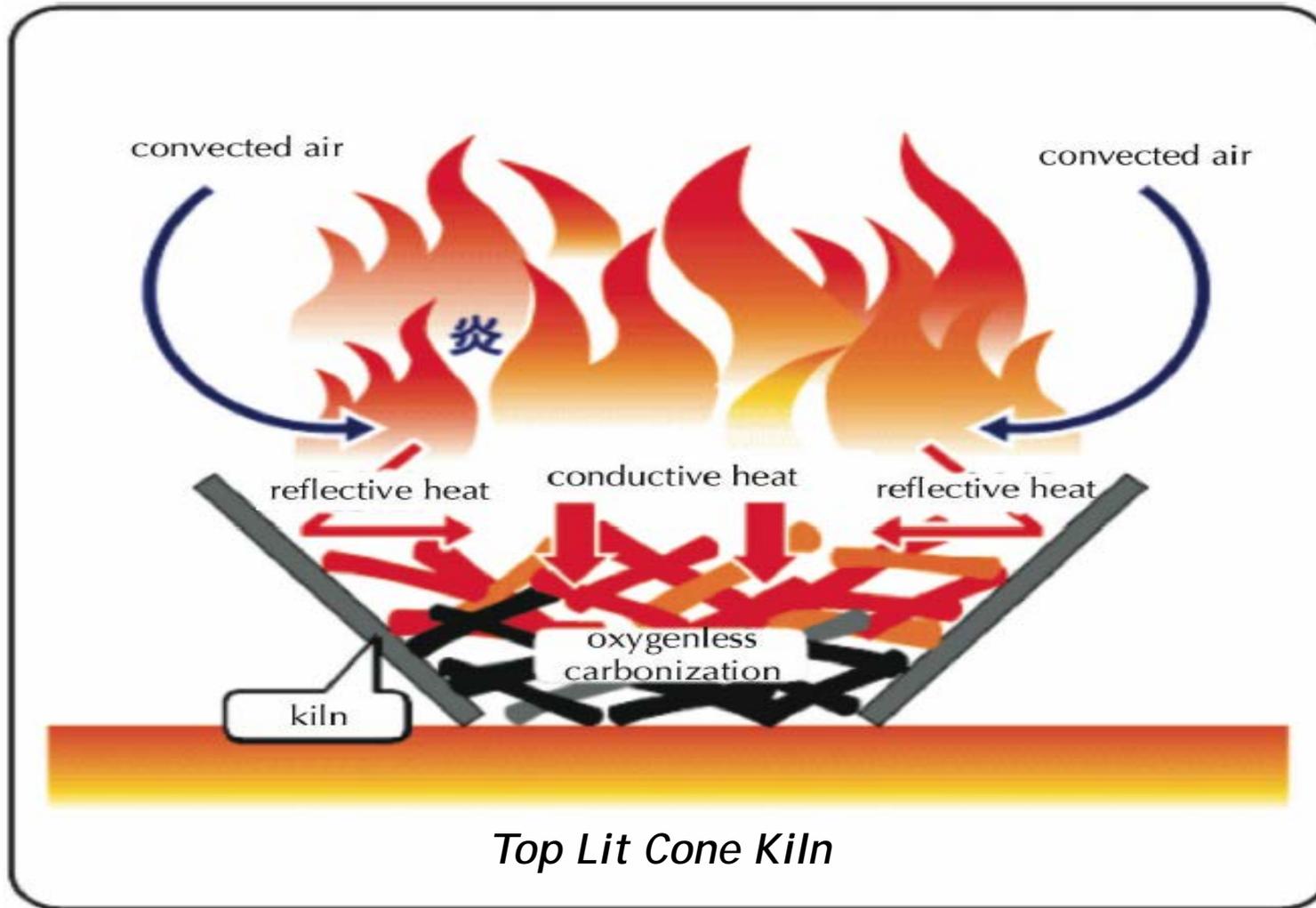


IBI Webinar June 2017 www.biochar-international.org/webinar_series Study Tour October 2017

Urban Opportunity: Convert Composting Wood and Debris to Biochar



Processes: Promote Char by Limiting Oxygen at Base of Fire



McGreevy, Ogawa, Shibata



Shea, Blackshear, Okimori



Wilson Biochar Associates
www.wilsonbiochar.com

Portable Industrial Kilns Can Make Biochar



Roll off refractory lined “Air Curtain Burner” making biochar from forest residues, Oregon

ubetbiochar.blogspot.com/2016/04/making-biochar-with-air-burner-in.html

airburners.com



**Mobile burner/carbonizer, Canada
ROI Equipment Envirosaver350, Est. 6-10 tph**

www.roi-equipment.com

Testing a New Mobile Kiln in Canada, March 2018



Convert land clearing, road construction wood to biochar for direct use on site.

www.roy-equipment.com



www.roy-equipment.com



www.roy-equipment.com



www.roy-equipment.com



Improved Gasifiers for Making Biochar

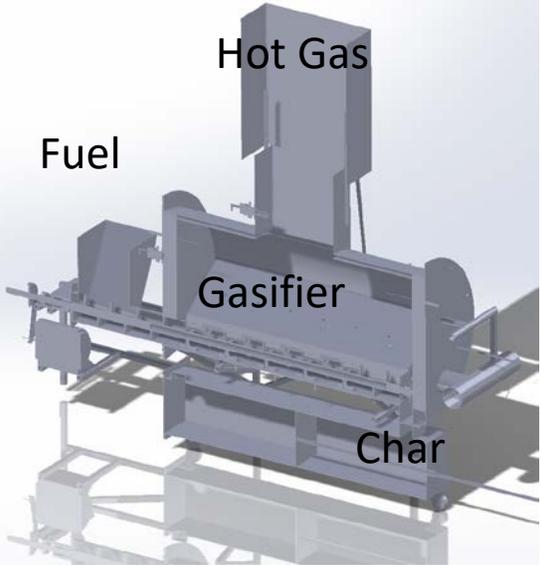


www.biocharsolutions.com

Portable Gasifiers Developed for Farm Use



BES Australia



New Biochar Products, Systems, and Processes can help:

- **Soil Health**
- **Food Security**
- **Clean Water**
- **Environment, pollution control, organic recycling**
- **Climate Resilience**

Join the International Biochar Initiative

<http://www.biochar-international.org/join>



Engage with Biochar Community

Network - Join Biochar Discussions and (USBI/IBI) Social Media

Attend USBI Biochar 2018, Aug 20-23, Wilmington, Delaware

Support Regional Biochar Organizations

Contact us: info@biochar-international.org, USBiochar@gmail.com





BIOCHAR 2018

08.20.2018 // // // 08.23.2018

Chase Center on the Riverfront
Wilmington, Delaware USA

EARLY REGISTRATION OPEN NOW

Abstracts & Workshop Proposals Currently Being
Accepted Until **March 1, 2018**

Conference Exhibiting, Sponsorship & Promotional
Opportunities Available

“The Carbon Link in Watershed Ecosystem Services”

USBI Biochar 2018 is the largest event in North America dedicated to advancing the sustainable production and use of biochar through scientific and engineering research, policy development, field practice, and technology transfer. Attendees can expect to:

- **Learn** about ground breaking scientific research and technologies
- **Discover** the benefits that biochar can provide
- **Hear** from biochar experts about ways to restore and remediate our watersheds
- **Connect** with leading biochar businesses, producers and distributors

www.Biochar2018.org

info@Biochar2018.org

Conference Sponsors



US Biochar Initiative biochar-us.org



Biochar Listserv www.biochar.bioenergylists.org

International Biochar Initiative Biochar-international.org



TR Miles Technical Consultants, Inc.

503-780-8185 tmiles@trmiles.com

www.trmiles.com



Design and development of energy and environmental processes

Industries

Biomass energy

Pollution control

Materials handling

Feed, Food and Fuels

