Intro to Bio-char

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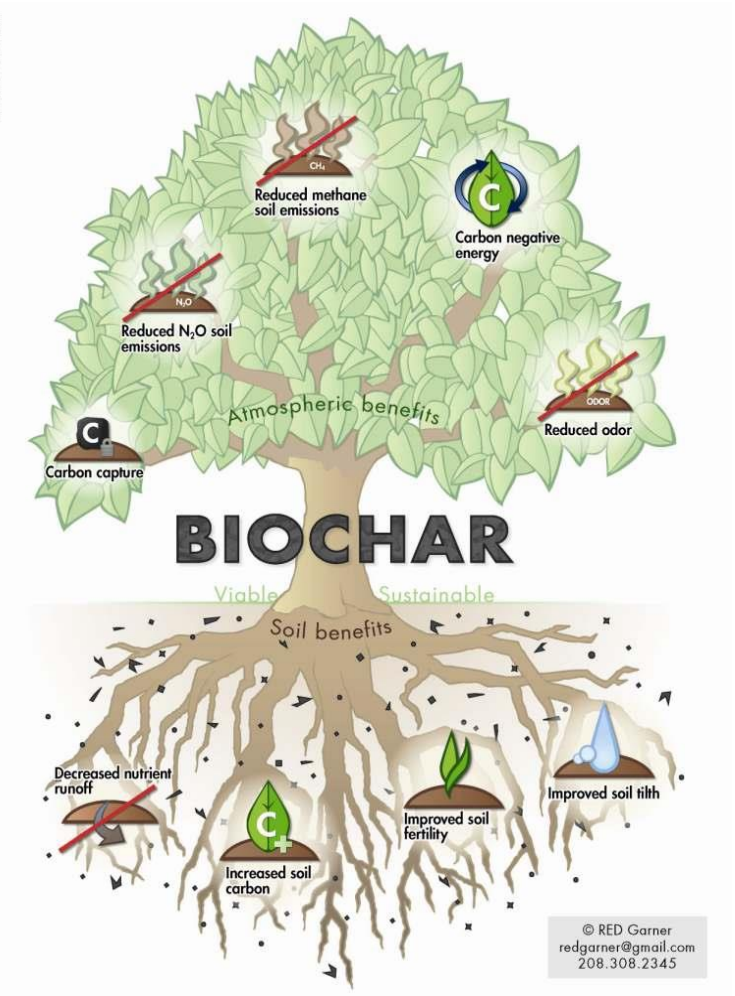
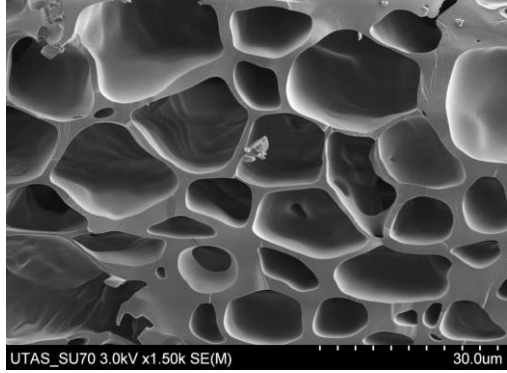


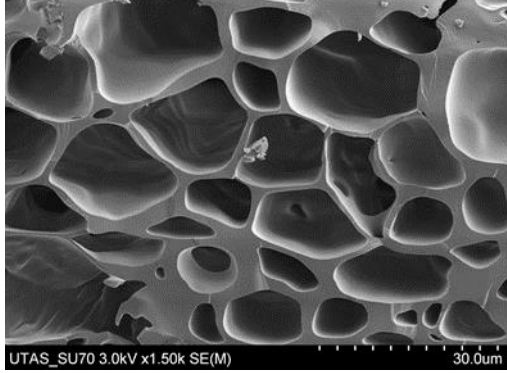
What is Biochar?



Definitions

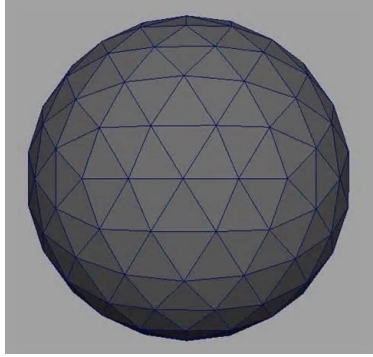
- “Simply put, bio-char is the carbon – rich product obtained when biomass, such as wood, manure or leaves, is heated in a closed container with little or no available air.”(Lehmann & Joseph, 2009)
- A type of charcoal, the difference being that bio-char is applied as a soil amendment so as to improve it’s productivity, to store or lock up carbon or filter water in it. Whereas charcoal is used as a fuel and other non-agricultural purposes.
- When you light biomass in the presence of oxygen it turns into ash relatively quickly, which will then have a higher mineral ash content such as Calcium © and Magnesium (Mg) which is also useful as a soil additive but does not last as long as it generally has a low carbon content.
- Biomass allowed to decompose in nature or compost will help build humus and release nutrients into soil but will end up as greenhouse gas in the atmosphere over a relatively short period of time, e.g. 12 months and regularly needs to be added.
- What sets bio-char apart is it’s unique properties such as high carbon content, increased surface area, chemical stability and structure. It can last up to thousand s of years in the soil.
- a “dead” chemical matter with no vital force.
- A piece of bio-char 10 mm in size has been estimated to have approximately an acre of surface area within it.

What is Biochar? (cont'd)



- A five star motel for soil microbes, water and fertilizer to live and interact symbiotically with mycorrhizal fungi hyphae and plant roots.
- It is made via a process called **slow pyrolysis**
- **Pyrolysis** occurs when the feedstock is heated to appropriate temperatures usually between 400 – 700 degrees forcing gases and other volatiles out of the biomass and lighting when it hits oxygen. This process then self regulates and continues to raise the temperature of the feedstock. Effectively you're cooking or roasting biomass pushed through to a place of oxygen where it ignites.
- Bio-char is therefore, not charcoal, not coal, it is not burnt, but rather pyrolysed in an inner chamber with fuel around it. (**retort** kiln) or
- when the biomass is lit from the top with air flow through the medium to the bottom in the same chamber. You will be left with 50-30% of original biomass. Top Lit Updraft Kiln (**TLUD**)
- Bio-char structure, content and application to soil types will vary depending on the different types of **feedstock** and systems that you use to pyrolyse.
- A general rule for **plant based** feedstock's (veganic gardening) is any fibrous woody waste that can't be composted. They include, bamboo (carbon & silica), hemp (bast & hurd), camphor, macca nut shells, pine cones, Bunya Pine Nuts, Teak seed pods, dried food scraps, coconut shell and husk, tip green waste, woodchip, bio-solids, paper mill sludge, sugar cane, rice husks, wheat chaff, grasses, clay. Macadamia Nut Shells have been shown to have the highest carbon content.
- Other feedstock's include animal manures such as chicken, cow, bat guano, bones for high mineral content, whole carcasses, cane toads.

What is Biochar? (cont'd)



- Industrial Waste products: Plastic syringes, bottles, cigarette lighters, coffee pods, tyres & metals. (Tru Energy). These will be different in content and may not be suitable for application to soil or can be used as a filler with other plant based or animal manure feedstock's to dilute. (Bio-char Mineral Complexes)
- High Temperature bio-char 600 plus. Activated/charged or inoculated post pyrolysis. Soaked in, liquid fertilizer, mixed with compost
- Enhanced Low Temperature Bio-char. Smoke and lower temps enhance microbial activity. Inoculated prior to pyrolysis. Bio-char Mineral Complexes, e.g. clay, wood and straw
- **Properties/Characteristics**
- Porous substance with high water and air holding capacity; Suitable habitat for some microbes and plant growth, good material for soil amendment, absorption of chemicals and humidity control
- Alkaline; Neutralization of acidic soil and improvement of chemical components of soil and selection of microorganisms
- Low mineral content ;
- Chemically speaking, bio-char has irregular arrangements of Carbon (Geodesic Sphere or **"Bucky Ball"**) with Oxygen and Hydrogen and sometimes minerals depending on the feedstock. (refer to DPI Analysis overleaf)
- A piece of bio-char 10 mm in size has been estimated to have approximately an acre of surface area within it.

What is Bio-char?

History

Bio-char was discovered by scientists early this century via the “Terra Preta” soils, which is Portuguese for Black earth and are of pre-Columbian (before European Settlement) nature. They were created by humans (anthropogenic) between 450 BC and AD 950 at sites throughout the Amazon Basin.

It is generally accepted that they were the soils close to living quarters where residues from food preparation accumulated. They contain high charcoal content from cooking fires, broken pottery, animal & fish bones, etc.

The intentionality of the Terra Preta soils is not known for sure because the areas for growing food were separate. It is commonly accepted that they were created under kitchen middens, therefore created accidently.

Terra preta soils are found mainly in Brazilian Amazonia, where Sombroek *et al.* estimate that they cover at least 0.1 to 0.3%, or 6,300 to 18,900 square kilometres of low forested Amazonia; but others estimate this surface at 10.0% or more (twice the area of Great Britain).

Terra preta exist in small plots averaging 20 hectares (49 acres), but areas of almost 900 acres (360 ha) have also been reported. They are found among various climatic, geological, and topographical situations. Their distributions either follow main water courses, from East Amazonia to the central basin, or are located on interfluvial sites (mainly of circular or lenticular shape) and of a smaller size averaging some 1.4 hectares (3.5 acres), see also distribution map of terra preta sites in Amazon basin. The spreads of tropical forest between the savannas could be mainly anthropogenic — a notion with dramatic implications worldwide for agriculture and conservation.

What is Bio-char?

History

Terra preta sites are also known in Ecuador, Peru, French Guiana, in Benin, Liberia, and on the South African savannahs. Similar dark earth was found in late Roman Britain.

Bio-char is one of the oldest soil amendments in the history of agriculture evident from these Amazonians. European settlement diseased and dispersed them and they became nomadic. This devalued the need for creating stable humus that would last.

In the 19th century it began with Justus Liebig, the “father of organic chemistry” who wrote that charcoal “surpasses all other substances in the power which it possesses of condensing ammonia within its pores… it absorbs 90 times its volume of ammoniacal gas, which may be again separated by simply moistening it with water.” (Agricultural Chemistry, p 35.) This simple statement launched a wave of practical experimentation using charcoal for agriculture and waste management that lasted for nearly a century. (Wilson,2013)

“In the midst of the disastrous drought of last summer, while crossing a field in Moriah, occupied by Mr. Richmond, in pursuit of some Durham cattle I wished to examine, I observed a lot with its surface deeply and singularly blackened. Upon inspection I found it thickly strewn with pulverized charcoal. The field presented a rich verdure, strongly contrasting with the parched and blighted aspect of the adjacent country.” (New York State Agricultural Society, 1853)

What is Bio-char?

Porosity of a coal ash clearly visible to the naked eye. (Photo: Andreas Thomsen)

History Cont'd

"Poudrette (human faeces deodorized with charcoal dust) is one of the best manures for the rose… Charcoal dust is an excellent surface dressing; it imbibes and retains moisture, keeps the plant healthy and intensifies the color of red varieties." (The Garden Diary of Martha Turnbull)

"A dead rat, nicely buried in a cigar box so as to be surrounded at all points by an inch of charcoal powder, decays to bone and fur without manifesting any odour of putrefaction, so that it might stand on a parlour table and not reveal its contents to the most sensitive nostrils." (The Garden, 1873)

However, a bio-char industry never took hold. The reasons were certainly economic in the main: more than one enthusiast echoed the complaint made in the 1847 volume of the American Journal of Agriculture and Science: "The use of charcoal as a fertilizer is generally well known. Its expense, however, often precludes its use."

Scientist Rattan Lal estimated in 2007 that "most agricultural soils have lost 30% to 75% of their antecedent soil organic carbon," equivalent to 30 to 40 tons of carbon per hectare.

What is Bio-char?

Modern Research

“Bio-char may represent the single most important initiative for humanity’s environmental future. The bio-char approach provides a uniquely powerful solution, for it allows us to address food security, the fuel crisis, and the climate problem, and all in an immensely practical manner. ” Prof. Tim Flannery 2007 Australian of the Year “

NSW DPI WOLLONGBAR is running the world's largest demonstration of bio-char, with over 150 field plots under management as of 2008.

Projects include;

***Land management to increase soil carbon sequestration in NSW

*Assessment of Bio-char for agronomic benefits, improved fertiliser use efficiency, greenhouse gas abatement, and reduced off-site migration of chemicals.

*Soil carbon sequestration and rehabilitation: Landholders develop, implement and assess bio-char

*Benefits of paper mill bio-char (Agrichar TM)

*Assessment of Bio-char in Sugarcane cropping systems

*Characterisation of Bio-char by analytical Py-GC-MS (a system for testing the quality of bio-char**)**

What is Bio-char?

Projects Cont'd

Reduction in N2O emissions from soils amended with Bio-char

Nitrogen dynamics of bio-char in soils

http://en.wikipedia.org/wiki/Terra_preta#Early_theories

(Wilson, 2013) http://www.biochar.org/joomla/index.php?option=com_content&task=view&id=70&Itemid=25

http://www.dpi.nsw.gov.au/research/topics/biochar

The Benefits of Biochar

- Mitigation of climate change, Waste Management, Energy production & Soil Improvement
- Social and financial benefits
- Good returns on agricultural inputs such as fertilizers rely on soil organic matter, this is what addition of bio-char provides
- Uses existing onsite resources more efficiently which has many environmental outcomes such as improving soil fertility & nutrient use efficiency in a sustainable way
- Farmers and gardeners in resource poor systems can convert biomass onsite (particularly woody matter) into bio-char at a minimal cost and get a far greater return on harvests whilst spending less on inputs.
- Rejuvenate poor soils that are depleted from fertilizer use.
- Used with existing best management soil practices, humus building to decrease impact on soil and water resources.
- Help to manage wastes and reduce methane emissions from landfill, reducing energy use to get it to landfill

The Benefits of Biochar (cont'd)

- Increasing C sequestration by storing carbon in soil.
- Reducing nitrous oxide and other greenhouse gases coming off the soil
- Transforms the rapid biological cycle of decay into a much slower bio-char cycle. The natural carbon cycle can be slowed down to offset human induced carbon in atmosphere currently 400 PPM.

- Bio-char for Environmental Management – Edited by Joseph Lehmann & Stephen Joseph
- The Bio-char Revolution – Edited by Paul Taylor
- Agronomic values of greenwaste biochar as a soil amendment -http://www.publish.csiro.au/?paper=SR07109
- Using poultry litter biochars as soil amendments - http://www.publish.csiro.au/?paper=SR08036