Biochar

carbon-negative fertility, food & fuel

Frequently Asked Questions

1. What is *biochar*?

Biochar is a new word selected to describe fine-grained charcoal made from biological material (biomass), high in organic carbon. This excludes fossil fuel products, geological carbon and industrial synthetics (plastics).

A primary purpose for ***biochar*** is as soil enhancement. Since this includes food-producing farm soils, careful, precise specifications are needed to define this material.

2. Why should I be interested in *biochar*?

Biochar is a key ingredient in a new Carbon-Negative strategy that offers solutions to several critical current ecological, energy and economic challenges:

- Sequester carbon from air to reverse global warming
- Increase soil fertility and agricultural yields
- Improve soil structure, aeration & water penetration
- Reduce use of synthetic fertilizers and pesticides
- Reduce nitrous oxide and methane emission from soil
- Reduce nitrate & farm chemicals leaching into watersheds
- Produce renewable fuels from biomass
- Convert green and brown wastes into valuable resources
- Reduce dependence on fossil fuels
- Reduce dependence on imported oil
- Support local, distributed energy production & distribution
- Create local jobs and economic cycles
- Increase community food & energy security

USDA soil scientist Dr. David Laird published an article in 2008 calling this carbon-negative ***biochar*** strategy:

A Win–Win–Win Scenario

for Simultaneously Producing Bioenergy, Permanently Sequestering Carbon, while Improving Soil and Water Quality

3. How is *biochar* made?

Biochar is the by-product when biomass is burned or heated with a minimum or absence of oxygen. In normal combustion, biomass is *oxidized* into alkali ash, plus steam, CO_2 and other gases and vapors. When air is excluded, oxygen for combustion is stripped from the biomass, which is thus *reduced* to carbon-carbon bonds of charcoal.

Charcoal has been made for centuries worldwide by simple methods with little or no tools. Modern *pyrolysis* and *gasification* technology uses controlled combustion in air-tight retorts to process tons of biomass into energy gases and liquids.

4. Can *biochar* support sustainable agriculture?

Biochar enhances soil in numerous ways. Its use in soil is new, exciting and not fully understood yet. *Biochar* isn't a fertilizer, or food source for plants or microbes. Understanding its action is a paradigm shift from chemical views to biological insight into fertility and the soil food web.

Recently archeologists discovered indigenous tribes in the Amazon rainforest used char to enrich soil 500 to 4,000 years ago. Japanese used char in soil for centuries before it was replaced recently by industrial chemicals and methods.

New research shows *biochar* has several effects in soil:

- increase water infiltration and water holding capacity
- improve soil structure, tilth and stability
- adsorb ammonium, phosphate and calcium ions
- enhanced nutrient retention capacity
- better root development
- increased soil pH and buffering
- increase cation exchange capacity, and also anions
- increase fertility and nutrient retention more than conventional soil organic matter
- increase soil biological activity and diversity, creating conditions described as a "microbial reef"
- reduce fertilizer runoff, especially nitrate & phosphorus
- 50-80% decrease in nitrous oxide emissions from soil
- reduces total fertilizer requirements
- mitigates climate and environmental impact of cropland
- reduces phosphorus runoff into surface water
- reduces nitrogen leaching into groundwater

5. Does *biochar* increase crop production?

Research consistently reveals that poor soils enriched with ***biochar*** grow bigger, stronger plants that yield higher crop quantity and quality. Even better, soils retain nutrients and sustain their productivity better than soils without ***biochar***.

Plants grow well in soils with up to 9% ***biochar by volume***, at less cost and increased yield, and sustain this greater production longer with less fertilizer.

In soil, ***biochar*** significantly increases fertilizer efficiency, thus reducing needs for chemicals, while enhancing crop yields.

A Mississippi corn farmer plowed 15 tons an acre of ***biochar*** into sandy river bottom, and saw corn yield more than double. After the first year, his fertilizer use declined.

Australian research in New South Wales applied 4.5 tons/acre (20lb./100sq.ft.) to carbon-depleted soils, and doubled soybean biomass and tripled wheat biomass.

Tomato transplant trials in 2008 at Virginia Tech with less than a cup of ***biochar*** in a gallon of soil mix found an average 48% increase in yield.

Crop response is enhanced if ***biochar*** is inoculated with beneficial micro-organisms, which increases nutrient use efficiency and overall plant health.

Field observations reveal reduced need to irrigate when ***biochar*** is applied.

6. How is *biochar* applied to soils?

Biochar can be broadcast, or applied by drop spreaders in most applications.

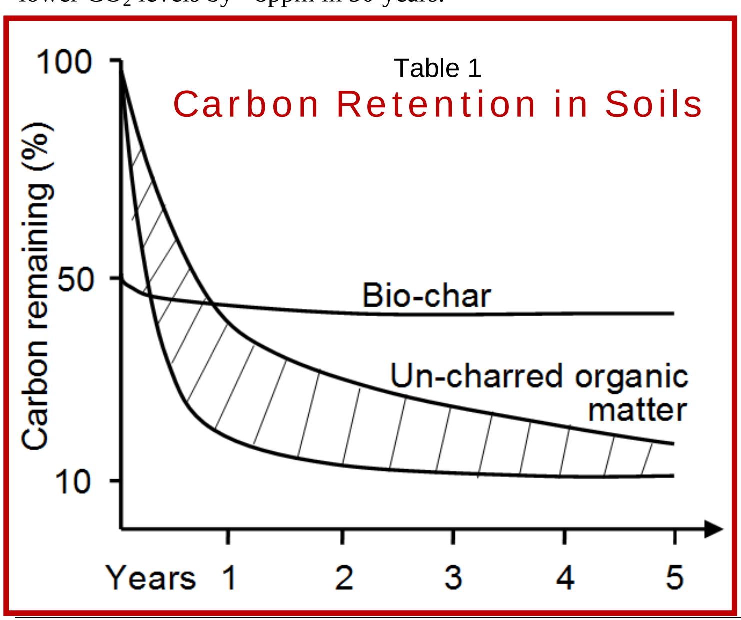
When applied to corn, soybean and similar row crops, drop in furrows with seed to support growth as soon as seeds germinate.

7. Can *biochar* reduce greenhouse gas levels?

Plant photosynthesis fixes CO_2 out of the air, combined with water to make carbohydrates, or sugar. When biochar is made, some C returns to the air by burning, but 20-50% of the C remains in the biochar.

When ***biochar*** is put in soil, its carbon-carbon bonds don't break down, and remain in soil thousands of years—far longer than C in compost, plant residues or animal wastes, which oxidize into the air quickly. So, C fixed by photosynthesis is converted to inert forms safely stored long-term.

Thus, ***biochar*** in soil is a true Carbon-Negative strategy. Worlwide, adding ***biochar*** to farmlands could remove many gigatons of C02eq from the air. NASA scientist James Hansen estimates if applied worldwide, soil sequestration of ***biochar*** can lower CO_2 levels by ~8ppm in 50 years.



Theoretically, ***biochar*** applied to arable land could reduce and store up to 12% of annually produced, human-generated CO_2 in the atmosphere today. But back in soil, char improves fertility, stimulating greater plant growth, which then fixes more CO_2 from the atmosphere.

Research shows adding biochar to soils reduces nitrous oxide emissions by 80% while also eliminating methane emissions—far worse greenhouse gases than CO_2.

Biochar produced by modern methods of controlled pyrolysis is an approved Clean Development Mechanism under the U.N. Framework Convention on Climate Change, recognized as a way to avoid methane produced by biomass decay.

Currently ***biochar*** isn't recognized as a method to sequester carbon, and doesn't earn credit on any carbon exchange, YET.

8. Does *biochar* replace compost in soils?

Biochar is distinctly different than conventional organic matter created by decay of plant and animal wastes. Biochar applied to soil is more effective if inoculated with microbial cultures. with compost. Compost tea. Mycorrhizae.

9. Can *biochar* produce renewable energy?

Biomass is the world's third largest fuel source, after coal and oil. Most biomass is woody matter, green wastes, crop residues, food processing wastes (eg. rice husks). Current biomass-to-energy technology is at best carbon neutral, and is not sustainable, because harvesting depletes nutrients, reducing soil fertility and productivity.

Making biochar by pyrolysis also produces energy. As hydrocarbons in plant matter break down, hydrogen, methane and other gases are released. They can be captured and burned. Renewable oils and gases produced can be used as fuels. Energy produced making biochar can be turned into electricity, process heat, reformed into ethanol & methanol, or an ultra-clean liquid diesel fuel. Thus, this strategy also produces renewable energy.

Pyrolysis uses wastes, and about half the original carbon and most of the minerals are returned to the soil, where the biochar supports sustainable, biological fertility.

This energy production doesn't require planting forest or farm crops, but instead uses crop residues and biomass wastes to produce hydrogen, electricity, bio-oils, ethanol, and biochar.

The National Renewable Energy Laboratory research report concluded that for every 1 GJ of hydrogen produced and used 112 kg carbon dioxide is utilized and stored in the soil.