A Farmer's Guide to Biochar

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Farmers today use "slash and burn" methods to cut down the forest, clear the land and plant crops. The trees are piled up and burned. The ashes have some nutritional value to plants, but everything else goes up in smoke, which must be replaced by using fertilizers.

Thousands of years ago, farmers in the Amazon rainforest, used a different method: "slash and char." Cut down trees were piled up and covered with dirt and debris so that the fire could be controlled.

This pile of biomass was slowly "heated, but not burned" to make charcoal. Afterwards, there were some ashes, but mostly hard, vitrified charcoal called biochar that was added to the soil. Today this soil is called Terra Preta or dark earth. It is still very fertile after thousands of years.

This new, yet old, farming technique is the foundation of the next Green Revolution in Agriculture and the worldwide, carbon-based economy currently emerging. Farmers can collect, transform and store organic matter for the benefit of future generations of farmers.

No longer will valuable carbon be wasted, but be safely stored in fertile soil for thousands of years.

Key benefits of biochar to the farmer:

- Persistent in soil. Does not rot or decompose in soil.
- Adds unique physical properties to the soil that improves water and nutrient holding capacity
- Increases beneficial microbes in soil.
- Reduce agricultural run-off of valuable nutrients.

Ultimately, all organic matter is decomposed and mineralized into carbon dioxide or methane gas, which will escape into the atmosphere. Soils constantly lose organic matter. When organic matter is transformed into biochar, it does not decompose. Nor will it will contribute to greenhouse gases, because, unlike compost, which continues to decompose, biochar adds no further CO2 to the atmosphere.

The process of pyrolysis, or heating with fire in the absence of oxygen, does not burn the organic matter. Instead, imagine a piece of wood inside a pressure cooker. The wood would not burn, but all the moisture would be driven off in the escaping steam. Heat cooks away all the dross materials or impurities in the biomass, leaving behind a pure form of carbon. Graphite, coal, and diamond are other examples of long-lasting, pure carbon found in nature.

Pyrolysis vaporizes, volatilizes or distills off all of the plant juices which can then be collected, to be used as fuel to run the pyrolysis process. Both energy production and biochar are the results of this carbonization process.

Persistence in the soil is biochar's greatest benefit to the farmer. Thousands of years ago, indigenous peoples of the Amazon turned the worst soil on the planet into the richest. Their biochar exists to this day. With this kind of example, every farmer today should start making biochar.

Compost is a wonderful soil amendment, but farmers cannot afford to add ***only*** organic matter to their soil, year after year after year. In fact, biochar is often mixed with compost before it is applied to the soil. Biochar does not replace compost, rather biochar enhances compost.

The practice of farming consumes large quantities of raw materials like water or fertilizers and organic matter like compost and manure. Biochar is not consumed or used up.

For this reason, a bank can secure a loan with biochar as the collateral, but not decomposing compost. Pure carbon has value because it lasts. It is like putting money in the bank. Biochar is the new "black gold" that you don't dig up or drill for in the ground. You grow it and make it yourself.

Structure of Biochar

Biochar is charcoal intended for agricultural use as a soil amendment. It is not a fertilizer, but reduces fertilizer use because it acts like a giant sponge. The multitude of pores makes a honeycomb structure that is lighter or less dense than soil. Soil becomes more open to the movement of air, water and roots.

The carbonized structure of biochar is completely dehydrated so it has a powerful attraction for water and anything dissolved in water. Anything that can dissolve in water has either a positive (+) charge or a negative (-) charge. Biochar attracts, absorbs and holds onto both kinds of charged particles. Nothing else in soil can do this better than biochar.

Farmers use a test called Cation Exchange Capacity (CEC) to measure how much attraction there is in the soil for the (+) charged minerals or metallic ions in the soil.

Clay and organic matter together make humus in soil which attracts positive (+) charged minerals like calcium, magnesium or iron. However, humus does not attract negative (-) charged nitrogen or phosphorus fertilizers. Biochar does. It absorbs both positive (+) and negative (-) charged particles so it greatly increases the holding capacity for all nutrients in the soil.

A tremendous amount of water pollution occurs because nutrients from animal waste and agricultural fertilizers are very soluble in water and easily wash out or leach into the groundwater. Drinking water contaminated with excess nitrates is one cause of Sudden Infant Death Syndrome.

Pros and Cons of Biochar

Biochar has the ability to attract and absorb water soluble plant nutrients. However, if plain, raw charcoal is put into the soil, it will absorb nutrients out of the soil to fill its empty pores. Stalled or delayed growth from a lack of available nitrogen can sometimes occur for a few weeks.

Experienced biochar farmers fill up the empty space in biochar with nutrients before adding it to soil. These farmers fortify their biochar with water, nutrients and beneficial microbes to make a complete soil amendment that will not be washed or leached away for years to come.

Water Capacity of Biochar

Soils that are low in organic matter, i.e. humus, do not hold water or nutrients very well. Biochar-enriched soil can hold up to 20% more water and nutrients than plain soil. Instead of "flood or drought", biochar modulates or evens out the amount of water available to a plant growing over a longer period of time.

Biochar can work differently in different soils. Added to sandy soils, biochar greatly increases holding capacity for water and nutrients. Added to a high clay soil, the porous biochar opens up the soil and allows it to drain better, while holding more water at the same time. Farmers can feel safe using biochar, knowing that farmers have used it before.

More Mycorrhizial Fungi

Although biochar acts differently in different soils, one fact remains clear; the addition of biochar to soil greatly increases mycorrhizial fungi activity. These fungi are not parasites but are the beneficial partners that surround the roots of plants and enter into a symbiosis with the plant.

In exchange for sugar from the plant, mycorrhizial fungi grow hair-like filaments called *hyphae*. These fungal *hyphae* can grow great distances away from the root of the plant, greatly increasing how far the plant can penetrate into soil. A root hair only extends a few millimeters away from the main root, but symbiotic fungal filaments can extend more than a foot away from the root.

Mycorrhizial fungi dissolve minerals such as iron, phosphate or copper in rocks and then transport the nutrients back to the plant root, greatly increasing the fertility of soil and the health of growing plants. Beneficial fungi also suppress diseases and assist the plant with water utilization during drought.

Disease Suppressing Soil

A soil with large numbers of beneficial microbes has more bio-diversity. This gives the soil the ability to suppress or prevent diseases. Other soils lacking beneficial microbes are virtually sterile or filled with pathogenic, disease causing microbes. What makes the difference?

Imagine that you are pioneer farmer. You find a piece of forest for your new farm. The forest is a completely self-contained, sustainable system for recycling nutrients. The forest is filled with all kinds of microbial life in the soil. Forest soil is alive and healthy. Everything is in balance.

Then the farmer cuts down the trees, burns them and plows the ground. By exposing the soil, some microbes die. Then the water-soluble, acid-based fertilizers and fungicides kill more. It is called "extinction pressure". The soil becomes more and more sterile as more and more chemicals are used.

Plus, rainwater is acidic due to automobile exhaust and power plant emissions mixing with the rain. This kills even more microbes and leaches valuable minerals from the soil. Very few microbes can survive under these conditions.

Soil can be returned to health when farmers add both the missing nutrients and the missing microbes to the soil. Both must be added, not one or the other.

Compost cannot contain some of these beneficial soil microbes because composting uses heat to sterilize the organic matter. Also, mycorrhizial fungi do not form spores like other fungi, but must be in contact with a living root to germinate or grow. New microbial technology allows farmers to add beneficial microbes to their biochar.

More Is Better

The more beneficial microbes, the better. We cannot kill all the pathogenic microbes in the soil, but we can outnumber them with the good kind. Disease cannot take hold when beneficial microbes outnumber the pathogens.

When biochar is fortified with nutrients and microbes, it is an investment that lasts for generations. Biochar also saves money and prevents environmental damage. Plus, improved fertility, yield, and disease resistance repays the initial effort and expense many times over for biochar farmers making their own Terra Preta.

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