Energy Facts

# Putting U.S. Biochar Policy on the Right Track

**Biochar is a term for charcoal that is formed by heating biomass at high temperatures in the absence of oxygen and then added to soil to improve its health. Biochar has generated attention as a global warming mitigation tool because of its potential to sequester large amounts of carbon dioxide—that is, remove it from the atmosphere and store it safely in soils. But questions about the environmental impacts of biochar's lifecycle must be answered before we can responsibly scale up its production and use. NRDC recommends a well-coordinated, national research and demonstration strategy to mitigate these uncertainties and ensure an environmentally sound U.S. policy on biochar.**

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## Research should focus on biochar's potential to produce multifold benefits

In addition to sequestering carbon dioxide, biochar has other positive attributes: its ability to protect water quality through improved nutrient uptake, to use multiple biomass waste streams as feedstocks, and to yield a variety of renewable energy resources. Considered together, they make a more robust case for developing our understanding of biochar systems than a narrow focus on biochar's potential to mitigate global warming. To date, development of biochar systems has been hampered by the lack of market value for most of these attributes. However, research has shown that biochar can reduce soil emissions of nitrous oxide and methane, both potent global warming pollutants.[1] Though not fully documented, biochar also appears to improve a soil's ability to retain synthetic fertilizers, reducing nutrient runoff into watersheds. In addition, biochar systems produce bio-oil, synthesis gas, and charcoal, which all have value as energy sources.

## Understanding biochar's potential starts with increased production

The performance of biochar systems depends on the feedstock used, the conversion process employed, and the manner in which the biochar is handled, transported, and applied. Much of what is written about biochar is hypothetical or based on small-scale, laboratory demonstrations. A key barrier to understanding the performance of different biochars is the shortage of pilot and commercially operating biochar production systems on which to base assessments, especially slow pyrolysis systems, the preferred technology for producing biochar. Consequently, there is a critical shortage of biochars for field trials.

Before we can embrace biochar as a tool for mitigating global warming, we must greatly increase the number of systems in operation and test a wide variety of biochars on a range of soils. An aggressive research and demonstration strategy is needed to develop a classification scheme that can be used to answer the following questions:

- Which feedstocks are most promising from an environmental, economic, and energy generation standpoint?
- Which conversion systems are best from an economic and environmental standpoint?
- How can biochar be applied to maximize soil benefits and create stable pools of soil carbon?

## Key environmental concerns must be addressed

There are two sets of environmental concerns when it comes to biochar production and use. The first is associated with the sustainable supply of biomass feedstocks and the impacts of their production, harvest, transport, and transformation. When land is converted from forest, pasture, or conservation reserves to grow crops for energy production, the carbon stored in those lands is released into the atmosphere. Similarly, when land is taken out of food production to grow energy crops, this can lead farmers elsewhere to convert carbon-rich forests into cropland to meet global food demand. Studies indicate that the carbon released from land conversions reduces or negates any carbon benefits we hope to gain by replacing fossil fuels with bioenergy. It also risks eliminating habitats and losing local biodiversity to monoculture.

The second set of concerns deals with the way biochar is produced and used. There is uncertainty about emissions from the operation of different biochar systems—especially small systems, for which environmental regulations are less stringent or absent. Since some of these emissions may contribute to global warming, we must understand the extent to which they would offset biochar's carbon benefits. Similarly, if tillage is used to incorporate biochar into soils, carbon emissions from soil disturbance could reduce total carbon sequestration. There is inconclusive data on the performance of biochar in soils, including insufficient data on the stability of biochar-based carbon pools. Biochar is easily reduced to tiny particles and there is evidence that biochar can be lost during transport, handling, and application.[2] We must know more about the composition of this "fugitive" biochar, especially the fraction in the submicron range known as black carbon, which can be a powerful climate forcer if made airborne.[3]

Assessment of the impacts of any biochar system must account for the energy required to produce, collect, transport and process the feedstock and the potential for soil carbon loss during the production, harvest and application of the biochar. More research, development, and demonstration efforts are needed on application methods that reduce soil carbon loss and delivery systems that reduce or eliminate fugitive biochar loss. Finally, the monitoring and verification (M&V) required to certify biochar-based carbon offsets remains a significant challenge.

### Biochar: Beginnings in the Amazon

Research on ancient Amazonian *terra preta* soils provides much of the original evidence on the role biochar can play in soil ecology. In the Amazon, aboriginal inhabitants added charcoal to soils, improving fertility. These findings have been supplemented by research on the impact of various charcoals on soils and crops, providing evidence that charcoal can improve soil structure, chemistry and ecology. Studies in the Amazon also suggest that the terra preta soils contain elevated levels of carbon that has been stable for millennia. This provides the basis for claims that biochar can create highly stable carbon pools and potentially play a role in mitigating global warming through carbon sequestration.

## Certain feedstocks and production systems may be preferable

Using waste biomass as a biochar feedstock is likely preferable to growing primary biomass, as it does not incur the cost in energy inputs or the land-use change emissions associated with producing primary biomass. Animal manures, organic municipal solid waste, and urban wood residues are the most promising feedstocks because they are most concentrated, minimizing the energy and emissions costs of collection.

Large production systems, uniform feedstocks, and tightly controlled application regimes will likely be more reliable from an M&V standpoint. Though there is interest in small biochar production systems, stemming from efforts to introduce more efficient cookstoves in the developing world, smaller systems will be much more difficult to characterize and monitor. As a result, small systems should not be thought of as frontline tools to combat global warming.

## A coordinated program is needed to study a range of biochar systems

Five to ten commercial-sized projects are needed to gather data on biochar production systems and provide an ongoing source of biochar for a national field trial program. Demonstrations are needed on a range of technologies, but as the leading candidate for maximizing production, slow pyrolysis is particularly important. Projects should be located around the country to ensure access to a wide range of potential feedstocks and make biochar available to a representative spectrum of soil types and crop systems. Waste biomass feedstocks should be prioritized for production and field testing.

The U.S. Department of Agriculture (USDA) should conduct a five-year program of field trials to test the agronomic and carbon sequestration performance of a wide variety of biochars on crops and soils. Five regional institutions representing the broad agricultural regions of the country could help manage this work. Biochar production system developers receiving federal support should be required to coordinate strategies and schedules to support the national program. USDA should coordinate with existing national and international efforts to develop a meaningful biochar classification scheme.

[1] J. Lehmann and S. Joseph, ed. *Biochar for Environmental Management: Science and Technology* (London: Earthscan, 2009).
[2] B. Husk and J. Major, "Commercial scale agricultural biochar field trial in Quebec, Canada over two years: effects of biochar on soil fertility, biology and crop productivity and quality," Dynamotive Energy Systems, February 2010, http://www.dynamotive.com/assets/resources/BlueLeaf-Biochar-FT0809.pdf (April 29, 2010).
[3] Any gas or particle that alters the Earth's energy balance by absorbing or reflecting radiation.