KENTUCKY STATE UNIVERSITY COOPERATIVE EXTENSION

INFO SHEET

Kentucky State University Cooperative Extension Connections

Biochar: A Tool to Improve Soil Health

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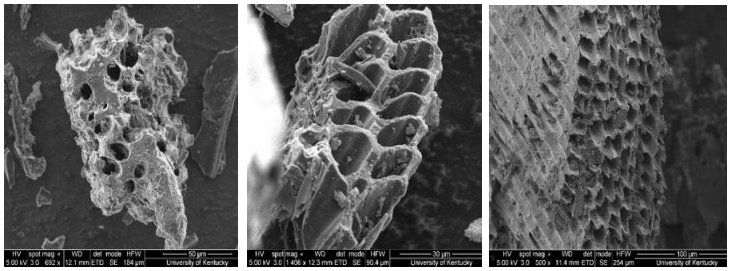
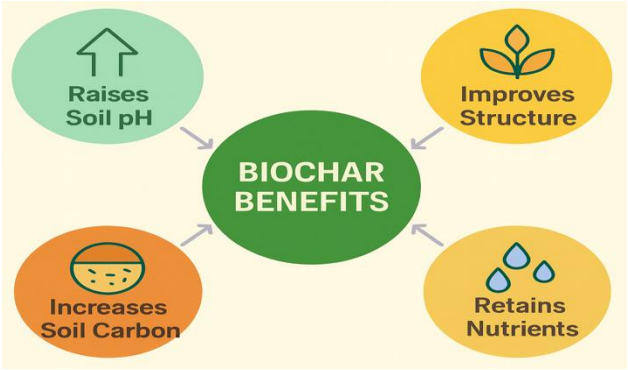
What Is Biochar?

Biochar is a carbon-rich material produced by heating wood, crop residues, or other plant materials in low oxygen (pyrolysis). Its porous, stable structure makes it a long-lasting soil amendment that can help retain water and nutrients. Its properties and effects may vary with the feedstock and production conditions.



Why Biochar Matters for Farmers

Many Kentucky soils are moderately acidic and lose nutrients after heavy rainfall. Declining organic matter and poor soil structure reduce crop vigor and long-term productivity. Biochar can help by:



How Biochar Improves Soil Health

1. Raises Soil pH and Improves Buffering

Biochar supplies base cations and alkalinity that neutralize acidity. Incorporation increases pH and stabilizes acidity over time, improving nutrient availability and reducing Al stress. Kentucky State field results showed measurable increases in soil pH during the first two years after biochar application at 12 Mg ha^{-1} yr^{-1} in a continuous soybean cropping system.

2. Improves Soil Structure and Porosity

Biochar loosens compacted soil and increases pore space for air and water movement, supporting early root growth and better tilth in trafficked or tilled fields. Its porous particles also help form stable soil aggregates, which improve infiltration and reduce crusting after heavy rainfall.

3. Builds Soil Organic Matter and Stable Carbon Pools

Biochar can persist for decades, contributing to long-term soil organic matter and supporting microbial activity and nutrient cycling. In Kentucky State research plots, organic matter and total carbon increased by the second year.

4. Enhances Nutrient Retention

Biochar surfaces hold ammonium, potassium, and other cations, improving fertilizer efficiency and reducing leaching. Effects can be modest at first in fertile silty soils but strengthen over time.

5. Supports Soil Water Management

Water-holding benefits are generally greater in coarse-textured soil; short-term changes are smaller in silty loams. Aggregation and infiltration can still improve as biochar becomes integrated into stable soil aggregates, reducing crusting after heavy rainfall, helping roots access water.

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KYSU-CEP-INFO-ANR-2026-007

How to Apply Biochar

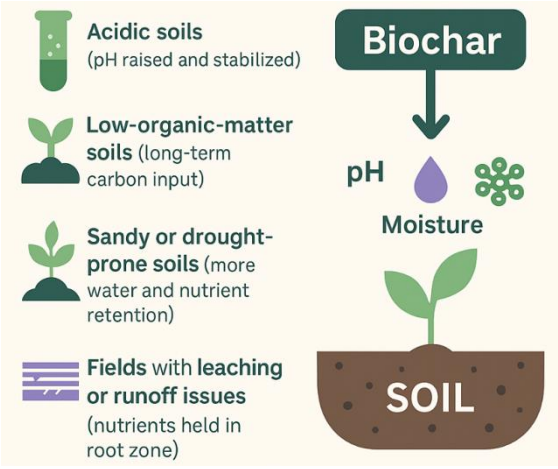
Recommended Rates: The Kentucky State field study evaluated an annual biochar rate of 12 Mg ha^{-1} (approximately 5.4 tons $acre^{-1}$)**.** Rates may vary with soil conditions, crop, biochar properties, and management goals. Follow product guidance and begin with a small demonstration area before treating an entire field.

Application Guidelines

- Apply before planting or during field preparation.
- Spread biochar evenly using suitable equipment, such as a manure spreader or drop spreader.
- Lightly incorporate into the top 4–6 inches of soil using suitable tillage equipment, such as a disk harrow or rotary tiller.
- Moisten dry biochar to reduce dust.
- For stronger early benefits, blend biochar with compost or manure before application to add nutrients and moisture to its porous structure.
- Wear gloves and a dust mask when handling dry biochar.
- Apply biochar during calm or light-wind conditions to minimize dust and material loss.

When and Where Biochar Works Best

- Biochar improves soil gradually; it is not fertilizer.
- Expect steady, long-lasting benefits rather than immediate changes.
- Greatest benefits occur in:



- Biochar also complements compost, manure, and cover crops in organic and regenerative systems.

Practical Tips for Farmers

- Test soil before application and monitor changes over time.
- Begin with a small demonstration strip before treating a whole field.
- Choose biochar from a reputable supplier that identifies the feedstocks and intended use.
- Match the application rate to soil conditions and management goals.
- Keep records of the biochar source, rate, application date, and crop response.

Long-Term Soil and Environmental Benefits

Biochar provides long-term benefits because its stable carbon can remain in soil for decades. By retaining carbon, nutrients, and water, it may reduce nutrient losses, improve fertilizer-use efficiency, and strengthen soil resilience. These benefits may lower input needs over time, but actual savings depend on the soil, biochar, application rate, crop, and management system. Research does not support one universal percentage for fertilizer or cost savings across farms because responses vary widely among conditions.

Early results from the ongoing Kentucky State study showed increased soil pH, buffering capacity, organic matter, and total carbon in silty loam soil during 2023–2024. Short-term changes in soil nutrients and water-holding capacity were small, and seasonal rainfall remained the main influence on soil moisture. Long-term monitoring is continuing under Kentucky field conditions.

Biochar is not a quick fix; its benefits may develop gradually over several growing seasons.

Acknowledgments

We thank Dr. Ammar Bhandari and Mr. Jacob Brown for their time and thoughtful review of this publication. We acknowledge USDA-NIFA Capacity Building Grant (Award Number: 2023-38821-39960) for the financial support.

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