UCONN | EXTENSION

Call for farmer collaboration

Can biochar be a sustainable soil amendment for Connecticut farms?

Shuresh Ghimire and Jacqueline Kowalski, UConn Extension

Biochar is carbon rich organic matter created by burning organic constituents like wood or other biomass waste at high temperatures with limited oxygen, a process called pyrolysis. This process breaks down the organic matter into a stable form of carbon while releasing gases and leaving behind a porous carbon-rich material. The pores within biochar increase its surface area, enabling it to efficiently retain water, nutrients, and act as a habitat for soil microbes. Furthermore, it can absorb and retain various substances, including organic compounds and heavy metals, making it valuable for soil remediation.

Because of its fine particle size and porous structure, the application of biochar reduces the bulk density, improving soil structure. It can also help reduce greenhouse gas emissions by trapping carbon in the soil for long periods, thus mitigating climate change. However, potential downsides arise when biochar is applied at high rates: it may absorb nutrients, rendering them unavailable to plants, and interfere with soil macroorganisms, such as earthworms.

Specimens of different biochar materials. (Photo: UC Davis Biochar database)

Biochar has been known for its benefits for over 2,000 years, dating back to the "slash-and-burn" farming method. It is also created artificially by heating biomass at 600 to 1800 °F. Without oxygen, the material doesn't completely burn, resulting in biochar and other by-products. The amount and type of by-products depend on the temperature: lower temperatures yield more solid char material, while higher temperatures (above 1300 °F) produce more liquid or gas components.

Commercial biochar production utilizes a wide range of biomasses, encompassing agricultural and forestry residues like wood, straw, wood chips, and nut shells, alongside industrial by-products such as bagasse and paper sludge. This approach not only diminishes waste but also offers an efficient means to repurpose these materials effectively. Choosing the right materials and heating conditions allows us to customize biochar. This makes it better at improving soil or soaking up pollutants, like chemicals and metals, at a low cost.

Recent studies show the effectiveness of biochar and climate-smart agricultural practices in enhancing soil health and reducing greenhouse gas emissions. Biochar application increases soil organic carbon by 7-40% (Huang et al., 2023) and reduces nitrous oxide emissions by 32-54% across a wide range of biochar application rates (Borchard et al., 2019; Liu et al., 2018).

Studies have shown that the positive impacts of biochar are most pronounced in soils with low organic matter and coarse texture, compared to soils with high organic matter and fine texture.

While cost and accessibility have been the primary barriers to the widespread application of biochar, Connecticut, with over 60% forest cover, has enormous potential. By producing biochar from dead and less desirable wood found in trees, we can utilize it in agricultural lands to enhance soil health and provide climate benefits.

Call for collaboration:

UConn College of Agriculture, Health and Natural Resources is leading a USDA Sustainable Agricultural System (SAS) proposal on biochar. The goal of the proposal is to investigate wood-based biochar applications in agricultural lands to support sustainable and climate-smart agriculture and forest systems in the Northeast. Specific objectives include evaluating the effectiveness of biochar from soil health and climate-smart perspectives as well as training Extension folks, farmers, and forest owners on biochar technology. We would like to invite you to participate in this proposal.

We plan to conduct 10 on-farm trials, with research plot sizes approximately 0.15 acres for each vegetable grower (total 4-6 farms) and six 4 ft x 8 ft beds for each urban farmer (total 4-6 farms). Each trial will have two treatments: biochar vs no biochar, replicated 3 times. If selected for funding the project will run from Fall 2025 to Fall 2030. We will apply biochar and monitor soil health and environmental parameters, including soil physical, chemical, and biological properties, as well as carbon dioxide and nitrous oxide release. We intend to provide a stipend to our host farmers for allocating their land for the trials and participating in the project. The anticipated outcomes from on-farm trials are to optimize the biochar application rate, assess the impact on soil health, measure greenhouse gas emissions, and model the data obtained from these trials along with other intensive replicated research experiments to develop a decision support tool for extension folks and farmers to use. If you are interested in learning more about this project and potentially hosting an on-farm trial, please contact vegetable specialist Shuresh.Ghimire@uconn.edu or urban agriculture educator Jacqueline.Kowalski@uconn.edu.

References:

M.L. Cayuela, L. Van Zwieten, B.P. Singh, S. Jeffery, A. Roig, M.A. Sánchez-Monedero. Biochar's role in mitigating soil nitrous oxide emissions: a review and meta-analysis. Agric. Ecosyst. Environ., 2014; 191:5-16, 10.1016/j.agee.2013.10.009

N. Borchard, M. Schirrmann, M.L. Cayuela, C. Kammann, N. Wrage Mönning, J.M. Estavillo, T. Fuertes,Mendizábal, G. Sigua, K. Spokas, J.A. Ippolito, J. Nova, K. Biochar, soil and land-use interactions that reduce nitrate leaching and N2O emissions: a meta analysis. Sci. Total Environ. 2019; 651:2354-2364, 10.1016/j.scitotenv.2018.10.060

Q. Liu, Y. Zhang, B. Liu, J.E. Amonette, Z. Lin, G. Liu, P. Ambus, Z. Xie. How does biochar influence soil N cycle? A meta-analysis. Plant Soil. 218;426:211225, 10.1007/s11104-018-3619-4

Y. Huang, B. Tao, R. Lal, K. Lorenz, P. A. Jacinthe, R. K. Shrestha, X. Bai, M. P. Singh, L. E. Lindsey, W. Ren, A global synthesis of biochar's sustainability in climate-smart agriculture - Evidence from field and laboratory experiments. Renewable and Sustainable Energy Reviews, 2023; 172: 113042,doi.org/10.1016/j.rser.2022.113042