

Biochar's benefits questioned: new review reveals flawed evidence

GA, UNITED STATES, July 1, 2025 /EINPresswire.com/ -- [Biochar](#) has long been hailed as a sustainable tool to improve soil fertility and boost crop yields, but a new scientific analysis suggests the enthusiasm may be outpacing the evidence. A deep dive into over 100 experimental studies reveals that most fail to meet basic standards for agricultural trials—lacking appropriate controls, long-term assessments, or toxicity evaluations. When tested on real agricultural soils, biochar showed little to no effect on productivity. While biochar may still hold potential, the findings urge a cautious and evidence-driven approach before scaling its use in farming systems.

With agriculture facing mounting challenges—climate change, soil degradation, and food insecurity—biochar emerged as a hopeful remedy. Derived from biomass through pyrolysis, it promises carbon sequestration and improved soil health. The discovery of rich "terra preta" soils in the Amazon sparked global interest in mimicking their fertility through biochar application. However, as with other "climate-smart" practices like no-till and cover crops, the scientific foundation is more fragile than it appears. Inconsistent methods and short-term trials have led to exaggerated claims. Due to these challenges, robust and critical research into biochar's true impacts is urgently needed.

A global team of researchers from the Institut de Recherche pour le Développement (France), University of KwaZulu-Natal (South Africa), University of Sydney (Australia), ICAR-Central Citrus Research Institute (India), and other partner institutions has re-examined the experimental foundation behind biochar's agricultural promise. Their study published in *Pedosphere* in January 2025, critically analyzes 109 peer-reviewed experiments cited in leading meta-analyses. The results are sobering: despite biochar's rising popularity, the majority of studies lack the rigor to support its widespread application in farming. The authors call for higher research standards to truly understand biochar's benefits—and limitations—before it becomes embedded in global agricultural policy.

From more than 12,000 publications on biochar and agriculture, only 109 offered experimental data on yield outcomes—and most of those were methodologically flawed. None included control treatments with equivalent nutrient inputs, and only two assessed potential toxicity. Fewer than 6% tracked effects beyond a single season. When narrowed to actual farmland trials, average yield changes dropped from a reported 16% gain to a marginal -0.64%—suggesting negligible benefits in real-world conditions.

The researchers found massive variability in outcomes, ranging from yield reductions of 81% to increases of nearly 300%, depending on soil, climate, and biochar type. Such inconsistencies, coupled with a bias toward publishing only positive results, undermine the credibility of past meta-analyses. The paper recommends future experiments use carefully matched controls, evaluate longer-term impacts, and assess environmental risks, including pollutant buildup in soil. Only then can science offer clear answers on whether biochar helps or harms productivity.

"Biochar's reputation as a soil savior isn't backed by solid evidence," said Dr. Vincent Chaplot, lead author and researcher at IRD France and the University of KwaZulu-Natal. "Most experiments fail to isolate their true effects, and the lack of rigorous testing is concerning. We're not dismissing its potential—but before promoting biochar on a global scale, we need better data and better science."

This review raises red flags for researchers, farmers, and policymakers eager to embrace biochar as a cure-all for soil and climate woes. The findings suggest that scaling up its use without solid scientific backing could waste resources—or worse, harm soils in subtle ways. Moving forward, the focus must shift to long-term, field-based research that reflects actual farming practices and measures both benefits and risks. As the world looks to nature-based solutions for sustainable agriculture, evidence—not optimism—must guide the path ahead.

References

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