

Incorporating Biochar into Forest Management Practices to Deliver Carbon Benefits

By Derek Pierson

Forests play a critical role in regulating global levels of atmospheric carbon dioxide. The carbon that trees absorb from the atmosphere provides the backbone for plant tissues, such as wood, leaves, roots, etc. However, as a fundamental part of the carbon cycle, when a tree or branch falls in the forest, the stored carbon is released back to the atmosphere through decomposition. Depending on the size and type of biomass, as well as climate, this decomposition process can take weeks to centuries. For common forms of woody slash, much of the stored carbon returns to the atmosphere in less than 10 years. This decadal timescale for decomposition may seem like an opportunity to bolster carbon storage. However, this timescale is still far too short to support our need for a sustained drawdown of atmospheric carbon.

Additionally, common forest management practices, like harvest and thinning, generate scattered branches, twigs, and leaves; often referred to as slash. On any drive through your local forest, you're likely to come across a slash pile or two,



or two hundred. Traditionally, this slash is viewed as a waste product, with no cost-effective use. As such, standard practice for removing this waste material is to simply pile it up and burn it. Yet, burning slash piles has many drawbacks, including the risk of fire, long-term soil damage and poor effects on air quality.

Further, pile burning is not climate smart. When burned, carbon stored in the biomass is sent into the atmosphere, in the form of carbon dioxide and other greenhouse gases. Alternatives to pile burning are few, and fewer still are cost effective. However, with advances in technology and growing emphasis on sustainable, climate-smart forestry practices, a solution with wide ranging benefits has entered the conversation—biochar.

Since biochar has been covered in earlier issues of the *Western Forester*, most recently “Finally, a Market for Slash” in the Jan/Feb/March 2022 issue, I’ll only give a high-level detail of what biochar is. Biochar is a charcoal-like substance created by heating organic matter in an oxygen-limited environment. This process, known as pyrolysis, roasts the organic material, but stops short of complete combustion. The result is a stable, carbon-rich material with tremendous pore space and surface reactivity-good properties for soil water retention and remediation. Further, with a high carbon content (~80 percent), biochar has the unique potential to sequester carbon while simultaneously improving soil health.

The time required for the decomposition of biochar is on the scale of hundreds to thousands of years. Due to the low nutrient content and durable structure of biochar, decomposers in the soil, like fungi and bacteria, have a hard time breaking it down. Indeed, studies

have shown that biochar in the soil can persist for millennia, offering a long-term pathway for carbon sequestration.

Carbon storage improved through forest management

Forest management offers a diverse toolkit for delivering carbon benefits, with biochar fitting in as a cornerstone in combination with other climate-smart practices. For example, selective thinning can help promote healthier stands that capture more carbon while reducing fire risk. In turn, this generates more merchantable timber, which when used sustainably, can also serve as a long-term carbon store, further offsetting emissions. Additionally, forests can be strategically managed to promote reforestation and afforestation efforts, expanding overall carbon sequestration potential.

Biochar complements these approaches by transforming the slash leftover from all these practices into a long-term carbon store. Together, these types of adjacent management practices form the foundation of climate-smart forestry, offering a multifaceted approach to help mitigate climate change.

Innovative biochar production technologies can also offer multiple pathways for maximizing the carbon storage benefits from forest biomass. When integrated with bioenergy systems, converting slash to biochar not only creates a long-term carbon store, but can also generate heat and electricity for landowners and municipalities. Similarly, the potential to coproduce biofuels offers a pathway to provide alternatives to fossil fuels that help to further reduce net greenhouse gas emissions. These integrated approaches provide a diverse logistic and economic framework for building out climate-smart forest management strategies, centering around the efficient use of forest biomass for carbon storage and offsets.

Two for one

Biochar also stands apart as a unique carbon sequestration solution because it

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When slash is pile burned, carbon is released into the atmosphere, but turning this slash into biochar offers a long-term carbon sequestration solution.

simultaneously offers broad opportunities to improve damaged soils. Soil degradation is a widespread global challenge, threatening food security and the health of our natural ecosystems. Combating this global crisis is expensive, to the tune of billions of dollars spent each year on amendments and sustainable practices aimed at restoring soil health. The magnitude of these investments on the global scale underscores the economic viability of biochar production.

Biochar's power for improving soil health lies in its porous structure, water retention capacity, and ability to promote soil aggregation. For agriculture, these properties lead to higher crop yields with reduced needs for fertilizer and irrigation. In degraded lands, biochar's ability to remediate pollutants and boost fertility offers cost-effective pathways for land restoration. All of this is possible alongside the benefits from sequestering the biomass carbon that would otherwise be lost to the atmosphere. This unique combination of long-term carbon sequestration and economic viability makes biochar production from waste biomass amongst the most viable and promising methods for land management-based climate action.

The challenges and uncertainties of biochar adoption

So where is the biochar? All sounding too good to be true? Is biochar the latest climate mitigation snake oil?

Despite biochar's promising potential for long-term carbon storage and soil improvement, significant barriers continue to hinder widespread adoption. Upfront costs of shifting management

practices and purchasing specialized equipment are an expected, yet major hurdle, particularly as biochar production goals expand to ever larger scales. Market uncertainty also clouds the future of biochar-based practices, as inconsistencies in supply and demand make it difficult to plan future investments for both biochar producers and end-users. Further, the certification process for the carbon offsets achieved by producing or applying biochar remains uncertain, with few standardized guidelines.

Without a clear roadmap, investors looking for carbon credit opportunities often remain hesitant to provide substantial investments in biochar-based practices. While these shortcomings present their own unique challenges, they currently combine to create significant uncertainty and hesitation for land managers and private stakeholders who are considering investments in biochar.

Overall, perhaps the most widespread barrier is limited public awareness of biochar and its benefits. Providing accurate information is essential for building greater support, adoption and investment. Educational programs and expansion of outreach initiatives are vital for informing farmers, land managers, investors, policymakers, etc. about the potential of biochar as climate mitigation strategy and as a valuable amendment to help fight the global soil health crisis.

On a positive note, these barriers are hiding in plain sight, and significant progress continues to better address these challenges and accelerate the adoption of biochar. Public and private research and development initiatives are exploring

novel cost-effective methods for biochar production and evaluating the benefits of biochar applications across various agricultural and natural systems. Furthermore, growing collaborations between industry groups and government agencies are expanding the standards and improving regulations for biochar carbon credits and applications. Finally, new and diverse educational materials are rapidly evolving to help raise public awareness of biochar's potential, paving the way for its wider adoption and support.

The bottom line: moving the needle

While biochar derived from forest slash won't single-handedly solve our forest management and climate challenges, it's a powerful tool to add to our collective toolboxes. The potential of biochar production and use remains largely untapped, offering clear benefits for public and private lands, as well as commercial industry. By investing in research and new technologies, we can transform forest waste into a valuable resource that stores carbon, improves soil health, and protects vital ecosystems. Given the current practice of open burning of forest residues, biochar production offers a clear alternative with few drawbacks—an opportunity to turn a wasteful process into a restorative one. Raising awareness and garnering public support will help turn these opportunities into widespread realities. *WF*

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