

Wood-based Biochar: Soil Health Effects and Economic Feasibility

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Introduction

There are several studies that support the benefits of biochar to the soil and crop yields, but not all biochar is created equal. The function of biochar depends upon the raw materials used and the production technology. Biochar is created when a substance is burned in a low-oxygen environment at a very high temperature ($>400^{\circ}\text{C}$) in a process called pyrolysis. The biochar yield and carbon content depend on the pyrolysis conditions (temperature ($^{\circ}\text{C}$), heating rate ($^{\circ}\text{C}/\text{min}$) and residence time (min)). For further information on the making of biochar and biochar basics, see [FSA2196](#) (Burke and Sharpley, 2021). The feedstock is the raw material before pyrolysis and is often either manure, crop residue, or timber waste. The feedstock for biochar has a large impact on its effects on the soil (Joseph et al. 2021). The feedstocks mentioned here are abundant in Arkansas and could provide a new product for their respective industries, depending on the desired functions of the biochar.

Soil Health and Biochar

Soil health is a comprehensive term that includes measurements of soil biological, physical, and chemical properties to assess soil functioning and the sustainability of that functioning in the environment. Biochar, in general, can increase soil CEC and nutrient retention (Joseph et al. 2021), improve water holding capacity and reduce bulk density (Madari et al. 2017), and increase soil microbial populations (Jin et al. 2024). Therefore, biochar is generally considered beneficial for soil health and crop yield. The USDA-NRCS has included utilization of biochar as a soil amendment in their list of conservation practices. It is referred to as Soil Carbon Amendment (code 336) and is eligible for cost-share options.

Nutrient biochar and structural biochar were terms developed by Jeffery et al. (2017) to categorize types of biochar. Biochar from manure and some crop residues (e.g., pecan shells, rice husk, coconut shell, crop straw, etc.) are considered

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Figure 1. Biochar produced from pine chips.
Photo by Sagar Chhetri.



nutrient biochar capable of increasing crop yields due to their higher concentrations of plant essential nutrients and lower carbon amounts.

Wood-based Biochar

Wood-based biochar (with paper mill waste, sawmill residues, slashes, etc. as feedstock) are considered structural biochar and more useful for carbon sequestration due to its high lignin and associated carbon content. Generally, wood-based biochar has a higher carbon content than most agricultural crop-based biochar (Spokas, 2010; Chaturvedi et al., 2021; Wijitkosum, 2022) and offers higher stability of carbon in the soil for more than 1,000 years (Spokas, 2010), providing a potential substrate for increasing soil carbon sinks. Wood-based biochar, of a larger particle size (Fig. 1), also has reduced N₂O (a greenhouse gas) emissions from rice fields (Gwaltney et al. 2025).

Wood-based biochar provides soil benefits similar to that of biochar from other feedstocks, but they should be utilized with caution. Potentially, wood-based biochar applied alone can inhibit plant nutrient uptake from the soil (Brantley et al. 2015; Pokharel and Chang, 2019; Ye et al. 2020). Most research has shown that these negative effects do not last past the first year of biochar application.

Potential for Biochar Production

The raw materials required for biochar production are obtained from logging (Fig. 2) and sawmill residues. Thirteen southern states in the U.S. have an estimated average annual net growth rate of aboveground tree biomass of 404 million metric tons (USDA Forest Service, 2024). Assuming that 20% of the total biomass is available for biochar after deducting raw materials for timber production, paper production, biodiversity concerns and inaccessibility, more than 80 million tons of woody biomass are readily available in the southern United States. This amount could produce 16 million tons of biochar (assuming 20% of biomass is converted to biochar). Similarly, there are huge piles of mill residue and bark residue seen on the log yard of sawmills. An estimated 1.7 million green tons of mill residues were available in the southern regions (USDA Forest Service 2024). Thus, biochar production could be an alternative utilization of that waste and can be established through the co-location of biochar production lines at sawmills.

Figure 2. Timber logging operation leaves slash on the forest floor. Photo by David Dick.



Potential Economic Impact to Arkansas Timber Industry

Biochar production is expanding quickly across the globe. Global production is estimated to be approximately 0.5 million metric tons (Mt) in 2025, up from 180,150 Mt in 2023. Asia has emerged as the leading production region, surpassing North America. In 2025, the industry's total revenue from commercial biochar was \$245 million and is projected to approach \$1 billion by 2027 (IBI, 2026). The industry is not just producing more biochar; each ton generates significantly more value. Investing one dollar in the biochar industry generates a value-added economic return of \$1.82 to \$2.37 dollars, depending upon the production costs and outputs (Nematin et al. 2021). In recent years, biochar production has generated a carbon dioxide removal (CDR) credit, generating approximately 2.5 carbon credits per ton (Elias et al., 2024) and receiving between \$90 to \$600 per credit (Nasdaq, 2022), providing revenue beyond the conventional market value of biochar.

More locally, as far as is currently known, there are only a few biochar production facilities (Fig. 3) in Arkansas as of 2026. One is a crop-residue-based biochar production facility located in Stuttgart, and the other two are wood-based located in Monticello and Amity. These facilities have contributed to job creation, labor income generation, and state

GDP. Recent analyses using Input-output modeling estimated that biochar contributed approximately \$2.2 million to Arkansas' GDP in 2023. In addition, the facilities supported 17 jobs and contributed \$1.2 million in labor income. With growing demand, biochar could potentially contribute more to the local, regional, and national economies.

Summary

Many studies have demonstrated that biochar is beneficial to soil health. The feedstock of biochar is a very important consideration when determining what type of biochar to utilize for agriculture production, carbon sequestration, or other uses. Wood-based biochars tend to sequester more carbon for a longer time but should be applied with a fertilizer source to offset its relatively low plant available nutrient content. There is ample timber waste for the production of wood-based biochar in Arkansas. Biochar facilities can be established within sawmill facilities (co-locations), utilizing the sawmill and bark residues to reduce hauling costs. A portable biochar production facility could also be utilized close to the forest management activities (thinning, prescribed burning, and logging operations). Biochar producers generate revenue not only by selling the product but also by a carbon dioxide removal credit.

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Figure 3. Small-sized Biochar production facility located in Arkansas. Photo by Sagar Chhetri.



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