BAMBOO BIOCHAR: BENEFITING SOILS AND BALANCE SHEETS



After pyrolysis, the shape and structure of bamboo are still recognizable, but as biochar, it now has extraordinary sponge-like porosity for water and nutrient retention. Credit: Fred Hornaday

Carbon markets are maturing in the Global South, and producers are reaping the rewards.

Bamboo, as we know, is a remarkable plant with an exceptional capacity to grow and replenish itself sustainably, and to create models of circularity. Biochar production can further maximize this potential, making the system fully circular and ensuring that every part of the bamboo gets utilized. What would otherwise go to waste is transformed into something valuable that increases soil fertility for future bamboo growth. In addition to using waste and improving the soil, the application of biochar also creates permanent carbon sinks that can be monetized through Carbon Dioxide Removal Credits. While the first bamboo biochar carbon removal project was certified in 2022, the industry has evolved dramatically in the last four years, presenting new opportunities (and challenges) for bamboo growers across the Global South.

Closing the loop

Like any other agricultural value chain, bamboo production and processing typically generate a measurable quantity of waste in the form of small branches, crooked culms and unused offcuts. Ordinarily, these remnants are cast aside and left to decompose. In the worst cases, facilities simply incinerate these byproducts to free up space on their property and send plumes of greenhouse gases into the sky. In more responsible scenarios, they might turn the bamboo residues into woodchips for mulch or compost, returning the organic matter to the soil.

Biochar, however, offers a superior alternative through a process that farmers have known about for thousands of years. From rudimentary soil pits to high-tech gasification systems, the variety of methods for producing biochar is nearly endless. But they all rely on the same fundamental principle, known as pyrolysis, the thermochemical

transformation of organic material at high temperatures (approximately 400–800°C) with little or no oxygen present. And the good news for bamboo growers in tropical, low-income countries (where bamboo grows most prolifically) is that high-quality pyrolysis is possible even with some very low-tech and relatively inexpensive equipment, such as the Kon-Tiki kiln.

The result is a black, charcoal-like substance with a very high concentration of organic carbon. In the case of a woody feedstock like bamboo, the organic carbon content of the biochar is generally around 70–80% on a dry weight basis. This figure varies depending on the specific pyrolysis methods and conditions, including factors like temperature and residence time.

Bamboo is a particularly preferable feedstock for biochar for a number of reasons. With its woody composition, bamboo yields a biochar with a much higher carbon content than softer biomasses like wheat straw or rice husk. Yet because of bamboo's hollow structure, it generally pyrolyzes much faster and forms a larger surface area than other woody logs or branches. Finally, as with any bamboo product, we cannot ignore the plant's rapid growth rate and its ability to renew itself every season, making it possible to harvest continually, year after year, without the need for replanting.

Waste to wealth

Recycling bamboo residue into mulch can be an effective strategy to manage waste and build organic matter in the soil, but transforming the bamboo into biochar increases these benefits in a few ways. While mulch breaks down quickly, biochar is extremely durable and will remain present in the soil for centuries or even millennia. Increasing soil organic carbon on a long-term basis leads to more resilient soil structure and greater nutrient availability. Over time, microbial life accumulates and creates much more fertile growing conditions in ways that conventional fertilizing cannot.

One of biochar's most interesting and impressive properties is its porosity, which can be measured in terms of surface area. Because of its microscopic pores and crevices, a single gram of biochar can have as much surface area as an entire football field. In simple terms, biochar acts like a sponge. This brings significant improvements in water and nutrient retention, meaning less irrigation and lower fertilization costs.

It's important to note that biochar is not a fertilizer in itself. As a sponge, most untreated biochar doesn't contain any meaningful quantity of nutrients. In the long run, biochar will lead to healthier soil with a greater diversity of microbial life. But for more immediate benefits, when growing annual crops, for example, it's necessary to charge or inoculate the biochar with something like compost, manure or liquid fertilizer. A blend of two parts manure and one part biochar (by weight) will generally produce positive results, but there's no one-size-fits-all recipe. The optimal mix depends entirely on the specific crop, climate and soil constraints that you're working with.

Carbon credit markets

Biochar has been in use for thousands of years, with the best-known case in the Amazon Basin, where evidence of Terra Preta, its fertile black soil high in soil organic matter, dates to around 1000 B.C.E. But in recent years, biochar has attracted increasing attention for its carbon removal capability, creating a whole new financial opportunity. As described above, biochar has very high levels of organic carbon, carbon that was originally sequestered during the lifetime of the plant through photosynthesis. Every kg of carbon permanently stored in the ground represents 3.67 kg of carbon dioxide (CO_2) kept out of the atmosphere. This CO_2 removal can be monetized.

In 2022, Planboo registered the first bamboo biochar project for carbon credits with Carbon Standards International (CSI). That project, based in Malawi, began issuing and selling credits in 2023, but it is no longer active. WongPhai, in Thailand, followed suit in 2023 and remains the best-known bamboo biochar carbon removal (BCR) project in the world. Both of these projects were using Kon-Tiki kilns and selling CSI credits for somewhere between $100 and $200 per tonne, with one credit representing one tonne of removed CO_2.



The WongPhai biochar site in Prachin Buri, Thailand, goes through staggering volumes of bamboo offcuts that otherwise have little or no value. Credit: Fred Hornaday

When it comes to the Voluntary Carbon Market (VCM), biochar remains the most highly supported form of carbon removal. Between 2022 and 2024, biochar credit sales skyrocketed from USD 14.6 million to USD 181.5 million a year. The market continued to grow in 2025 thanks to some massive offtakes from the tech sector, namely Google and Microsoft. But we're also seeing the market mature, with some important changes taking place.

One of the most significant developments in the BCR space has been in how the market distinguishes between high- and low-tech biochar production. Low tech is often perceived as low integrity, and although perception is not always reality, it can make an enormous difference when it's time to sell the credits. Essentially, the market is pricing low-tech biochar projects, like open Kon-Tikis, without robust digital monitoring, reporting and verification tools, in a separate category from high-tech BCR, such as industrial kilns with an array of built-in sensors. Projects are gradually being forced to choose between massive capital expenditures of six or seven figures (USD) or settling for a lower price on their credits.

Future trends

Today, only a handful of carbon registries (including CSI and Rainbow) will accept open pyrolysis systems such as Kon-Tikis. Most premium standards and credit buyers favor enclosed industrial pyrolysis systems with extensive digital monitoring, making certification easier and generally resulting in higher-valued credits. As a result, many financially constrained biochar projects in the Global South are now scrambling to find the best of both worlds, a simple, closed pyrolysis system comparable to the Kon-Tiki on price and efficiency.

Another challenge for producers in the tropics is the lack of market demand for biochar as a product. So most of these enterprises have had to rely entirely on carbon credit revenue to stay afloat. This puts them in a vulnerable position financially, and also incentivizes them to put their biochar into the ground as quickly as possible, often without charging it with nutrients, just to get their credits issued.

But now, as prices for low-tech BCR credits seem to be dropping, another new trend offers hope for these low-tech projects. Awareness and demand for physical biochar are slowly increasing, and with that, more producers are able to sell their product, making them less exposed to the ups and downs of carbon prices. To sell biochar in the tropics, it's advisable to turn it into an agronomic product by mixing it with compost or manure and packing it in a way that clearly communicates its various benefits.

For the average biochar producer in the Global South, the vicissitudes of the VCM are challenging to keep up with, on top of managing unpredictable biomass supply chains and meeting the requirements of the carbon standard. But the good news is that the industry is maturing. Markets are taking biochar seriously, and those who can produce it seriously will reap the benefits for their soils, and their balance sheets.

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