From Roots to Revenue: Securing Finance and Climate Solutions Through Bamboo Agroforestry

Key points

- Bamboo is a versatile material indigenous to many parts of Asia and the Pacific and is used to make various products; when integrated with advanced technology, bamboo can also become a secure, bankable, tradable asset.
- Bamboo agroforestry has the potential to empower Indigenous and grassroots communities to reduce poverty and, at the same time, contribute to carbon capture, climate change mitigation, and adaptation, contributing to the attainment of multiple Sustainable Development Goals.
- In construction, especially for affordable, climate-resilient housing, bamboo's tensile strength and versatility make it an excellent building material, making it a key tool in the drive to address the growing global affordable housing shortage.
- The strategic use of technology is key to harnessing the transformative potential of bamboo agroforestry, notably the geocoding of bamboo plants, geospatial technology to map areas of bamboo cultivation, and artificial intelligence to support precise asset valuation and predict risks to future yields.
- Bamboo agroforestry also needs a supportive policy and regulatory environment and the necessary infrastructure to transport and process bamboo into value-added products.

Introduction

Bamboo, the adaptable woody grass that is abundant across Asia and the Pacific, is a fast-growing natural material. It is well known for its versatility, used to make lightweight, economical furniture; durable, beautiful flooring; supple and hard-wearing textiles; pulp and paper; cooking and heating fuel; and even scaffolding for constructing skyscrapers. It can have the tensile strength of steel[1], and it can be tender enough to eat.[2]
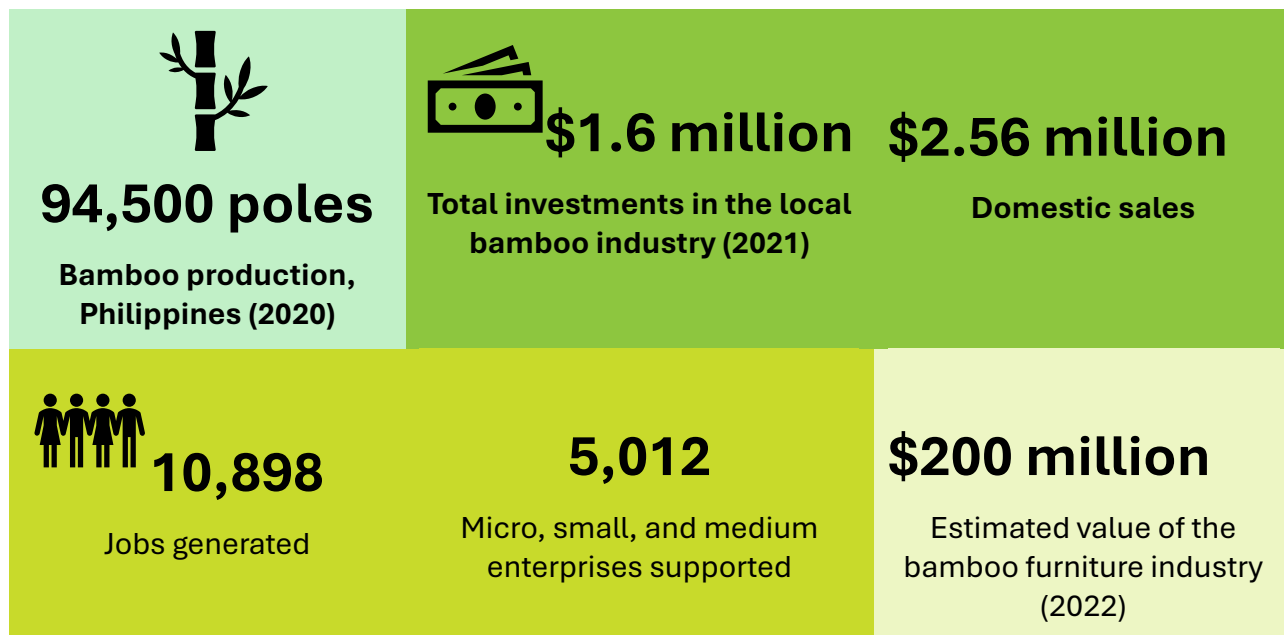
What is less well known is that when integrated with advanced technology, bamboo can also become a secure, bankable, tradable asset that can transform the lives of rural communities and, at the same time, contribute to carbon capture and climate change mitigation and adaptation. Moreover, bamboo's adaptability enables it to play a crucial role in restoring degraded land, empowering Indigenous and grassroots communities, preserving cultural heritage, and reducing poverty.

This paper examines the potential for this natural product to revolutionize finance, housing, and sustainability. For illustrative purposes, the paper uses rural areas of the Philippines with a predominantly Indigenous population as its reference. However, this concept can be applied to where the relevant bamboo species are already native plant species and in similar settings, with or without Indigenous populations, across Asia and the Pacific.

Bamboo in the Philippines

Bamboo is found in large parts of the Philippines, with 62 species, including 21 species that are native to the country. An estimated 39,000-53,000 hectares of bamboo stands are growing sporadically in backyards and riverbanks in forest lands.[3] In 2020, bamboo production in the Philippines reached 94,500 poles.[4] In 2021, total investments in the local bamboo industry were worth Php 89.2 million ($1.6 million), with domestic sales of Php 143 million ($2.56 million). The industry generated 10,898 jobs and supported 5,012 micro, small, and medium enterprises (MSMEs). In 2022, the value of the bamboo furniture industry was estimated to be $200 million and is expected to grow at a compound annual growth rate of 6.1%.[5] The Philippines is the world's 6th largest exporter of the material. Key export destinations are France, Germany, Japan, the United Kingdom, and the United States. However, many of those involved in the bamboo industry are part of the informal sector, and bamboo has not reached its full potential as a driver of economic growth because of limited investment, outdated technologies, and gaps in various policies.

Figure 1. The Economic Impact of Bamboo

94,500 poles

Bamboo production, Philippines (2020)

$1.6 million

Total investments in the local bamboo industry (2021)

$2.56 million

Domestic sales

10,898

Jobs generated

5,012

Micro, small, and medium enterprises supported

$200 million

Estimated value of the bamboo furniture industry (2022)

The Philippines is the world's 6th largest bamboo exporter.

The future of bamboo

Bamboo's unique qualities make it a prime candidate for increased use in the future. Not only is it highly fit for purpose as a building material, but it is also a recognized resource for climate change mitigation. Its fast growth rate means it absorbs more carbon dioxide (CO_2) and releases more oxygen than most trees, making it a highly effective plant for carbon sequestration. When grown over large areas, bamboo forests contribute to water conservation, watershed protection, and landslide prevention, making them vital for enhancing disaster resilience.

Challenges that Bamboo Agroforestry Can Address

Financial Challenges Faced by Indigenous Communities

Typically reliant on subsistence farming, Indigenous communities in the Philippines face the same financial challenges as other marginalized groups. With regard to access to the finance needed to go beyond subsistence living, they struggle to secure affordable credit. This makes it difficult for them to weather financial shocks, manage short-term finances, achieve long-term goals, and maintain overall financial health. One solution is to enable communities to possess an asset that can be measured, valued, and used as collateral. Planted bamboo can perform this function: by harnessing technology for geotagging and geocoding, individual bamboo roots can be accurately quantified with help from geospatial technologies such as geographic information systems (GIS).

Demand for Adequate, Affordable, Sustainable and Resilient Housing

There is a global shortage of adequate, affordable, sustainable and resilient housing. It is estimated that by 2030, there will be 3 billion people worldwide living in substandard housing.[6] The Philippines has an affordable housing backlog of 6.7 million units.[7] Moreover, more than 3 million low-income Filipino families are excluded from formal housing markets and rely on owner-driven construction.[8] This typically results in poor construction practices, leaving their homes vulnerable to natural disasters and extreme weather events. Demand for housing is exacerbated by those displaced by natural disasters, which, due to climate change, are happening with increasing frequency. More than 3.6 million Filipinos are displaced each year each year.[9]

Adequate, affordable, sustainable and resilient housing is a significant bulwark against a changing climate and increasing climate-driven disasters.[10] In its National Climate Action Plan, the Philippines has emphasized the role of constructing adequate, safe, resilient, and sustainable housing.[11] The housing sector stimulates economic growth through construction activities and related industries. This not only creates jobs but also boosts local economies. Affordable housing has important domino effect benefits for families. By reducing the financial burden on low-income families, it enables them to allocate resources to education, healthcare, and nutrition, thereby contributing to poverty alleviation. Adequate and sustainable housing improves health outcomes by providing stable and sanitary living conditions. Affordable housing fosters social cohesion by bridging socioeconomic divides, enhancing stability, and reducing disparities. Resilient housing is built to withstand natural disasters or climate-related events and helps ensure long-term durability and safety for occupants.

Increasing the supply

Bamboo agroforestry can play a significant role in increasing the supply of sustainable, affordable, and disaster-resilient housing.[12] Bamboo grows rapidly and is a sustainable alternative to traditional timber, maturing in as little as three to five years.[13] Bamboo's strong and flexible structure makes it resilient against earthquakes and typhoons, which are common in the Philippines. Its lightweight nature also simplifies construction processes, and its natural insulating properties lead to energy-efficient buildings, further enhancing sustainability. The technology already exists to do this. Cement bamboo frame technology was developed by the Hilti Foundation in 2012 (reference 6) and has been used to construct over 1,400 affordable homes, primarily in the Philippines (such as by the BASE Bahay Foundation) and Nepal.[14] Bamboo is locally available, reducing the need for imported materials. Its cultivation and processing create rural employment opportunities, supporting local economies and indigenous communities. Moreover, using bamboo maintains cultural heritage while addressing modern housing needs, blending tradition with innovation.

Nationally Determined Contributions under the Paris Agreement and the Sustainable Development Goals

Under the Paris Agreement, the Philippines has committed as part of its Nationally Determined Contributions (NDCs) to reduce 75% of greenhouse gas (GHG) emissions by 2030.[15] Bamboo has enormous potential for both climate adaptation and mitigation. Bamboo forests can contribute to water conservation, watershed protection, and landslide prevention, as well as to the country's NDCs.

Bamboo usage also displaces the usage of wood. The production of bamboo uses less than half of the total biomass of the tree; thus, every tonne of bamboo building material can save at least 2.94 tonnes of trees from being cut. These uncut trees would then continue to store the CO_2 in their fiber and expand their CO_2 storage capacity as they continue to grow.[16]

Bamboo's fast growth rate and high biomass production enable it to capture and store significant amounts of CO_2 from the atmosphere.[17] Various studies of Chinese Bamboo have shown its high carbon sequestration capacity, with about 5.4 to 16.9 tons of carbon sequestered per hectare per year, depending on the bamboo species and environmental conditions.[18] One Italian study found that the potential CO_2 sequestration per land unit (1 hectare) is about 36 times that of a mixed Italian forest.[19] Notably, one bamboo species endemic in the Philippines (*Dendrocalamus asper*) may be among the most robust carbon-capturing bamboo species of all.[a]

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[a] An unpublished study of this species shows up to 80 tons of carbon sequestered per hectare per annum. ADBs Climate Change and Sustainable Development Department engaged an international agroforestry carbon specialist to conduct a peer review of this study and other related studies.

Carbon credits

Bamboo cultivation can be used to generate carbon credits in three key ways. Firstly, planting bamboo in degraded or deforested areas can create new carbon sinks. These projects can be certified to generate carbon credits based on the amount of CO2 sequestered by the bamboo. Secondly, integrating bamboo into agricultural systems can enhance carbon sequestration while providing additional benefits such as soil stabilization and improved biodiversity. These integrated systems can also qualify for carbon credits. Thirdly, projects that promote sustainable bamboo harvesting and processing techniques can generate carbon credits by reducing emissions compared to conventional practices.

Sustainable Development Goals

Bamboo cultivation also has the potential to help attain the targets of the 2030 United Nations Sustainable Development Goals (figure 2).

Figure 2. Bamboo Cultivation and the Sustainable Development Goals

Source: International Bamboo and Rattan Organization https://www.inbar.int/why-bamboo-and-rattan/.

The Building Blocks of Bamboo as a Bankable, Tradable Asset

There are three important building blocks to realizing bamboo's full potential as a bankable, tradable asset:

- a supportive environment, both in terms of public policy, and in terms of physical infrastructure;

- research; and

- technology.

Policy Support and Community Engagement

Supportive public policy is key to realizing bamboo's climate change adaptation potential. This includes the integration of bamboo into national and local climate adaptation strategies that fully engage Indigenous and local communities in bamboo cultivation and management. Communities engaged in bamboo agroforestry need education and training on sustainable bamboo cultivation, processing techniques, and business management, and beyond basic training, specialized courses, and certifications to develop skilled workers and entrepreneurs in the bamboo industry.

For the bamboo industry to thrive in the Philippines, the government will need to invest in comprehensive infrastructure that supports every stage of the value chain—from cultivation and processing to transportation and, last but not least, marketing. Without sustainable and reliable markets, processors cannot sell their products at a profit. Thus, activities to promote these products should be given due attention.

The Philippines Bamboo Industry Development Roadmap, co-published by the Board of Investments, the Philippine Bamboo Industry Development Council, and the Department of Trade and Industry, set goals for the country's bamboo industry to be achieved by 2040:

- have a stable institution shepherding its growth and development;

- have stable and supportive polices;

- be self-sufficient in sustainable raw material resources;

- have cost-effective technologies and production processes;

- have well-trained manpower;

- have established bamboo-based enterprises in rural areas;

- have high capacity but affordable machineries and equipment; and

- have stable and reliable local and foreign markets.[20]

The roadmap also identifies enabling strategies to reach these goals:

- establishment of a reliable institution to shepherd the industry;
- establishment of supportive policies;
- conduct of inventory of raw material supply, survey of enterprises engaged in bamboo processing, including employment in these enterprises and their contribution to the economy, and establishment of a system of managing data and information
- development of a sustainable supply of quality raw materials;
- steady input of relevant and cost-effective production technologies and new products;
- development of high-capacity machines and equipment;
- training of highly skilled manpower;
- establishment of rural-based enterprises; and
- development of reliable local and international markets.

Land use planning

Effective land use planning is essential to ensure bamboo is cultivated in appropriate areas, maximizing yield and minimizing negative environmental impacts. This can be supported by the strategic use of geospatial technology and mapping tools, such as GIS, to assess land use suitability for bamboo cultivation across different regions. Developing integrated land use policies that allow bamboo cultivation alongside other agricultural and forestry practices can enhance biodiversity and soil health, particularly in vulnerable areas.

Harvesting: roads and infrastructure

As bamboo production expands in the Philippines, the development of reliable harvesting roads and related infrastructure becomes crucial for enhancing efficiency throughout the supply chain. Improved infrastructure can significantly reduce post-harvest losses and increase market access for growers. In addition to rural transport networks, community-based processing centers will be needed in key bamboo-producing regions to facilitate the conversion of raw bamboo into value-added products. These include flooring, furniture, engineered and structural building materials, textiles, and paper products. Public-private partnerships to fund and manage infrastructure projects can play a key role in enhancing local employment and economic opportunities while promoting the use of bamboo in the construction and furniture industries, with shared benefits for the local community.

Research

Establishing nurseries dedicated to bamboo propagation is fundamental to ensuring a steady supply of high-quality planting materials in the Philippines. These nurseries guarantee the availability of genetically diverse, disease-resistant saplings that can thrive in varying climatic conditions and soil types across the archipelago.

The Philippine government could provide financial assistance and technical support to establish bamboo nurseries, especially in rural areas. This can encourage local entrepreneurs and communities to engage in bamboo cultivation. Research partnerships with institutions such as the University of the Philippines Los Baños can help to develop and disseminate improved bamboo varieties tailored to the local environment and resistant to local pests and diseases.

Involving local communities in nursery management through community cooperatives, offering incentives for their participation while educating them on best practices for bamboo cultivation, is another good approach. Extension training programs can equip Filipino farmers with the knowledge needed to optimize bamboo cultivation practices, including pest management, sustainable harvesting techniques, and market access strategies. In addition to in-person workshops with agriculture experts, digital platforms using mobile technology and applications tailored for Filipino farmers can disseminate instructional content and updates on best practices, market trends, and innovative technologies in bamboo farming.

Technology

Strategic use of technology can supercharge bamboo agroforestry to go beyond being simply a natural resource and become a tool to promote financial inclusion and sustainability.

Geospatial technology
Geospatial technology is key to the cultivation process. Geocoded bamboo data helps track species distribution and manage plantations for maximum environmental benefit, contributing to biodiversity conservation and ecosystem services. Geocoded data allows performance tracking and impact assessment, ensuring continuous improvement in bamboo plantations.

Geospatial data from satellites and drones and artificial intelligence (AI) can support effective land use planning and sustainable harvesting, preventing over-exploitation and supporting long-term sustainability. It supports resource management and market analysis, ensuring efficient supply chains and market competitiveness.

Policymakers can use this data to make informed decisions on land allocation, environmental regulations, and disaster management. Geospatial data supports scientific research and innovation, leading to new bamboo-based products and technologies. Finally, geospatial data also allows precise estimation of carbon stocks, enhancing climate change mitigation strategies and landscape resilience management. There are examples of machine learning technology already in use to map the natural distribution of bamboo[21] and mobile app-based bamboo resource assessment.[22]

Alternative data as a means to enhance financial health

At the community level, data-driven insights improve agricultural practices and livelihoods, enhancing community engagement and income by supporting precise asset valuation. By using geocoding data, precise valuations of natural assets can be determined to identify and quantify the precise location, health, and density of bamboo. This enables individuals and businesses to understand the current value of their assets, making it easier to manage and allocate resources efficiently.

Microfinance institutions can use geospatial data to identify potential clients and assess the viability of bamboo projects. This data-driven approach lowers the risk and enhances the ability to offer small loans to bamboo farmers. Geocoded data can help form and strengthen bamboo farming cooperatives by providing a clear picture of available resources and enabling collective decision-making. Cooperatives can then access financing and negotiate better terms with buyers and suppliers.

Geospatial data also makes it easier for banks to determine, for example, asset value, future cash flow and revenue generation, and collateral value. AI can be used to analyze alternative data sources, such as geocoded and geospatial data, mobile phone usage, utility payments, and social media activity, to create comprehensive credit profiles for individuals and MSMEs without traditional credit histories, enabling unbanked people to access financial services.

Future goals

The same technology can be used to attain future financial goals. AI can analyze historical real-time data and current environmental conditions to forecast future yields from agricultural activities. It can also help predict potential financial shocks and advise on preventive measures. For example, AI can examine weather patterns, soil health, and growth rates to forecast the potential revenue from a bamboo plantation, aiding in financial planning and securing investments.

Predictive models can also forecast potential crop failures or market downturns, allowing businesses to take preemptive actions such as diversifying their crops or adjusting their financial strategies to mitigate potential losses. Insurance companies can use drone and geospatial data to assess the risk and impact of natural disasters affecting agricultural assets like bamboo plantations. They can offer tailored insurance products to mitigate these risks, including quick payouts in the event of a natural disaster, helping farmers recover more rapidly.

Financial literacy

Geospatial data can also support educational initiatives by providing visual and practical tools for training bamboo farmers on sustainable practices and financial management. Increased financial literacy empowers farmers to make better financial decisions.

Taking it further: Bamboo bonds, tokenized bamboo roots

Bamboo Bonds

The global market for carbon credits is growing, driven by increasing regulatory requirements and voluntary commitments to reduce carbon emissions. Bamboo projects can tap into this market by selling carbon credits to companies and governments looking to offset their emissions. This provides financial support for sustainable bamboo cultivation and processing. The potential for generating carbon credits makes bamboo projects attractive to investors focused on sustainability and climate impact.

Bamboo bonds can raise capital for sustainable development and stimulate economic growth by creating jobs and new business opportunities, particularly in rural areas. Proceeds from bamboo bonds can support microfinance initiatives, enabling smallholder farmers to access capital and participate in the bamboo value chain.

Tokenizing Bamboo Roots

Tokenizing bamboo roots offers significant potential for green finance, enabling a broader base of investors to support sustainable projects. The concept of tokenizing bamboo roots as assets involves converting ownership or rights over the bamboo into digital tokens on a blockchain. These tokens can be fractionalized, traded, or used as collateral, making bamboo roots a secure, bankable, and tradeable asset. Tokenization opens up investment opportunities by allowing people to invest in small portions of bamboo projects, even if they don't own the underlying land.

However, legal frameworks governing land and property in countries like the Philippines pose challenges to this model. In particular, land ownership regulations may hinder the separation of bamboo roots from the land they grow on, complicating the tokenization process. Currently, the legal framework governing land and property in the Philippines tends to tie assets to the land they are on, making it difficult to separate a tangible asset like bamboo from the land itself.

In the context of tokenization, this poses a significant problem. Tokenization works best when assets can be easily fractionalized and traded independently, offering flexibility to investors and enabling greater access to finance. However, if the asset—such as the bamboo root, which is part of a larger sustainability project—cannot be separated from the land due to ownership regulations, it becomes difficult to tokenize it in a way that ensures both liquidity and transparency for investors. There needs to be a deeper exploration of legal reforms or innovative legal mechanisms that would allow the asset (e.g., the bamboo root) to be treated separately from the land, enabling tokenization to reach its full potential in providing access to finance for housing and sustainability projects.

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