BRU

Bamboo & Rattan Update

INBAR

Sharing the latest news and activities from the bamboo and rattan sectors

POWERING THE WORLD WITH BAMBOO

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Cover Image
Truck in the process of being filled with dried and chopped bamboo biomass.

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About INBAR
INBAR is an intergovernmental organization which promotes the use of bamboo and rattan for sustainable development.
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B R U

EDITORIAL

Welcome to the third issue of the* Bamboo and Rattan Update *for 2024, which details bamboo's contribution to clean and affordable energy.

According to statistics released by the United Nations (UN), as of 2021, 91% of the global population has access to electricity, representing steady progress over the years. This marked improvement in standards of living for people around the world has, however, come with a cost.

In most places, fossil fuels such as coal, oil or gas are the major sources for generating energy, accounting for nearly 60% of total greenhouse gas emissions. These emissions accelerate climate change and are responsible for many health hazards and environmental problems. In spite of these issues, short-term economic development continues to reign supreme over long-term holistic development to meet the immediate needs of rapidly urbanizing populations. This has led to large reductions in poverty across the world, but sustainable solutions are increasingly needed as more countries begin to scale up energy production.

Sustainable Development Goal 7 of the UN 2030 Agenda for Sustainable Development aims to "Ensure access to affordable, reliable, sustainable and modern energy." In particular, the goal seeks to encourage more investment in clean energy sources and upgrade infrastructure and technologies to provide clean energy in developing countries, encouraging economic growth and safeguarding the environment. While some progress has been made on reaching sustainable energy targets and upscaling new renewable energies like solar, wind and thermal, a large gap still remains, and one that is expanding as more and more people connect to the power grid.

Growing across the Global South, bamboo can be a potent solution to the problem. In Africa, many countries urgently need more reliable and sustainable electricity generation: Despite being home to almost one-fifth of the world's population, the continent is responsible for just 2% of global electricity production. In Asia and Latin America, a similar story is at play, with nonrenewable electricity production on the rise while renewable energies fall short of keeping up with surging demand. These lands are home to abundant "green gold," as bamboo is also known.

The first story of BRU 5-3 offers an example from India in which a unique partnership is bringing stakeholders together to identify land for scientific bamboo plantation and management. Sustainable bamboo harvesting and processing is helping generate a new biomass material in the country, which is being utilized as a biofuel in select cement factories. This is one

example of a well-designed project that is having a tangible impact on not only the country's economic development and environmental stewardship but also on expanding its renewable energy plan. The author even includes a list of recommendations to make project goals and outcomes more relevant for national planning.

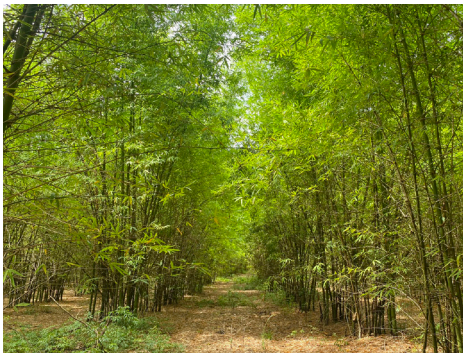
The second article turns its gaze upon China. As has been elucidated upon before in the BRU, China is at the forefront of the worldwide bamboo industry, given its vast natural resources and highly developed value chain. Authors of this article show how the plant's biomass contributes to China achieving its "dual carbon" targets, which refer to peaking carbon emissions before 2030 and reaching carbon neutrality by 2060. Bamboo is playing a role in solidifying the country's energy security, protecting the environment and raising farmers' incomes. The authors ultimately lay out a cogent vision of bamboo's holistic integration within China's energy system

The third article takes us to Latin America. Brazil is home to over 300 bamboo species spread across 5.2 million hectares of land. In these landscapes, bamboo is entwined with the local communities, with applications in cuisine, construction and handicrafts. Despite this, the resource remains underutilized. However, with its natural potential in agriculture, Brazil offers favorable climatic and soil conditions for its development. Given its wide range of economic applications, the resource has the potential to make a large contribution to in-country sustainable development initiatives, including contributing to Brazil's portfolio of renewable energy production. One local company is working hard to boost bamboo's energy contribution while championing it as a key resource for the advancement of global sustainable development.

This issue of BRU is the first that includes a new section: "In Science." This section will highlight new developments in cutting-edge bamboo research. This issue showcases how one research team in China has devised a new treatment method for improving the mechanical strength of bamboo's inner layer. Owing to bamboo's gradient structure, its mechanical, physical and chemical properties deteriorate from the outer to inner layers, which means the innermost sections are often discarded as waste. This new treatment leads to enhanced strength, water resistance, hardness and density, enabling the full utilization of the plant and increasing its engineering applications.

From Asia to Latin America, bamboo is being increasingly wielded as a vital component of green energy plans, ones that deliver renewable and affordable electricity to communities while building a sustainable ethos. We hope you enjoy BRU 5-3: "Powering the World With Bamboo."

THE EDITORS



INDIA LOOKS TO BAMBOO FOR BIOFUEL

Bamboo's short harvesting cycle and ability to thrive on degraded land make it a potent solution to the energy crisis.

Unique partnership is helping green India's power sector.

According to the Ministry of Power, India has been responsible for an almost 10% increase in global energy demand since 2000. This is attributed to rapid industrialization and improved standards of living, driving higher energy consumption. Industrial consumption alone accounts for around 41.16% of the total energy consumption in the country. Coal is the main source of energy, contributing around 73% to the national energy mix. The cement manufacturing sector is one of the country's major users among the manufacturing sectors, coming in at approximately 10 million tonnes of coal per annum.

The overexploitation of fossil fuels, coupled with unsustainable energy production and consumption, has severe climate impacts on the country. Hence, bioenergy is a critical pathway for meeting long-term climate mitigation targets. According to a World Bioenergy Association report from 2019, bioenergy accounts for approximately 13% of the world's primary energy supply and 70% of global renewal energy consumption. When broken down, the share of biomass among renewable energy sources is 96% in Africa, 65% in Asia, 59% in the Americas and 59% in Europe. In 2017, the global use of biomass for bioenergy reached approximately 56 exajoules, or EJ, with 1 EJ being equivalent to 174 million barrels of oil, mainly for heating applications. In total, 86% were used for primary solid biofuels (e.g., wood chips, wood pellets, fuelwood and charcoal), 7% for liquid fuels and 2–3% for biogas. The projected growth in primary bioenergy supply is estimated to reach approximately 138 EJ/year

by 2050, constituting about 23% of the global primary energy supply. The increasing need of bioenergy for sustainable consumption requires the development of new bioenergy products and supply chains. This is where bamboo can be a potent solution, as a source of bioenergy with vast potential to address climate change and generate new economic avenues.

Introducing the nature-based solution

Goal 7 of the 2030 Agenda for Sustainable Development of the United Nations aims to "Ensure access to affordable, reliable, sustainable and modern energy." This approach can help drive multi-sector development while also tackling climate change, as energy consumption contributes to a whopping 60% of total greenhouse gas emissions. It is in this regard that bamboo can play an important role in strengthening energy systems.

As a lignocellulosic biomass, bamboo can be biochemically and thermochemically converted to solids (e.g., chips, pellets, briquettes and charcoal), liquids and gaseous fuels, with applications across heating, electricity and transportation. In fact, the use of bamboo for solid energy options has already been undertaken in many developing economies. These unique characteristics and robust experiences with the resource allow it to be utilized within India's power sector.

However, at present, millions of tons of bamboo resources remain neglected in bamboo-rich countries, including India. At the same time, millions of hectares of degraded and potentially available land are suitable for bamboo plantations. An INBAR working paper from 2021 found that, if 10% of the estimated current global bamboo resources can be economically exploited, approximately 50 Mt/year can be produced, helping to diversify the world's biomass feedstock portfolio.

Greening the land has been recognized as a natural and effective approach, and bamboo has emerged as an ideal choice due to its distinct characteristics. With its short harvesting cycle and remarkable ability to thrive on degraded land, bamboo proves to be a fitting solution. Unlike many other plants, bamboo's shallow root system forms a protective network around the plantation, effectively anchoring the soil. Research by INBAR and the Indian Council of Forestry Research and Education suggests that bamboo can reduce soil erosion by up to a staggering 95%. Additionally, bamboo's water-efficient properties ensure it does not excessively deplete groundwater, thereby aiding in the preservation of groundwater levels, particularly valuable in regions grappling with water scarcity.

Uniting actors to harness bamboo bioenergy

In a timely initiative, the GiZ and Dalmia Cement Bharat Limited have now entered into a development partnership to promote the use of bamboo as a biofuel in select cement plants operated by the company. INBAR has been guiding and providing technical support along the way in this initiative, encouraging local communities to undertake scientific bamboo plantation to produce a better yield and increase income. Through a buy-back commitment from the Dalmia Cement, the project is a key demonstration of using bamboo as a biofuel in cement plants and other energy-intensive manufacturing companies. It reveals how bamboo resource-rich economies can use bamboo to address climate challenges and enhance the income of smallholders.

Compared to other plants, bamboo features many advantages such as fast growth, high crop productivity (10–40 ton $ha^{-1}yr$) high biomass density (300–900 kg/m3), annual harvesting, adaptation to various soil types and high carbon sequestration potential. As per a series of pilots and a technical report by INBAR, bamboo has a relatively high calorific value of 19.8 MJ/kg. It can be utilized to generate heat and electricity (i.e., about 0.83 kWh electricity/kg of bamboo through gasification technology). Specifically, the charcoal made from bamboo ranges between 26 and 29 MJ/kg.

Bamboo strengthens environmental protection via soil erosion, water recharge and reclaiming degraded lands. It also generates income avenues through various industrial applications such as scrimbers, bamboo-laminated composites and value-added products, as well as crafts,

Training program on planting bamboo at the Morigaon Plantation.

bamboo shoots, fodder and more. This allows it to contribute to tackling a range of synergistic problems across multiple sectors, from landscape restoration, biodiversity conservation and food security to climate resilience and poverty alleviation.

Challenges to overcome

Bamboo in India remains an under-researched sector that has not been effectively integrated into the country's broader national strategies, lacking clear sectoral policies or development plans. Moreover, farmers in many states lack motivation to plant bamboo. This is primarily because of insufficient technical knowledge on quality bamboo species, plantation and management techniques for producing a better yield; inadequate quality planting material of required species in required quantities; a shortage of standardized raw material resources; inefficient supply chains; low levels of certification and standards; and fragmented market linkages. In the past two decades, much emphasis has been placed on promoting the bamboo sector in the country, but due to weak engagement of the private sector and uncoordinated development efforts from disparate actors, impacts on farmer motivation and income are underwhelming. Consequently, positive environmental impacts are also less visible than expected.

Addressing the issues

As a core part of the initiative's implementation, partners developed a four-step process to address these issues. Step one involved *resource mapping and species prioritization* for better economic and environmental benefits. Out of the over-50 native species of bamboo in the area, three important species were prioritized for having higher biomass potential and better suitability to the existing climatic conditions. The mapping exercise included identification of wasteland and underutilized land where bamboo can be planted without disturbing the existing crops, with the twin objective of creating additional income and fostering environmental benefits.

Step two consisted of *identifying farmers for planting bamboo under the project*. These farmers were discovered through interactions with farmer leaders, government officers, organizations in civil society and local institutions. A tentative list of farmers along with their demographic breakdown and economic details, including landholding status and existing agricultural outputs, were created, and a work plan for sensitization meetings and trainings was prepared to suit their schedules. Farmers' existing knowledge and technical skills were also assessed during this period to tailor training plans and modules.

Step three featured *building awareness and conducting trainings on the economic and environmental benefits of bamboo plantations*. These were accomplished via workshops and one-on-one discussions with targeted farmers. Training modules (both audio-visual as well as text modules in local languages) were created using easy-to-understand language and implemented in workshops. In total, 51 suitable villages in project locations in Assam, a state in northeastern India, were identified. Over 50 awareness programs were organized, with almost 4000 farmers mobilized for bamboo plantation. Critically, 15 training programs for over 230 farmers, farmer leaders and local facilitators were conducted by bamboo experts on scientific bamboo plantation and management.

The fourth and final step comprised *implementing a range of extension services* after the conclusion of awareness building and training. Over 3000 farmers were provided technical guidance and support for bamboo plantation. Quality bamboo planting material (BPM) was sourced from a suitable nursery. INBAR assisted the farmers in planting the BPMs and managing the plantation scientifically to produce the best yield.

Going forward

India is still at a nascent stage as far as energy from bamboo is concerned. To develop a policy roadmap that supports the adoption of various energy and waste utilization options, the project sought to generate insights for enablers and stakeholders in Assam and other similar regions. Dalmia Cement and other energy-intensive manufacturing companies can strengthen their joint efforts to scale up the initiative, mutually grow, and contribute to a policy roadmap that leverages bamboo as an energy crop with economic and sustainable potential. To accomplish this, the following recommendations have been drafted:

Comprehensive bamboo resource mapping can strengthen India's database, including resource inventories and management practices. Value chain assessment can identify crucial information on production processes, value addition and waste types. Mapping current and potential markets for bamboo products and energy options is important for creating a concrete roadmap for maximizing social, economic and environmental benefits. *Creating economically and environmentally viable models* regarding centralized versus decentralized waste utilization are also key for determining the most viable approach, along with determining the viability of vertical or horizontal integration among stakeholders. To that end, a pilot demonstration site is required at the national level to validate the techno-economic viability of various energy options. Such a national demonstration can foster strong industry-academia-policy collaboration to ensure the diffusion and commercialization of viable options

At the same time, *new policies must be devised to favor biomass-based power generation*. This means comparing bamboo policies, strategies and action plans between bamboo-growing countries, reviewing relevant laws and programs, and drafting a policy, strategy and action plans. To reinforce these efforts, *certification systems and incentives* are encouraged, with incentives defined based on the nature and degree of risk involved. Finally, *developing specialized product clusters* based on the findings of the pilot demonstration and assessment of the existing resources, can contribute to bio-circularity and deliver social, economic and environmental benefits.

SANGEETA AGASTY

Sangeeta Agasty is the Director of INBAR's South Asia Regional Office.

UNLOCKING THE POTENTIAL OF BAMBOO ENERGY IN CHINA

The plant's biomass can help China achieve its dual carbon targets, ensure energy security, safeguard the environment and increase farmers' incomes.

Amid global energy shortages and growing environmental pressures, bamboo has emerged as an ideal choice for achieving sustainable economic and social development through the development of biomass energy. In September 2020, China announced the goal to peak CO_2 emissions before 2030 and achieve carbon neutrality by 2060. These "dual goals" of carbon peaking and carbon neutrality underscore China's ambition to facilitate the green transition. The renewable energy transition is key to achieving these dual goals. As a renewable source of green energy, biomass energy plays a vital role in the process. Characterized by rapid growth, wide distribution, abundant reserves, renewability and low environmental impact, bamboo can supply clean and affordable biomass energy to help power the future.

China's advantages in developing bamboo energy

Rich resources and wide distribution

China's massive territory spans multiple climate zones, including frigid, temperate, subtropical and tropical areas, featuring diverse and complex landscapes with significant elevation differences. This high degree of heterogeneity provides an excellent natural environment for the growth of various bamboo species. Accordingly, China is home to 39 genera and 837 species of bamboo, accounting for 44% and 51% of global totals, respectively. Bamboo forests in China are distributed in 20 provinces across 7.5 million hectares. Eight of these provinces — Fujian, Jiangxi, Hunan, Zhejiang, Sichuan, Guangdong, Guangxi and Anhui — account for nearly 90% of China's bamboo forest area. China's total bamboo stock volume exceeds 500 million tons, with an annually harvestable amount of approximately 150 million tons. About 40% of bamboo is left as residue during processing. Both bamboo and its residues offer valuable raw materials for producing high-quality biomass energy.

Huge market demand potential

With China's rapid economic development and adjustment of energy types, the demand for clean energy is on the rise. As a renewable and clean energy source, biomass energy plays an important role in the energy transition. According to the 2024 Annual Report on the Development of China's Biomass Energy Industry released by Biomass Energy Industry Promotion Association, at the end of 2023, the total installed capacity of renewable energy in China had reached 1.51 billion kilowatts. Among this, the installed capacity of biomass power generation connected to the grid nationwide was approximately 44.14 million kilowatts, accounting for merely 2.9% of the total installed capacity of renewable energy. In terms of the installed capacity structure of biomass power generation, the installed capacity for agricultural and forestry biomass power generation was approximately 16.88 million kilowatts, accounting for 38% of the total. Hence, the potential market for bamboo energy is expected to be massive in the future.

Ample space for resource development

Bamboo is a shallow-rooted plant with strong resilience. It has relatively low requirements for soil and environmental conditions, making it suitable for planting in areas with low economic output, such as mixed shrublands, wastelands, riverbanks, landslide areas and regions prone to mudslides. China has nearly 50 million hectares of barren hills and uncultivated land suitable for afforestation. In addition, there are large areas of land that are not suitable for grain cultivation, such as mountainous areas, barren slopes and riverbanks. These land resources offer untapped

With their rapid regrowth, bamboo forests can supply the biomass needed for making sustainable biofuels.

potential for the development of bamboo energy forests.

Strong technical foundation for cultivating and utilizing bamboo forest land

With a long history of bamboo forest cultivation and utilization, China is a global leader in technology for leveraging its bamboo resource base. Many high-quality bamboo species have been effectively developed and utilized, with numerous bamboo germplasm resource collection areas or species gardens already established. Bamboo charcoal is a direct form of energy utilization from bamboo. With its relatively advanced bamboo charcoal preparation technology, China is not only capable of but well suited for producing bamboo charcoal of high calorific value and energy efficiency, which forms the bedrock for utilizing the energy contained in bamboo.

Favorable policy environment

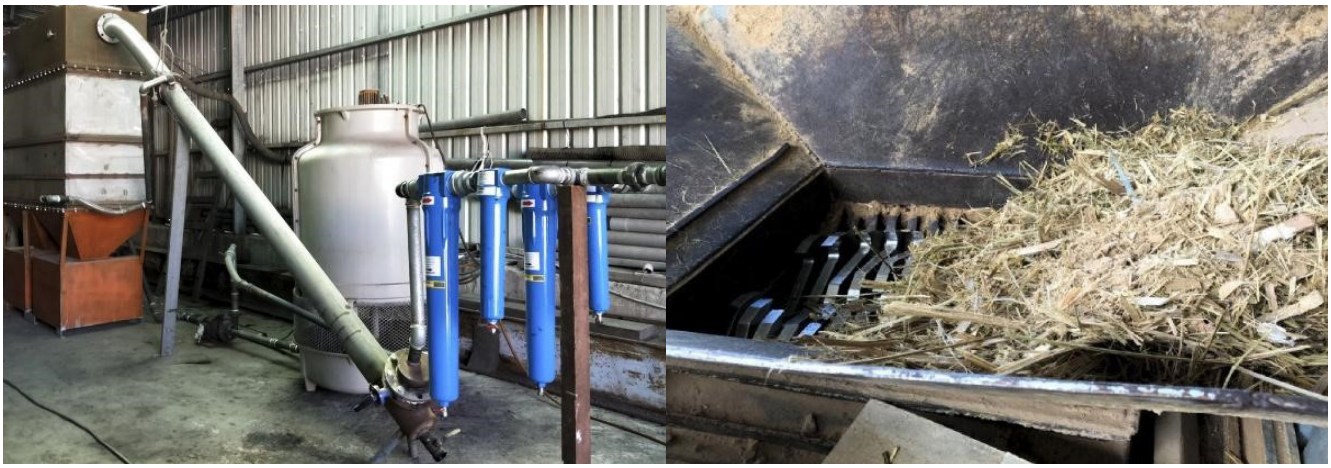
In recent years, China has introduced policies to develop biomass energy and the bamboo industry, creating new opportunities. In September 2020, the National Energy Administration of China issued the Implementation Plan for Improving the Construction and Operation of Biomass Power Generation Projects. In 2021, the State Council issued the notice, Guiding Opinions on Accelerating the Establishment of a Sound Economic System with Green, Low-carbon and Circular Development and Action Plan for Carbon Dioxide Peaking Before 2030. In November 2021, ten ministries, including the National Forestry and Grassland Administration and the National Development and Reform Commission (NDRC), released their Opinions on Accelerating the Innovative Development of the Bamboo Industry. In 2022, nine ministries, including the NDRC and the National Energy Administration, issued the "14th Five-Year" Development Plan for Renewable Energy focusing on optimizing biomass power generation, developing agricultural and forestry biomass and biogas power, and promoting biomass combined heat and power (CHP). In May 2022, the NDRC issued the Bioeconomy Development Plan for the "14th Five-Year Plan" Period, aiming to actively develop bioenergy, expand biomass power generation and promote the transition to CHP. Most recently, in October 2023, the NDRC and other departments published the Three-Year Action Plan to Accelerate the Development of Bamboo as a Substitute for Plastic.

Provincial and municipal governments in China are also promoting biomass power generation as part of their "14th Five-Year Plan" frameworks. For example, by 2025, Sichuan province plans to add 740,000 kilowatts of capacity for biomass power generation, Zhejiang province seeks to achieve over 3 million kilowatts of capacity for installed biomass, and Tianjin municipality aims to reach an installed capacity for biomass power generation of 450,000 kilowatts.

Challenges

As an energy plant, bamboo has significant potential for development and utilization. However, the development of bamboo energy in China still faces many constraints. For one, difficulties still exist for collecting and transporting raw materials. Bamboo resources are abundant in the world, but they are often distributed unevenly across diverse and challenging landscapes. This introduces problems for establishing efficient hubs for centralized processing. Bamboo and its various by-products also occupy a large amount of space while not being very dense, leading to inefficient transportation.

Bamboo has distinct properties that create unique technical barriers. Its energy conversion and utilization both differ from other biomass energies. Many of these technologies are still in the infancy of their development, such as pyrolysis, gasification, biochemical conversion and pelletization. As such, these technologies come



Bamboo waste gasification equipment (left) and processing bamboo waste (right). Credit: International Environmental Protection Online/Lin Yuren.

with high conversion costs and need more time to be scaled up.

In addition, the public remains generally unaware of bamboo's sustainable applications. An inadequate understanding of bamboo energy's potential has resulted in a greater focus on agricultural straw over bamboo biomass in agricultural and forestry energy projects. Consequently, this limited market demand for bamboo energy hinders the industry's development.

Finally, there is a lack of critical policy support and financial investment. Despite certain policy and financial support from some governments for the biomass energy industry, the overall level remains rather low. This dearth of policies, particularly regarding forestry production and management, has slowed the development of woody biomass energy and hampered efforts to attract greater investment into bamboo and wood energy research and development.

Recommendations

Despite these challenges, there are clear pathways forward for overcoming these hurdles to develop and promote bamboo as a sustainable energy source.

We can identify and cultivate high-quality bamboo varieties suitable for energy production, tailored to different regions, and develop them through various human interventions such as introduction, acclimatization and cultivation. At the same time, we can conduct research on bamboo cultivation techniques, site-species matching, seedling production, planting, pest control and integrated management while establishing bamboo forest bases for energy production to reduce costs and boost productivity.

In tandem with these two actions, pilot bases should be established to develop and test technologies to enhance bamboo energy production, processing and management. Once proven, these mature technologies and practices can be disseminated to other bamboo-producing regions to promote economic and social sustainable development.

Efforts should also be strengthened in innovation and R&D to facilitate greater investment into bamboo energy technologies, utilizing partnerships between industries and academia. Leveraging cutting-edge technologies from abroad can also enhance related bamboo technologies, but requires deepening global partnerships on transitioning to new bioenergy.

Raising awareness in the general public is also a key avenue for promotion. This includes organizing seminars and showcasing energy achievements. A broad range of stakeholders can also encourage enterprises to promote and build brands for bamboo energy products.

The last pathway forward involves advancing policy and financial support to support the rapid development of the bamboo energy industry. This includes encouraging tax policies and loan support from the government to reduce investment costs and risks. The establishment of a special fund could also be beneficial to reduce to support research, construction and operation of bamboo energy projects.

Vision for the future

Bamboo plants are characterized by their rapid growth, large biomass and wide adaptability, making them an energy resource with great potential and value. They can help phase out fossil fuels while boosting energy security and efficiency. China's vast bamboo resource base and advanced bamboo cultivation technology can lead global progress toward developing and utilizing bamboo energy, ensuring a continuous sustainable energy supply, achieving China's dual goals of carbon peaking and carbon neutrality, promoting ecological progress and increasing the income of bamboo farmers. The future is bright for bamboo energy.

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BRAZIL'S BAMBOO REVOLUTION

The Fueling Sustainability team with Pablo Jácome Estrella, INBAR's Regional Director for Latin America and the Caribbean.

One local company is helping the country tap into its bamboo resources for bioenergy.

Bamboo, often termed "green gold," is renowned for its rapid growth, versatility and environmental benefits. Brazil, with its vast ecosystems, including the Amazon Rainforest, Atlantic Forest and Cerrado biome, hosts over 300 bamboo species across 5.2 million hectares. Traditionally, bamboo has been integral to Brazilian communities, with applications in construction, handicrafts and cuisine, highlighting its diverse cultural and economic significance.

With a total output value in excess of USD 70 billion and trade value of USD 3.6 billion, the global bamboo industry demonstrates the immense potential of the plant to be part of countries' economic and environmental policies. This expansion is being fueled by rising global sustainability efforts, with bamboo being increasingly recognized as a crucial resource for eco-friendly products and renewable energy

Brazil has yet to fully capitalize on its bamboo resources. With its natural agricultural potential, Brazil offers a positive scenario for this crop, featuring favorable climatic and soil conditions for the development of bamboo. Given its wide range of economic applications, the resource has the potential to make a large contribution to in-country sustainable development initiatives.

The importance of renewable energy in Brazil

Renewable energy is a critical component of Brazil's overall energy strategy, accounting for

approximately 45% of the country's energy production and over 85% of its electricity matrix.

In 2023, Brazil achieved a landmark figure in renewable energy, generating 3.21 average megawatts from biomass, constituting 4.6% of the nation's total energy consumption. This milestone, reported by the Ministry of Mines and Energy, highlights the growing role of biomass in Brazil's energy matrix. The previous record, set in 2020, was surpassed thanks to an increase in installed biomass capacity and an anticipated rise in output, showcasing Brazil's commitment to developing renewable energy sources.

FS Fueling Sustainability: Innovating with bamboo biomass

FS Fueling Sustainability, or "FS" for short, is a global biofuel and animal nutrition company. FS adopts a different approach to Brazil's bioenergy sector, pioneering the use of bamboo as a sustainable biomass source. Established in 2017, FS has now become the third-largest ethanol producer in Brazil, known for its competitive production costs and low carbon footprint. The company uses biomass as fuel and second-crop corn as feedstock (meaning, corn planted in rotation with soybean plantations within the same year), which enables it to obtain a fuel that emits 80% less greenhouse gases than gasoline.

FS sources various agricultural residues as biomass and plants more than 10,000 hectares of crops annually, including bamboo, to meet its biomass needs. Bamboo can be a valuable biomass crop because it features a shorter production cycle compared to eucalyptus, at three years for bamboo versus six years for eucalyptus, while maintaining similar levels of calorific power. This strategy ensures that bamboo remains an economically viable option while offering a steady supply of biomass material for the company's operations.

Cultivating bamboo biomass: From planting to harvest

The bamboo farming operations of FS span 13,000 hectares across multiple farms in Mato Grosso, Brazil. Since the initial planting in December 2019, the project has expanded rapidly, already seeing multiple successful harvests. The cultivation process includes comprehensive land preparation, nursery establishment and long-distance seedling transportation. Bamboo's resilience and ability to regrow stronger after each harvest make it an ideal and sustainable biomass source for energy production.

Bamboo plays a vital role in Brazil's bioenergy sector, particularly in Mato Grosso, where corn ethanol production demands significant biomass resources. Bamboo's rapid regrowth, low replanting costs and efficiency in terms of land use offer a highly sustainable and economically beneficial alternative to traditional sources like eucalyptus. FS's innovative use of bamboo has demonstrated significant cost savings at around 40% cheaper than current eucalyptus wood chip prices, contributing to the long-term economic and environmental sustainability of the resource.

FS primarily cultivates *Bambusa vulgaris* in a monoculture system. This approach presents an opportunity to refine best practices for large-scale bamboo farming, tailoring future efforts. By focusing on one species, the company can closely monitor growth patterns, streamline operations and apply targeted solutions for potential risks like disease. Bamboo's resilience and adaptability to different climatic conditions further enhance its viability as a renewable resource. This strategy allows stakeholders to leverage targeted bamboo species to maximize their contributions to Brazil's sustainable energy goals, while laying the foundation for upward scaling or diversification in the future.

Global implications and prospects

Bamboo's potential extends far beyond Brazil, and globally, it is gaining recognition as a critical resource for sustainable development. Countries in Asia, Africa and Latin America are exploring bamboo's applications in renewable energy, construction and sustainable agriculture. The global bamboo market's growth underscores the rising demand for eco-friendly products and renewable energy.

As countries worldwide strive to meet their sustainability goals, bamboo's role in

Two-year-old bamboo plantation ready for harvesting (left); bamboo chips to be used as biomass (middle); and truck in the process of being filled with biomass from dried and chopped bamboo pieces (right).

environmental conservation and economic development has become increasingly vital. FS is finalizing research on carbon sequestered by aboveground bamboo, with promising results thus far. It is expected that implementing a robust carbon trading mechanism could further enhance bamboo's competitiveness against eucalyptus. Collaborative efforts among governments, businesses and research institutions are essential to fully harness bamboo's potential and drive global sustainability initiatives.

Lowering our dependence on fossil fuels

Bamboo represents a cornerstone of sustainable development, offering diverse solutions for environmental conservation, economic growth and social well-being. In Brazil, strategic initiatives like the innovative use of bamboo as biomass reveals its transformative potential. By tapping into bamboo's rapid regrowth and low carbon footprint, Brazil can significantly advance its renewable energy goals, reduce deforestation pressures and contribute to global climate targets.

Economically, expanding bamboo cultivation and processing could create thousands of new jobs, particularly in rural areas, boosting local economies and providing sustainable livelihoods. Additionally, integrating bamboo into construction, textiles and other energy sectors can help to diversify Brazil's economy. These would enhance its global competitiveness and meet sustainability standards both domestically and internationally.

Globally, efforts to promote bamboo are gaining momentum through international frameworks and cooperative agreements. INBAR

and other international organizations play a crucial role in facilitating bamboo's entry into multilateral sustainable development programs. Initiatives such as the United Nations' Sustainable Development Goals, the Paris Agreement and the Global Green Growth Institute recognize bamboo as a key player in addressing climate change, reducing poverty and promoting ecosystem restoration. Through these platforms, countries like Brazil can collaborate with global partners to develop bamboo as a green resource that meets both environmental and economic targets.

We have arrived at the threshold of a new era in sustainable development. The global community must embrace bamboo's full potential and work collaboratively to harness its benefits. Integrating bamboo into economic, social and environmental strategies will not only accelerate climate action but also promote equitable growth. Stakeholders from all sectors—governments, private companies, researchers and civil society—should contribute their expertise and resources toward a sustainable and prosperous future for bamboo. Working together, we can build a world where bamboo is not just a renewable resource but a powerful symbol of resilience and innovation in the quest for a greener future.

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Collating the latest international news and activities around bamboo and rattan sectors development

A worker makes a rattan chair in Cirebon, West Java, on 3 January 2024. Credit: ANTARA FOTO/Dedhez Anggara/rwa.

Indonesia's rattan furniture gains popularity

Indonesia's high-quality rattan furniture has gained popularity among foreign importers, including those operating in Japan, according to Deputy Minister of Trade Jerry Sambuaga on a visit to the rattan company Kimura Rattan in the country. He also noted that Indonesia's rattan is high quality and highly in demand across various international markets.

Rattan imports have made a positive contribution to good trade relations between Japan and Indonesia. In particular, Kimura Rattan's imports rose from USD 2.11 million in October 2020 to USD 2.33 million in September 2021, which is the most recent period for which trade data exists.

The deputy minister emphasized that Indonesia's Ministry of Trade had committed to supporting and facilitating the exports of high-quality rattan products to Japan. The ministry already has an Indonesia Trade Promotion Center based in Osaka which can assist in promoting and enhancing products, overcoming hurdles to potential issues and exploring potential cooperation arrangements.

Source: Antara, Indonesian News Agency, 5 July

A once-isolated forest hosts local travelers on bamboo rafts

Samar Kilang, a village in Indonesia's Bener Meriah district, was once isolated. Traditionally, farmers relied upon bamboo rafts to transport crops like maize and rice downriver. However, a new road was built in 2020, which significantly improved access and led to a large increase of local tourists seeking nature retreats. In response to this influx, young locals, such as Alif Mudin, adapted the traditional bamboo rafts for tourism, offering guided river trips and local delicacies for visitors. This initiative, Rafting Bamboo, has become popular on weekends

and holidays, providing an eco-friendly way for guests to experience the idyllic natural scenery while supporting local livelihoods.

The road's construction, however, has introduced broader challenges, as road building has been linked to deforestation in the district, threatening endangered species and ecosystems. Between 2002 and 2023, the district lost a significant amount of its old-growth forest, sparking concerns among environmental groups. Balancing development and conservation remains critical, with local nonprofits helping communities design and implement sustainable initiatives in ecotourism. These ventures not only provide economic benefits but also encourage conserving the surrounding forest land, ensuring the long-term sustainability of the surrounding ecosystems.

Source: Mongabay, 17 June

Kenyan environmentalists revive degraded river with Chinese bamboo planting initiative

In Kenya's Kirinyaga County, Chomba Nyaga and his community saw firsthand the degradation of the Kiringa River as a result of climate change and anthropogenic activities such as irrigation. To address this, Nyaga, in conjunction with the Kirinyaga Bamboo Environmental Guardians group, launched a project to restore the riverbanks by planting bamboo. Guided by organizations like INBAR and the Bamboo Association of Kenya, they chose two fast-growing Chinese bamboo varieties, *Dendrocalamus asper* and *Dendrocalamus giganteus*, for their environmental and economic benefits. These bamboo culms contribute to a reduction in soil erosion, improvement in water quality and also in mitigating climate change effects, while at the same time providing a green renewable material for harvesting and diverse value addition in the future.

The group has already planted 1500 bamboo culms along a four-kilometer stretch. It aims to plant 10,000 more along a 20-kilometer stretch. Bamboo's versatility is evident, as it can be transformed into structural components, briquettes, biochar, furniture and even sanitary products. Its regenerative nature makes it an ideal resource for sustainable harvesting. Despite facing challenges in propagation, the project shows promise both environmentally and economically, with increased interest from the private sector. These enterprises are partnering with local farmers to produce eco-friendly products like bamboo charcoal briquettes. Substituting bamboo bioenergy for traditional timber fuelwood can help alleviate pressures on dwindling forest resources, which are already overexploited across many lands in Kenya.

Source: Xinhua, 3 September

Are China's vast bamboo forests the answer to forever fossil plastics?

Bamboo is now increasingly recognized as an unharnessed tool for achieving sustainable development. A team of Chinese scientists recently created a new method to transform bamboo into a biodegradable alternative to traditional plastics. This can assist in the utilization of bamboo to address the global issue of plastic pollution, one of the triple planetary threats, as some plastics can take hundreds of years to break down.

Altering the cellular structure of bamboo and removing part of its lignin enables bamboo to be processed into water-resistant, recyclable plastic products. This bamboo-based plastic material, which can be used for items like tableware and phone cases, offers a sustainable solution to replace petroleum-based plastics. These emissions-intensive plastics not only degrade slowly but also emit greenhouse gases throughout their life cycle, exacerbating climate change.

The all-bamboo plastic, classified as a thermosetting plastic, demonstrated strong mechanical properties capable of biodegradation almost entirely within 90 days in soil tests. The technical process involves grinding bamboo into powder, removing lignin with eco-friendly chemicals, and hot-pressing the material to form durable products. This breakthrough opens the door for scaling up use of bamboo as a plastic substitute, promoting the high-value utilization of bamboo resources and offering a greener alternative to conventional plastics.

Source: South China Morning Post, 29 August

INBAR commissions research, conducts project work and raises awareness about bamboo and rattan across its 51 Member States.

H.E. Ali Mchumo, Chair of INBAR Board of Trustees (left), and Dr. Jyotsna Puri, Associate Vice President of the Strategy and Knowledge Department at IFAD (right) pose with newly signed partnership agreement.

New agreement strengthens INBAR's cooperation with UNCTAD

At a recent meeting in Geneva, INBAR signed a Memorandum of Understanding (MoU) with the United Nations Conference on Trade and Development (UNCTAD), building on a fruitful history of cooperation between the two organizations. The MoU seeks to enable the participation of more developing countries in the global value chains of bamboo and rattan.

This new partnership will benefit numerous stakeholders, including the Member States of both organizations. Increased trade of the two important non-timber forest products can generate environmental, economic and social benefits for local producers and the surrounding communities that depend on these resources.

INBAR was also invited to participate in UNCTAD's 60th Anniversary celebration. A meeting between both organizations was held on the margins of the celebratory event in order to explore potential contributions to upcoming events as well as other forms of cooperation.

As an Observer to UNCTAD, INBAR advocates for South-South trade, investments and technology and knowledge transfer, delivering benefits to INBAR's Member States and other countries while promoting policy frameworks that enable the development of green economies with bamboo and rattan. In addition, as an international commodity body for bamboo and rattan, INBAR also aims to synergize efforts with international partners like UNCTAD to support the integration of bamboo and rattan into international trading systems.

INBAR and IFAD sign partnership agreement to bolster historical alliance

On 25 July 2024, H.E. Ali Mchumo, Chair of INBAR Board of Trustees, and Dr. Jyotsna Puri, Associate Vice President of the Strategy and Knowledge Department at the International Fund for Agricultural Development (IFAD), signed a Letter of Intent aimed at leveraging a historical project-level cooperation in which both organizations participated even before the formal establishment of INBAR in 1997.

With steady financial support from IFAD, INBAR has implemented a total of 12 bamboo and rattan livelihood development projects, leading to the creation of green jobs and income with bamboo and rattan while improving the livelihoods of millions of people, benefiting women and youth, alleviating poverty, improving food security and nutrition, and restoring degraded lands.

Both INBAR and IFAD recognize the importance of enhancing joint resource allocation and mobilization for bamboo and rattan development. This takes place in a range of strategies, including the inclusion of bamboo and rattan development interventions in projects, promoting South-South technical cooperation exchanges, policy and advocacy at global and national levels to support common goals related to improving livelihood and environmental outcomes, and collaboration in data generation and knowledge sharing to establish evidence-based approaches for maximizing the contribution of bamboo and rattan to social, environmental and economic development goals.

FAO's top forestry body calls attention to bamboo innovation

The 27th Session of the Committee on Forestry convened in Rome, Italy at the Food and Agriculture Organization (FAO) headquarters from 22 to 26 July 2024. The Committee meeting aimed to bring together high-level representatives, heads of forest services, government officials and partner organizations to identify policy and technical guidance, seek solutions and advise on strategy and action.

As part of the event, on 24 July 2024, the side event on "Bamboo-based innovation to harness bioeconomy solutions" kicked off in the Ethiopia Room in hybrid format, co-organized by INBAR and FAO. This session ultimately shined a light on the latest innovations in global bamboo value chains, elevating its role in the bio-based economy. A wide range of presentations explored the ways in which bamboo can stimulate green growth, create jobs, advance sustainable production and consumption, improve life on land and deliver diverse ecosystem services. Speakers included key leaders from intergovernmental organizations as well as government officials, policy officers and project managers.

Throughout the side event, speakers consistently outlined the many advantages of bamboo for overcoming global challenges, highlighting where innovation is taking place and what steps need to be taken to facilitate scaling up production capacities. Stakeholders raised awareness on bamboo's unique role in the bioeconomy, in bolstering life ecosystem services, especially in the Global South where it is abundant, and on the urgent need to upgrade technologies across bamboo value chains, thereby fostering the diversification of innovative products, ensuring quality standards are met and improving access to global markets.

This high-level meeting in Rome and others like it are critical platforms for communicating the potential of bamboo to decision-makers, and mainstreaming it in broader sustainable development conversations around the world.

Teaming up with UNESCO for sustainable consumption

From 28 April to 2 May 2024, a public event themed "Green and Low Carbon Consumption at a World Heritage Site" was co-hosted by INBAR and the United Nations Educational, Scientific and Cultural Organization's Regional Office for East Asia, with implementation support from the Chishui Forestry Bureau.

The event took place at two locales: 1) The Chishui Danxia World Heritage Site; and 2)

At the IUFRO World Congress in Stockholm, Sweden, bamboo's vital role in the forestry sector was highlighted.

the Xiangzhanglin Square of Chishui city. The goal was to advocate for green and low-carbon consumption, actions and lifestyles with eco-friendly bamboo products.

This public event is one of the deliverables emerging from the Chishui World Heritage Sustainable Livelihood pilot project, "Bamboo for Carbon Neutrality in Rural Areas," which is being implemented by INBAR with support from the Chishui Forestry Bureau.

Throughout the course of this activity, project staff distributed promotional materials about green bamboo products, distributing over 2000 souvenirs, prizes, flyers and other items, representing significant outreach into the Chishui community. Visitors gained a deeper understanding of bamboo products, low-carbon and green consumption, and also learned about the intangible cultural heritage of Chishui bamboo weaving and its potential to positively impact local livelihoods alongside its numerous advantages over plastic products.

Bioeconomy, sustainable construction, plastic pollution: Bamboo at IUFRO World Congress

The 26th International Union of Forest Research Organizations World Congress was held in Stockholm, Sweden, from 23 to 29 June 2024. Under the theme, "Forests & Society Towards 2050," the Congress hosted 4300 delegates from academia, governments, industry, NGOs and civil society from around the world to discuss technical and societal issues of forest-related research, policy-making and management. INBAR had a strong presence at the event, co-hosting a side event and poster session, delivering poster presentations on a range of important topics, participating in a panel on forest products and services and speaking on plastic pollution.

On 27 June, the International Centre for Bamboo and Rattan (ICBR) and INBAR co-hosted a side event on "Innovative technologies for the development of bamboo and rattan products," moderated by Fang Changhua, Professor at ICBR. Since there are over 1600 species of bamboo

growing on over 50 million hectares of land spread across the developing world, alongside the plant's unique qualities such as being fast-growing with no need for replanting after harvesting as well as being a major powerhouse for carbon sequestration, there is great potential for scaling up its utilization to develop novel products.

INBAR experts also gave poster presentations. Fang Changhua and Li Yanxia, INBAR Senior Programme Officer, facilitated a poster session on "Innovative technologies for the development of bamboo and rattan products." Pablo Jácome Estrella, INBAR Regional Director for Latin America and the Caribbean, spoke on how climate-smart practices with bamboo can help Amazonian communities bolster adaptation and resilience. Nellie Oduor, INBAR National Project Coordinator for Kenya and Principal Research Scientist at the Kenya Forestry Research Institute, presented on the physical, mechanical and anatomical properties of a fast-maturing species that grows in the drylands of Kenya. Dagnew Yebeyen Burru, INBAR East Africa Regional Office Project Coordinator, discussed modeling habitat suitability for highland bamboo in Ethiopia in a changing climate.

René Kaam, Regional Director for INBAR's Central Africa Office, was also invited to speak on a panel hosted in the conference floor, and was asked to give his biggest takeaway message from the Congress with regards to the future of forest products and services. Kaam stated his hope for the future — that bamboo will play an increasingly prominent role in forest discussions as more countries realize its potential, particularly in Africa, which is home to abundant yet underutilized bamboo resources that can be used to address a wide range of environmental challenges, from climate change and biodiversity loss to desertification, while also delivering livelihood improvements and mitigating plastic pollution. Afterward, he also gave a presentation on "Bamboo for the Bioeconomy" in which he highlighted the Bamboo as a Substitute for Plastic Initiative.

The Congress championed the idea that forests play a critical role in driving the economy, but sustainable forest management practices are needed to ensure biodiverse landscapes and economic livelihoods.

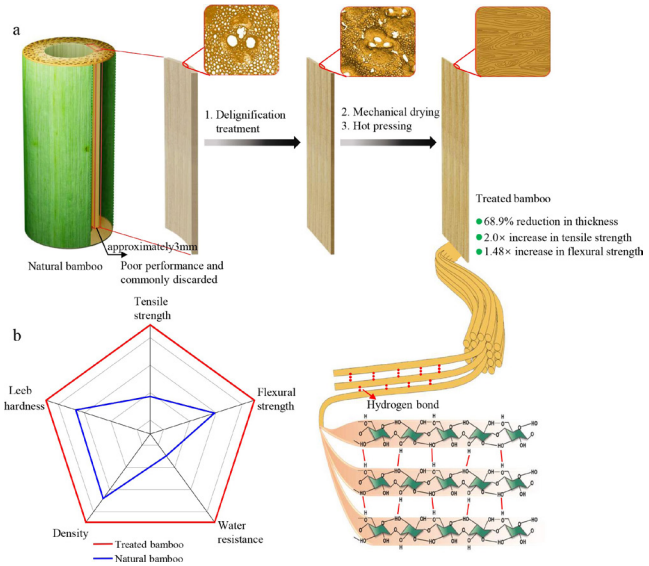
Ecuador's agriculture minister awards new bamboo certificates on good practices

Recently, in the Ponce Loma community of northern Ecuador, high-level officials visited a bamboo storage and preservation center, awarding certificates to participants on good forestry practices with bamboo as part of an official ceremony. H.E. Danilo Palacios, Ecuador's Minister of Agriculture and Livestock, led the delegation, visiting the Acero Vegetal Amazónico RAYU Bamboo Storage and Preservation Center of the Kichwa Women's Association of Napo.

Among the participants were producers who participated in the Field Schools on Sustainable Bamboo Management, instructors who facilitated the training sessions, and technicians from a number of relevant government agencies. These institutions supported the process of creating official certification in good forestry practices with bamboo. Representatives from local provincial governments, pioneers from the private sector, and several members of the Kichwa and Quijos nationalities also participated.

Afterwards, a tour of the center was conducted. Staff explained the complete post-harvesting process of bamboo, from receiving the material to its preservation and storage. The tour was led by Freddy Tapuy, a technician from the organization responsible for the center. Palacios then interacted with bamboo entrepreneurs who showcased their crafts and explained how these products and enhanced skills have allowed them to generate additional income in different settings such as fairs and markets.

At the end of the tour, everyone participated in a tasting of a dish of Wamag Yuyo (a type of *Guadua* bamboo shoot found in Kichwa), highlighting the versatile applications of bamboo even in cuisine, as it has long been an important part of the cultural identity of the Kichwa nationality. The event ultimately was testament to the joint efforts of multi-level government institutions, cooperation agencies, producers and community members to generate real impacts.



New method obtains high-performance composite material from bamboo's inner layer

Bamboo is a green, low-carbon, fast-growing, renewable and biodegradable biomass material known for its high strength and toughness. However, due to its functional gradient structure in which mechanical, physical and chemical properties deteriorate from the outer to inner layers, the inner layer is often discarded as waste. This practice generates significant material loss and is an inefficient use of the resource.

Accordingly, it is crucial to improve the mechanical strength of bamboo's inner layer to fully utilize this resource.

A research team of Chinese scientists has proposed a solution to this problem. Combining in-situ chemical treatment with mechanical processing, the new approach creates sustainable, ultra-thin, lightweight, high-strength and tough composite materials with applications in engineering, all the while using the inner layer of bamboo that is typically discarded. This also increases the sustainability of bamboo in the construction and transportation industries.

After applying the new treatment, bamboo composite material exhibits enhanced tensile strength, flexural strength, water resistance, hardness and density. Coupled with bamboo's inherent properties as a low-cost, energy-efficient and sustainable material, this research provides a new approach for producing high-performance composite materials from typically discarded bamboo for engineering applications, with potential for high-value utilization.

The remarkable physical and mechanical properties of the treated bamboo stem from its unique structure. It consists of interlocking components, dense stacking and an increase in the relative contents of cellulose, which results from the collapse of thin-walled cells. The process of strengthening during delignification with chemical treatment causes the bamboo to shrink on a macroscopic scale. On the mesoscale, the collapse of thin-walled cells generates closer connections in the transverse direction and denser stacking in the longitudinal direction. The high-strength bamboo fibers remain well preserved and tightly aligned in the longitudinal direction, enhancing interactions between adjacent cells. At the nanoscale, more of the surface area of the cellulose fibrils is exposed due to the partial removal of hemicellulose and lignin, resulting in close contact between cellulose fibrils, forming intermolecular and hydrogen bond forces and improving its physical and mechanical properties.

In the process of strengthening during mechanical drying and hot-pressing, widespread and uniform shrinkage reduces porosity and increases density on the macroscopic scale. The thin-walled cells of the treated bamboo form a tight interlocking structure on the mesoscale due to the microwave electromagnetic field and thermal pressure. The fibrils become more compact and uniformly arranged after densification treatment. At the nanoscale, the surface contact area of cellulose fibrils increases, enhancing hydrogen bonding and van der Waals forces, resulting in superior mechanical properties.

The approach developed by the research team unlocks a promising future avenue for bamboo processing, with significant implications for high-value utilization in heavy industries.

Summary of article published by Han, S., Chen, X., Chen, F., Lou, Z., Ren, X., Ye, H., and Wang, G in *International Journal of Biological Macromolecules*, Volume 267, Part 2, May 2024.

EVENTS

24 July
COFO 27 side event: Bamboo-based innovation to harness bioeconomy solutions
Rome, Italy

9 August
International Day of the World's Indigenous People
Global

11-17 August
International Bamboo Exchange Experience Tour
Colombia

4-6 September
2024 Summit of the Forum on China-Africa Cooperation (FOCAC)
Beijing, China

12 September
International Day for South-South Cooperation
Global

12-16 September
2024 China International Fair For Trade In Services (CIFTIS)
Beijing, China

18 September
World Bamboo Day
Global

18 September
Workshop in Construction: Bamboo Sustainable Footprint
Global

10-24 September
The 79th session of the UN General Assembly
New York City, USA

26 September
Webinar on Harnessing the Potential of Bamboo for a Greener Future: Energy and Beyond
Online

INBAR's exhibition space at 2024 China International Fair for Trade in Services in Beijing.

Training workshop in Cameroon for eco-entrepreneurs helps promote sustainable development and boost climate resilience.

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