

# The Climate Change Challenge and Bamboo: Mitigation and Adaptation

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# International Network for Bamboo and Rattan

The International Network for Bamboo and Rattan (INBAR) is an intergovernmental organization dedicated to reducing poverty and conserving the environment through pro-poor trade in bamboo and rattan. INBAR was established in 1997 and represents a growing number of member countries all over the world. INBAR's headquarters are in Beijing, China. It has regional offices in Ghana, Ethiopia, India and Ecuador.

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## Foreword

Bamboos are versatile resources that can help us tackle and live with climate change. Over the past three years, INBAR has studied how bamboos can help people mitigate and adapt to climate change, whilst growing and processing them to improve their livelihoods. INBAR's work with its partners on carbon sequestration in managed bamboo forests indicates that they are at least as good as comparable fast-growing tree species, and so planting and managing bamboos can help mitigate climate change. INBAR is demonstrating how bamboos can help adapt lives and livelihoods to increased occurrences of extreme climatic events, for example to landslides and floods, with a suite of innovative disaster-resilient bamboo houses and innovative ways of preventing erosion with bamboo. For many years, INBAR has been demonstrating how integrated development with bamboo can provide secure livelihoods in the long term, and we have helped many thousands of rural producers to make a living from bamboo where once they did not.



*Dr. Coosje Hoogendoorn*  
Director General, INBAR

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## Introduction

Bamboos are fast-growing woody grasses that grow mostly in the tropics and subtropics in mixed forests or as pure stands, and are cultivated in plantations, on homesteads and on farms. Bamboos are grown for their long, usually hollow, stems (called culms) that can be used as whole or sectioned poles and that yield softwood and fibre for processing. Millions of the world's poor people live with and rely on bamboos for their lives and livelihoods.

Climate change affects us all, but will affect the poorest the most. Bamboos help us all mitigate and adapt to the effects of climate change by:

- Absorbing and storing carbon
- Protecting forests and watersheds
- Insulating environments against extreme weather
- Providing low-cost, green housing and infrastructure
- Providing cleaner biofuels
- Providing renewable, sustainable resource for generating incomes
- Increasing the range and season of food sources



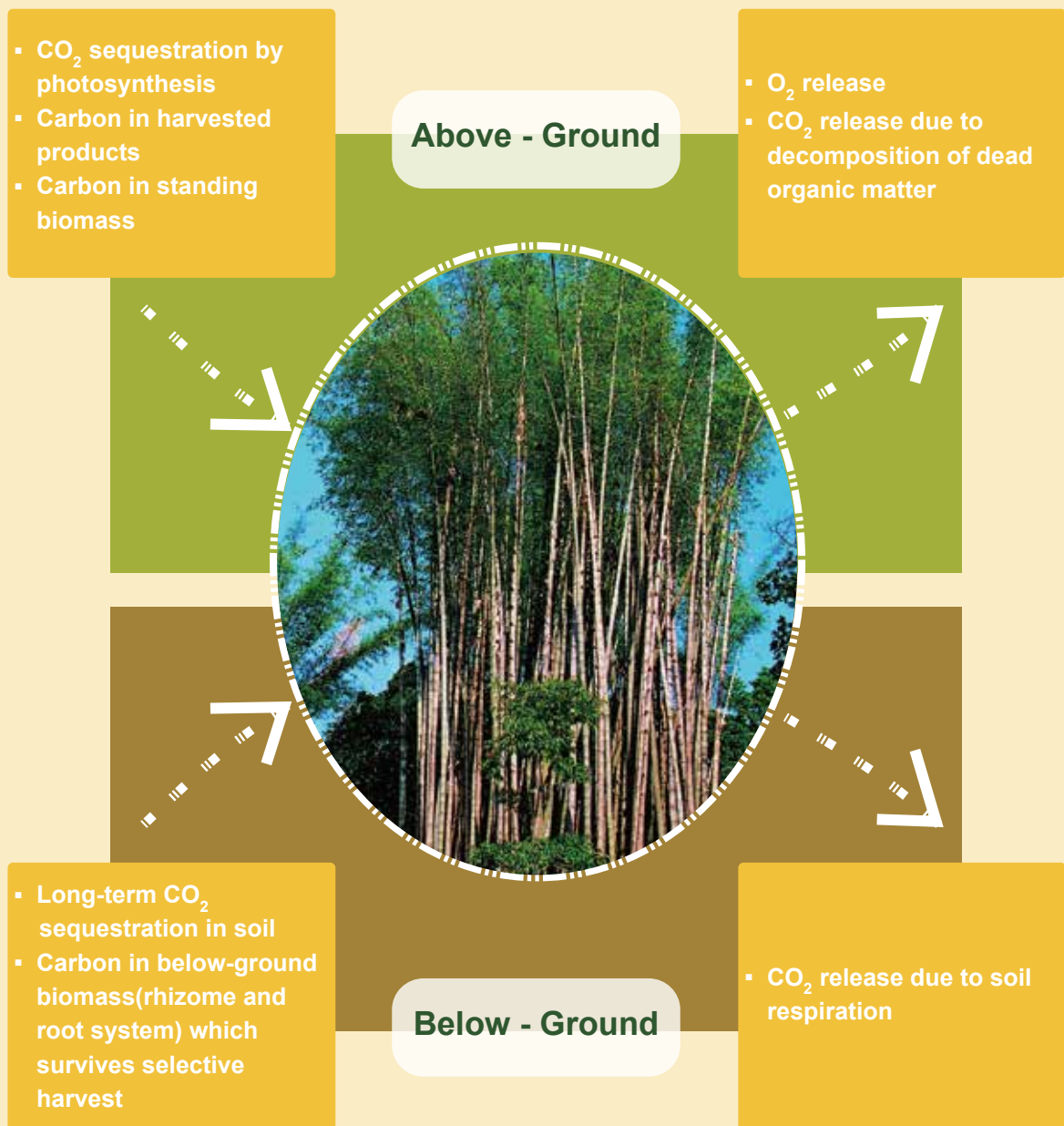


## How bamboos grow

Bamboos are amongst the fastest-growing plants, growing at up to a meter per day. Unlike trees, bamboos form extensive rhizome and root systems which can extend up to 100 km/ha and live for a hundred years. Culms that emerge from the rhizomes die naturally after about 10 years if not harvested before. The rhizome system survives the harvesting of individual culms, so the bamboo ecosystem can be productive whilst continuing to store carbon, as new culms will replace the harvested ones. The lost biomass is usually replaced within a year.



# The bamboo carbon cycle





# **Bamboos and Climate Change Mitigation**



## Bamboos and carbon sequestration

Bamboos are C3 plants and have normal photosynthetic capacities, so their main advantage for mitigating climate change lies in their fast biomass generation and in their renewability.

The biomass of newly planted bamboo forests increases rapidly for ten or more years before reaching a plateau, at which point emergence and death of culms each year is approximately equal. The biomass of underground rhizome systems follows a similar pattern. In managed stands, cultivation and harvesting practices enable much higher biomass production per unit area, at least doubling productivity.

Bamboos can be used for all main types of forest-based climate change activities:

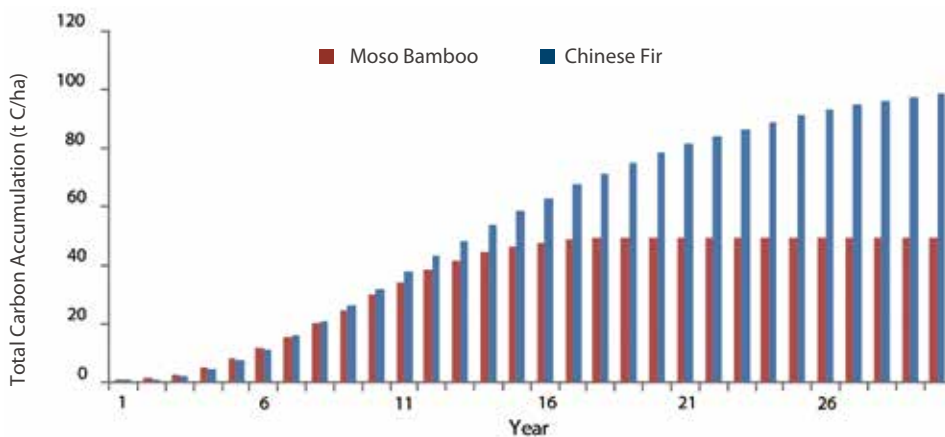
- Afforestation and re-forestation;
- Forest management;
- Avoided deforestation.



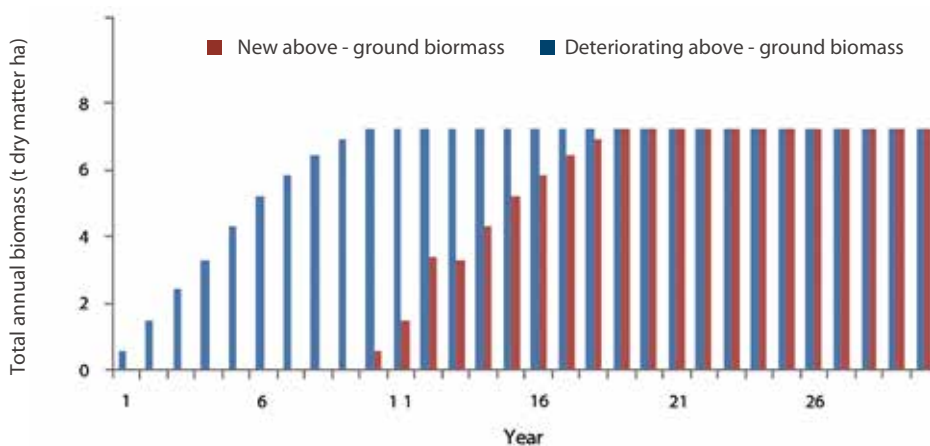
# Carbon storage in bamboo stands

Bamboos sequester more carbon in the early years of a plantation than comparable forest trees. Unmanaged bamboo stands do not store high levels of carbon, as their productivity is low and the accumulated carbon returns quickly to the atmosphere as the older culms decompose.

## Comparison of carbon accumulation of Moso<sup>1</sup> Bamboo and Chinese Fir - unmanaged stand



## Comparison of new and deteriorating above-ground biomass - unmanaged stand



In a managed stand, mature bamboo culms are harvested before they decay, so the total amount of carbon stored by the ecosystem increases, as new culms will emerge in subsequent years and sequester additional carbon. Unlike trees, which are usually clear cut, the regular and selective harvesting of bamboo culms doesn't kill the plant nor damage the ecosystem, and below-ground carbon in the soil and rhizome is not emitted as the bamboo forest continues to live after harvest.

<sup>1</sup>Moso bamboo (*Phyllostachys pubescens*) is the most commercially important bamboo species in East Asia.



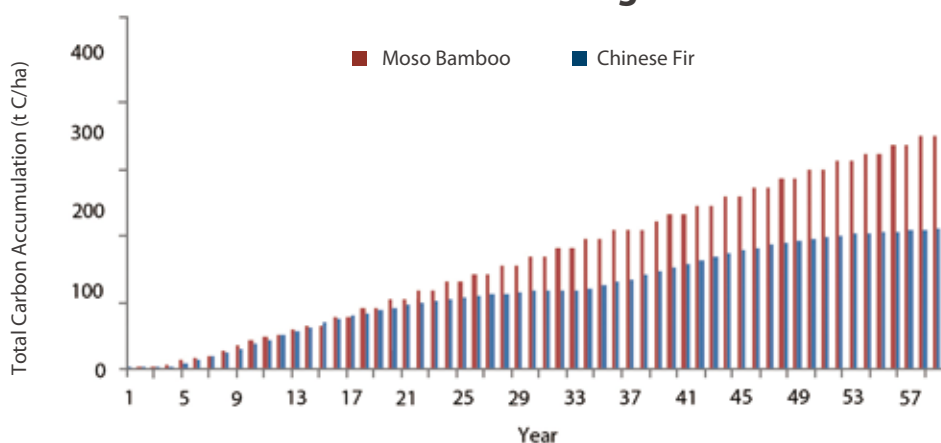
Unmanaged bamboo stands decay relatively quickly



Managed bamboo stands can sequester more carbon

A managed Moso bamboo forest accumulates about 300 tonnes of carbon per hectare after 60 years. Bamboos produce much more biomass when managed - by cultivation and selective, regular harvesting of mature culms - and INBAR's modeling shows that a managed bamboo forest sequesters more carbon than fast growing tree species such as Chinese Fir if the harvested culms are turned into durable products.

### Comparison of carbon accumulation of Moso Bamboo and Chinese Fir - managed stand



As management of bamboo forests results in greater removal of greenhouse gases compared to unmanaged stands, managing bamboos has potential to help mitigate climate change. As managing bamboos also increases the yields and quality of the culms and their wood, there will be benefits for both the environment and the farmers.

## One carbon, two carbons: A carbon accounting methodology for bamboo

Managing bamboos increases the yield and quality of culms, and increases farmers' incomes from their sale.

Carbon markets offer an additional opportunity to increase incomes. INBAR is working to develop a carbon accounting methodology so farmers can earn money through carbon credits by means of afforestation with bamboo.

INBAR, the China Green Carbon Foundation and Zhejiang Agriculture and Forestry University are developing a methodology that will enable project developers to quantify the carbon fluxes within a bamboo plantation, and allow the calculation of the carbon credits earned. Once adopted, the methodology should lead to more, and more sustainably-managed, bamboo plantations.



## Carbon storage in harvested bamboos and bamboo products

Some of the bamboo culms in the forest are harvested regularly and used to make products, so the potential for the forest to sequester carbon depends on the use, lifetime and durability of the harvested material or the products it is used to make. As long as the total volume of bamboo products keeps increasing, the bamboo system is a sink, as the rate of extraction is higher than the rate of release. Bamboo is put to over 1500 uses, but until recently the lifespans of many of these products were short. Recent improvements in processing and the development of new types of products mean that many have lifespans of decades, meaning carbon can be stored for much longer, which increases the size of the bamboo carbon sink.



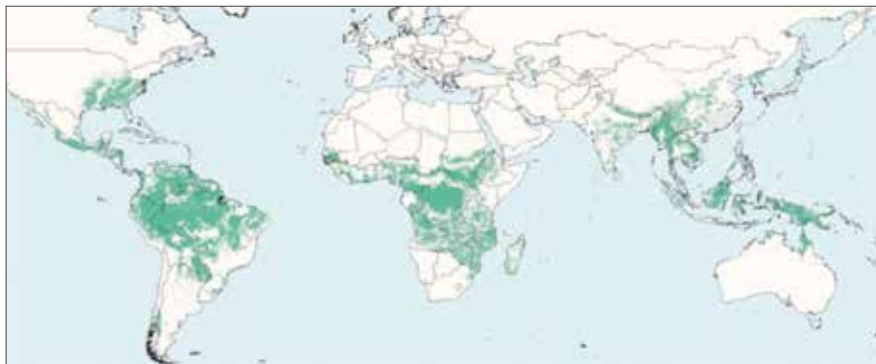
Prefabricated bamboo boards have lifetimes of at least 20 years

# Bamboos in climate change mechanisms

Mechanisms such as REDD, REDD+ and REALU are evolving. Including bamboo in these mechanisms would enable countries to generate carbon credits for forestry projects that involve bamboo, which would provide incentives to grow more bamboo. Future mechanisms might include a wider range of land uses of which bamboo could be grown, as bamboo can grow on wide range of soils and can be integrated into many productive systems. Bamboo's versatility expands its options beyond forestry into agro-forestry and even agriculture, where it might fit into future climate change mitigation schemes.

## The mitigation potential of bamboos

It is estimated that bamboos covers 22 million hectares today, which translates into sequestering 727.08 tera-grammes of carbon. Studies show that bamboo could be grown on many millions more hectares of degraded land in the tropics and subtropics, where it could provide additional incomes to farmers without affecting their existing crops.



Natural distribution of bamboo

## Avoided deforestation and substitution

Substitution of energy intensive products with bamboo can reduce greenhouse gas emissions indirectly. Producing bamboo products usually requires less energy than comparable fossil-fuel based products. Bamboo is selectively harvested and provides woody biomass each year, and can take pressure off other forest resources and contribute to avoided deforestation. These substitution processes not only reduce emissions indirectly, but can also contribute directly to climate change mitigation - the use of bamboo products with long life spans increases the terrestrial carbon sink, through the long-term storage of sequestered carbon.

## Bamboo flooring in shipping containers

Shipping giant MAERSK LINE is equipping its containers with sustainable flooring materials including bamboo to replace traditionally-used hardwood floorings. By 2012, MAERSK plans to have over 25,000 containers equipped with bamboo flooring.

See: [www.maerskline.com](http://www.maerskline.com)



## Bamboo charcoal in Africa

Tree-wood charcoal is the most important source of household energy in Africa and a major cause of deforestation. Unless African households adopt cleaner, more efficient fuels, the equivalent of 6.7 billion tonnes of CO<sub>2</sub> will be released into the atmosphere by 2050. Bamboo charcoal is not only less polluting when it burns, but bamboo can substitute for timber trees, thus reducing deforestation. INBAR's project aims to increase the use of bamboo as a source of energy for the poor in Ethiopia and Ghana, providing a more sustainable, environmentally friendly and economic alternative to firewood and wood charcoal. The project started in 2009 and in just two years:

- 350 households are using bamboo charcoal to meet their everyday household needs for cooking;
- 1,700 farmers from 150 communities know how to manage bamboo resources sustainably for charcoal making;
- 1,000 farmers and 142 specialist charcoal producers know how to produce bamboo charcoal;
- Three national bamboo charcoal micro small enterprise associations involving all 142 charcoal producers are providing livings to the producers and their families;
- More than 25,000 energy-saving locally-produced bamboo charcoal stoves have been distributed to households, food vendors and government agencies to promote the use of bamboo charcoal;
- Government institutions, non-profit organizations, and research centres in Ethiopia and Ghana have integrated bamboo charcoal components into their sustainable development programmes, and benefit from expert support and advice to help them promote bamboo as sustainable biomass energy.

### Project partners:

INBAR; Common Fund for Commodities; European Union; Rural Energy Development and Promotion Centre (EREDPC), Ethiopia; Federal Micro and Small Enterprises Development Agency (FeMSEDA), Ethiopia; Forestry Research Institute of Ghana (FORIG), Ghana; Bamboo and Rattan Development Programme (BARADEP), Ghana; Nanjing Forestry University (NFU), China.





Locally-produced bamboo charcoal in Ghana

## Future Needs/Next Steps: Bamboo and Climate Change Mitigation

### Research and Knowledge Generation:

INBAR's partnership with Zhejiang Agriculture and Forestry University (ZAFU) and China Green Carbon Foundation will enable us to develop the carbon methodology for bamboo afforestation projects further and to extend it to a methodology for harvested bamboo products. In 2012, ZAFU will open a bamboo carbon laboratory at ZAFU to focus research on carbon fluxes and pools within bamboo ecosystems, particularly:

- below-ground carbon accumulation throughout the life cycle of bamboo stands;
- carbon storage in harvested bamboo products;
- effects of management practices on the carbon sequestration capacity of bamboo.

INBAR will expand this partnership to reach out to partners throughout the world, with studies likely to focus on:

- The potential of bamboo to substitute for energy-intensive products;
- Modeling biomass generation under different conditions (climatic impacts, elevation, varying culm densities, intercropping);
- Defining the durability of commercially important bamboo products;
- Improving production processes to minimise GHG emissions.

One of INBAR's principles is South-South cooperation, and we will work with developing countries to transfer knowledge, experience and technology between them.

### Policy Frameworks:

INBAR and its partners will develop policy recommendations to enable bamboo to be included in climate change mitigation schemes. We will focus on including bamboos in REDD+ initiatives, emphasizing bamboos' versatility and suitability for many land uses.

### Management Practices:

INBAR will develop and define sustainable management practices which optimize bamboo for carbon sequestration. We will need to investigate the performance of bamboos in mixed stands and how climate change mitigation with bamboos can contribute to biodiversity conservation.

# **Bamboos and Climate Change Adaptation**

UNFCCC's "Bali Action Plan" defined climate change adaptation as the "strengthened future response to climate change". Bamboos can help provide local coping strategies that increase the resilience of ecosystems

## How can bamboos help us adapt to increased extreme weather events and disasters?

**By reducing soil erosion** – Bamboos reduce soil erosion. Erosion can destroy ecosystems and livelihoods. Bamboos' extensive roots and rhizomes bind the soil, and as they can grow on poor soils, bamboos are most effective in areas prone to runoff such as steep slopes, river banks or degraded lands. Bamboos are evergreen plants and the thick canopy and soil cover provided by dead leaves reduces direct and splash erosion and enhances infiltration.

**By making windbreaks and shelterbelts** – Bamboos can protect land from extreme winds. Bamboo culms bend in high winds, but usually do not break – so they are often used as windbreaks to protect cash crops, particularly in coastal areas where high winds are frequent.

## Pro-poor bamboo housing for areas vulnerable to Climate Change-induced disasters

**Disaster Resilient Permanent Housing:** For over 300,000 poor households in Guayaquil, coastal Ecuador, flooding and landslide-induced destruction of their homes is a constant and increasing threat. Through a World Bank funded initiative, INBAR is now helping to build flood-resistant elevated stilt bamboo housing that will provide local communities with innovative, low-cost, sustainable, flood-resistant, environmentally-friendly infrastructure.

**Post-Disaster Shelter:** Bamboo offers a cost-effective, strong, fast-to-construct and readily available material for short-term shelters. In the 2006 Jogjakarta earthquake in Indonesia, over 70,000 24 m<sup>2</sup> bamboo shelters were erected in nine months at an average cost of only US\$100 – 200, in one of the largest and most rapid humanitarian post-disaster shelter responses in recent history.



Elevated bamboo houses in Ecuador

## How can bamboos help feed the increasing numbers of people who will be hungry?

**By increasing the variety and season of foods** - Climate change will increase the number of people who don't have enough to eat. Bamboos can help provide food security in both human and livestock diets. The shoots of many species are edible, protein-rich and nutritious and they are a common ingredient in many dishes. Bamboo leaves are used as fodder for livestock and feed for fish.



Integrated farming system with bamboo



## How can bamboos help us develop more resilient ecosystems?

**By decreasing sensitivity** – Adaptation to climate change is a long term process. Bamboos grow very fast - productive stands can be established within a few years and individual culms can be harvested after 3-6 years, depending upon species. This rapid establishment reduces exposure to outside risks such as fire or extreme weather events, and increases flexibility to adapt management and harvesting practices in the face of climate change.

## Rapid recovery of snow damaged bamboo forests

In winter 2008, in central southern China unusually heavy snowfall caused many bamboo culms to break. By 2010 the forest had been restored as new culms had emerged to replace the broken ones.



Broken culms after unusually heavy snowfall



Recovered bamboo stand

**By helping rehabilitate degraded lands** – Bamboos can be used to (re-) establish functioning and productive ecosystems. Climate change might render land unusable for farming or productive ecosystems, so new land areas need to be found or created. Moreover, bamboos can help speed the conversion of degraded lands into productive and economically viable systems. Bamboos planted on degraded lands are not very productive, but help improve soil quality and the productivity of commercial and food crops grown on the land.

## Greening Red Earth

Bamboos have helped rehabilitate heavily degraded land near Allahabad, India, where for decades the soil had been harvested for brick making. After just five years, the red earth had been replaced by green expanses of bamboo, and many residents had begun farming again. The land now supports a diverse system of agriculture, medicinal plants and fisheries mixed with bamboo, the water table has risen by 7 meters, and the dust storms which originated from the area have subsided.



Before and after: Bamboos rehabilitated land at INBAR's project site in Allahabad, India, between 1996 and 2003

**By providing renewable energy** – Demand for energy will increase. Deforestation for household energy is a major driver of climate change in many developing countries. Bamboos can help reduce deforestation by replacing trees for firewood and charcoal, providing a more renewable source of energy - bamboo based firewood and charcoal are being recognized as sustainable alternatives to meet the energy demands of rural and urban dwellers. Bamboo-based renewable energy is also an option for climate change mitigation.



Traditional Ethiopian coffee ceremony using bamboo charcoal

**By reducing deforestation** - Bamboos provide an annual supply of woody biomass. Using bamboos instead of trees can reduce pressure on other woody forest resources and help avoid deforestation. In this way bamboo can contribute simultaneously to adaptation and mitigation of climate change.



Ecosystem Services Offered by Bamboo	
Category of Services	Type of Services
Support Services	Soil formation, nutrient cycling, primary production
Provisioning Services	Food, biomass energy, fibre
Regulating Services	Climate, disease, water regulation and water purification
Cultural Services	Spiritual and religious, recreation, aesthetic, inspirational, educational, sense of place, cultural heritage

## How can bamboos help us develop pro-poor lower carbon economies?

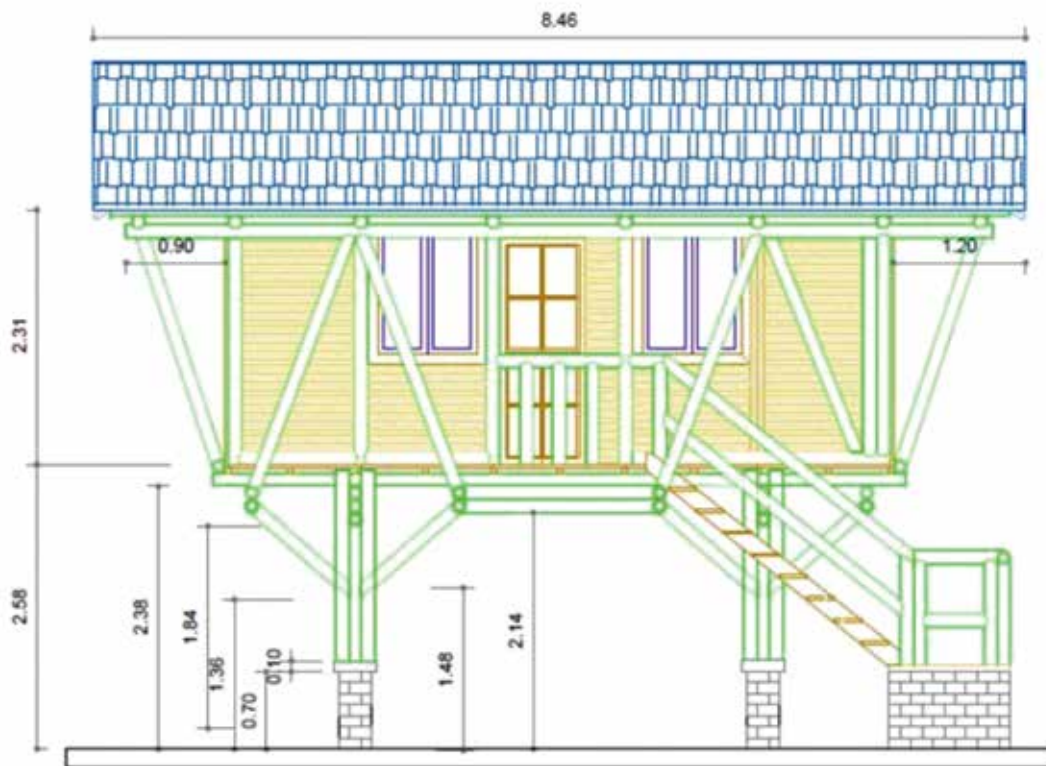
Bamboo provides a local, reliable and resilient source of shelter, energy and food for millions of people and contributes to livelihood resilience:

**By providing a regular source of income** - The fast growth and early maturation of bamboo culms means that a bamboo stand can be selectively harvested just a few years after planting. Regular selective harvesting of bamboo generates a regular income stream that provides bamboo farmers with quick returns on their investments and an important financial safety net.

**By growing on a wide range of lands** - Bamboos are very productive on fertile soil, but most bamboos can also grow on marginal lands, such as degraded land and steep slopes, leaving better land for more demanding crops. Bamboos are tolerant of a range of soil conditions, such as low pH values, so can grow on lands which would otherwise be unsuitable for productive ecosystems.

**By easy harvesting and access** – Increasing access to local resources is an essential part of climate change adaptation. Although harvesting bamboo is labour intensive, it is relatively easy and is usually done by hand. Bamboos can be processed locally, often by women because the culms are lightweight and easy to split by hand.

**By providing a low-energy resource for construction and infrastructure** – We must reduce our use of energy intensive construction and infrastructure. Bamboos are light and strong materials for construction and infrastructure. Bamboos have been popular housing materials for centuries, and bamboo houses use at most half the energy of brick and concrete houses – and much of that is due to the bamboo houses’ concrete foundations. New designs and production techniques coupled with changes in perception mean modern high quality houses that combine safety with durability and aesthetics are now available. Innovation has produced other bamboo structures such as bridges and housing components equivalent to those of more energy-intensive materials.



**ELEVACION FRONTAL - CASAS ELEVADAS DE BAMBU**

**ESCALA** \_\_\_\_\_ **1:50**

DISEÑO: ARQs. JORGE MORAN / SAUL VERA --- AGOSTO - 2011

Design of a modern bamboo house

**By the plethora of uses to which they can be put** - The broad range of possible uses of bamboos means demand remains high. Bamboos ability to replace wood in high demand products such as furniture or housing, along with biomass energy uses, are of particular importance in adapting to climate change.



An INBAR house in Beijing made of bamboo-based panels


Bamboos versatility and unique characteristics provides communities with options to diversify their economies and decrease their sensitivity. Bamboos can be a tool in local coping strategies that aim to increase the resilience of livelihoods.



## Future Needs/Next Steps: Bamboo and Climate Change Adaptation

<p><b>Research and Knowledge Generation:</b></p>	<p>INBAR and its partners will define bamboos' potential role in climate change adaptation efforts and its interactions with other parts of the ecosystem more closely. New possibilities for utilizing bamboos for climate change adaptation will be developed and researched. Sustainable supply chains will be developed to increase ecosystem and/or livelihood resilience of local communities.</p>
<p><b>South-South Cooperation:</b></p>	<p>INBAR and its partners will take the leading role in ensuring that knowledge and technologies are shared appropriately. Within the UNFCCC Nairobi Action Work Programme, INBAR will help stakeholders make informed decisions on practical adaptation measures.</p>
<p><b>Policy Frameworks:</b></p>	<p>As the challenges in adapting to climate change are diverse, specific and targeted approaches need to be developed. INBAR and its partners will develop policy recommendations to ensure that the wide range of options that bamboo offers for increasing ecosystem and livelihood resilience are incorporated into global forestry and agro-forestry schemes that tackle climate change.</p>
<p><b>Management Practices:</b></p>	<p>In order to enable stakeholders to utilize bamboos' full potential in climate change adaptation, INBAR and its partners will further define sustainable management practices. These management practices will focus on increasing ecosystem or livelihood resilience, or a combination of both. One of the first questions to answer will be how climate change adaptation with bamboos can help conserve biodiversity.</p>

# Conclusions



Bamboos offer a wide range of potential solutions to address the problems and hardships that may come with climate change. Bamboos can be integrated into all main types of forest-based climate change mitigation activities; afforestation / re-forestation, forest management or avoided deforestation. Studies showed that appropriately managed and regularly harvested bamboo forests can sequester more carbon than if left in their natural state, and moreover, can sequester more carbon than fast-growing tropical and sub-tropical trees in comparable conditions<sup>2</sup>. Due to its renewability, bamboo can take pressure of other forest resources and contribute to avoided deforestation.

Bamboos' unique potential contribution to mitigation relies on the fact that it can combine continued biomass production with regular selective harvesting, thus leaving a standing carbon stock and a living ecosystem that will continue to grow. Moreover, when bamboos are used to substitute for energy intensive products, their growing stock can represent an increasing carbon sink. Longer lifespans of modern bamboo products will help ensure that more carbon remains sequestered.

Increasing the cultivation and use of bamboos is likely to contribute to the resilience of rural and urban populations to the impacts of climate change. Bamboos are relatively easy to grow and maintain and can provide additional food, energy and income security to the rural poor, as well as a range of environmental services and uses in their growing and harvested forms. Bamboo products such as houses and charcoal, can contribute to the livelihood resilience of rural and urban dwellers.

But although many of the ways that bamboos can help are known, more work is needed to fully quantify, understand and develop the potential that bamboos offer, particularly for the millions of people in developing countries who are living in areas considered especially vulnerable to the effects of climate change. Therefore it is important that bamboos' unique properties are recognized and integrated into mechanisms for mitigating and adapting to climate change (such as REDD+) – especially as the mechanisms are developing further and will include a wider range of land uses.

Ensuring that bamboos can realize their potential in addressing climate change will require future (action) research, development and application. Through South-South technology and knowledge transfer, INBAR aims to introduce successful examples and best practices to new stakeholders and regions, and to fully enable stakeholders to utilize bamboo's potentials in climate change mitigation and adaptation.

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<sup>2</sup> INBAR (2010) Bamboo and Climate Change Mitigation. INBAR Technical Report 32.

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