INBAR Working Paper

INBAR
INTERNATIONAL BAMBOO AND RATTAN ORGANISATION

Policy Brief

Bamboo for Charcoal Production in Africa: Experiences from Ghana

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CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

About the International Bamboo and Rattan Organisation

The International Bamboo and Rattan Organisation, INBAR, is an intergovernmental organisation dedicated to the promotion of bamboo and rattan for sustainable development. For more information, please visit www.inbar.int.

About this Working Paper

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Executive summary

This policy brief is intended to inform among other stakeholders regional and national policymakers, private sector actors, and energy producers about the prospects of converting bamboo resources into charcoal for renewable energy in West Africa. It provides some success case of the use of bamboo for charcoal production and its contribution to sustainable economic livelihoods in several communities in Ghana.

1. Introduction

Biomass is a major source of energy in Sub-Saharan Africa. It is estimated that about 80% of Sub-Saharan Africa's population rely on traditional biomass fuels, mainly wood fuels in the form of charcoal and firewood, for their energy needs (Hall & Scrase, 2005; Sander et al., 2011; Sawe, 2012). Though Africa's urban dwellers are increasingly shifting from the use of firewood to the use of liquefied petroleum gas, charcoal remains an important source of household energy in the urban areas (Girard, 2002; Zulu & Richardson, 2013). In rural areas, firewood is the predominant source of household energy, in some places providing 100% of household energy (Cerutti et al., 2015). The high use of biomass energy in Sub-Saharan Africa contrasts with the situation in the developed parts of the world, where development has been associated with the transition to more advanced sources of energy. The destruction of the use of biomass energy in Africa causes to forests and the environment is a subject of discussion among resource managers and scientists (Msuya, 2011; Sanbata et al., 2014). In Ghana where about 90% of biomass energy is sourced from natural forests and the savannah woodlands (Obiri-Danso & Nutakor, 2011), the average annual per capita wood energy consumption is 1.3 m^3. This translates into an estimated national annual wood removal of more than 30 million m^3 for fuelwood and charcoal, which is about 85% of the total annual wood removal in Ghana[1].

2. Case for bamboo

The high use of biomass energy in Africa is expected to remain the same into the foreseeable future. The urgency of the need to find sustainable sources to ameliorate the environmental impacts of biomass energy production and use cannot be overemphasized. Bamboo is increasingly attracting global attention as a feedstock for biomass energy due to its fast growth, renewability and abundance in tropical regions. Under its rapid production of biomass, bamboo offers a sustainable alternative feedstock for biomass energy (Dwivedi *et al.*, 2014; Liu *et al*., 2016; Scurlock, Dayton, & Hames, 2000). It is the fastest-growing woody species, able to grow up to about 1 meter in a day. Harvesting can start 3-6 years after planting. The closest competitor in Africa, Acacia, takes 5-7 years to be ready for harvesting. Once the rhizomes are established, new shoots of bamboo can grow to their full size and height in a single year, only hardening in

[1] Source: http://www.fcghana.org/assets/file/Programmes/Forest_Investment_Plan_fip/Ghana%20%20FIP%20Final.pdf

subsequent years. The extensive and long-living rhizomes ensure continues re-growth after harvests without the need to replant. The rhizomes also tend to spread producing new shoots as they spread. The result is an exponential increase in the number of shoots as a bamboo plantation ages. This, when properly harvested, can be an extremely renewable source of biomass energy feedstock. In an established bamboo forest, 3-6 bamboo culms can be sustainably harvested per bamboo clump annually.

3. Bamboo charcoal and briquette

The biomass energy utilization options of bamboo include for firewood, charcoal, briquettes, pellets and gasification to produce off-grid electricity[2]. INBAR has demonstrated through its project in Ghana and Ethiopia dubbed 'Bamboo as sustainable biomass energy: A suitable alternative for firewood and charcoal production in Africa (2009 – 2013)[3]', that bamboo is a suitable alternative material for charcoal and briquette production. Indeed, the practice of producing charcoal from bamboo is not new. China has a long history of producing charcoal from bamboo, and currently produces over 100,000 tons of bamboo charcoal annually[4]. Bamboo charcoal compares favorably with conventional wood charcoal in terms of its biomass fuel qualities. Bamboo charcoal has yield recovery rates of 20% to 30% depending on the temperature of carbonization[5]. This compares favorably with figures reported for *Acacia drepanolobium* (10.2% to 18.2%)[6]. Bamboo charcoal has a high calorific value similar to conventional wood (29136 KJ/Kg, compared to 32573 KJ/Kg for acacia charcoal[7]). Bamboo charcoal burns clean (smokeless) because bamboo has relatively less volatile matter. Additionally, it burns without sparks. These qualities make bamboo charcoal and briquettes a preferred choice for charcoal and briquette users who have had the opportunity to try it. A comparative life cycle analysis study by Partey *et al.* (2017) indicates that it is greener to produce charcoal from bamboo than to produce bamboo from teak and acacia. The study results indicate that relative to *Bambusa balcooa*, the total eco-cost (comprising eco-cost of human health, ecosystems, resource depletion and global warming) of a cradle-to-gate production of 1 Kg charcoal will be 200% higher with *Tectona grandis* and 211%

[2] http://www.inbar.int/2014/10/can-bamboo-transform-bioenergy
[3] https://www.youtube.com/watch?v=I75QNYPpukQ, https://www.fornis.net/system/files/Michael-Kwaku.pdf
[4] Source: http://www.worldbamboo.net/wbcix/presentation/Yue%20Yongde%20INBAR.pdf
[5] Source : http://www.worldbamboo.net/wbcix/presentation/Hunde,%20Tesfaye%20and%20Fu,%20Jinhe%20INBAR.pdf
[6] Source: http://tpyoung.ucdavis.edu/publications/2001CharcoalForEcolManag.pdf
[7] Source : http://tpyoung.ucdavis.edu/publications/2001CharcoalForEcolManag.pdf

higher with *Acacia auriculiformis*. Furthermore, bamboo has unique anatomy that gives bamboo charcoal high absorption and adsorption capacities. It has a specific surface area of 200-600 m^2/g, compared to less than 20 m^2/g for conventional wood charcoal[8]. This quality is useful for the usage of bamboo charcoal as an absorbent material in many applications.

4. Opportunity for Africa

The many countries in Africa that are naturally-endowed with bamboo have the potential to ameliorate the environmental impacts of biomass energy production and use by substituting bamboo for the forest trees being used. Ghana, with about 400,000 ha of bamboo resources, has the potential to sustainably substitute bamboo for about 70% of the country's wood consumption for charcoal production, and Ethiopia, with about 1 million ha of bamboo resources, has the potential to sustainably substitute bamboo for the country's entire wood consumption for charcoal production[9]. Notwithstanding the existing potentials however, Africa is yet to experience large scale adoption of bamboo for charcoal production. It is important to understand what has been done and what needs to be done to upscale the adoption of bamboo for charcoal production in Africa.

4.1 Cases from Ghana

The remainder of this brief shares Ghanaian experiences of efforts at upscaling and commercializing the use of bamboo for charcoal production. It shares the experiences of two bamboo charcoal business enterprises and an individual small scale bamboo charcoal producer in Ghana. These three enterprises have all benefited from INBAR's transfer of bamboo charcoal and briquette technologies from China to Ghana through training and technical assistance.

[8] Source: http://www.worldbamboo.net/wbcix/presentation/Hunde,%20Tesfaye%20and%20Fu,%20Jinhe%20INBAR.pdf

[9] Source: https://www.fornis.net/system/files/Michael-Kwaku.pdf

The Ankrobra Farms Limited

The Ankobra Farms Limited is a branch of the Ankobra Beach Limited, a resort in Ghana's Western Region. The principal objective of the Farms is agricultural development in an organic and holistic manner. Among other initiatives, Ankobra Farms Limited has initiated a project on the use of bamboo as an alternative source of biomass fuel. The current phase of the project produces bamboo charcoal and bamboo vinegar from wild-growing stands of bamboo in the vicinity of the Ankobra Beach Resort. The vicinity has about 100 ha of wild-growing bamboo. This can sustainably produce about 1000 tons of bamboo charcoal annually. From this stand, the Ankobra Farms Ltd. produces bamboo charcoal, using high efficiency and low emission triple retort kiln. The present productions are on a pilot scale to test the retort kiln technology and the market for bamboo charcoal. The exhaust gas from the carbonization is distilled into bamboo vinegar, which is used for pest control on organic farms. The company intends to sell the bamboo charcoal regionally as solid biofuel and soil conditioner. It also intends to test the export market. Each kiln has a load capacity of about 900 Kg per carbonization batch. The Farms has a production target of up to two carbonization batches per day and an annual charcoal production target of 330 tons (at a recovery rate of 30%). The company sees good potential for the commercialization of bamboo charcoal in Ghana. The Commercial Project Manager of the company's program dubbed 'Ankobra Research and Training Center (ARTiC)' explained that 'if produced in the right way with high recovery, bamboo charcoal can be competitive with charcoal made from conventional wood and save Ghana from further deforestation'. He sees the challenges to be addressed to include: 'market acceptance of bamboo charcoal as a new solid biofuel; stable supply with fair and sustainably-produced raw material; keeping the price of bamboo supplies at acceptable levels so that the price of bamboo charcoal will not be higher than that of the conventional wood charcoal, and the proper operation of the quite advanced bamboo charcoal technology which requires training'.

The Global Bamboo Products Limited

The Global Bamboo Products Limited (GBPL) is a hybrid social enterprise located in Ghana's Ashanti Region for the development of bamboo and other non-timber forest products (NTFPs). GBPL's main focus of business is the cultivation of bamboo and its processing into products such as bamboo charcoal, briquettes, furniture, crafts and for housing. GBPL is also involved in skills training, agroforestry and sustainable alternative livelihood activities. The company has planted about 300 hectares of bamboo over the past 12 years and has plans to plant 1000 hectares of bamboo over the next 5 years. It has trained over 200 youth in craft production and over 2000 farmers and out-growers in the cultivation, management and harvesting of bamboo. The company is actively involved in the commercialization of bamboo charcoal, buying bamboo charcoal from small scale producers for onward processing into briquettes. It thus provides the market for bamboo charcoal producers in Ghana. From 2013 to 2015, the company has purchased about 5,000 Kg of bamboo charcoal from producers and produced an additional 5,000 kg of bamboo charcoal. It has produced about 10,000 Kg of briquettes from the bamboo charcoal. Additionally, it has produced about 45,000 Kg of briquettes from charcoal residues obtained from conventional charcoal producers and retailers. The company sells the briquettes to restaurants, distributors, households, cookstove producers, and at trade shows, market activations, exhibitions and shops. The company sees good potential for the commercialization of bamboo charcoal and briquettes in Ghana. To fully tap this potential, it sees the need for bamboo feedstock depots, affordable mobile kilns for charcoal production and government support in terms of developing and implementing a policy framework for the charcoal industry in Ghana to help boost investor confidence.

Alex Blay at Tandan in the Ellembelle District of Ghana's Western Region

Alex Blay is an individual small scale bamboo charcoal producer at Tandan, a community in the Ellembelle District of Ghana's Western Region. He is a beneficiary of the 2009-2013 INBAR project 'Bamboo as sustainable biomass energy: A suitable alternative for firewood and charcoal production in Africa', through which he received training on how to produce bamboo charcoal. Since the project ended in 2013, he has been producing bamboo charcoal on small scale, often on demand. He has produced more than about 200 bags of bamboo charcoal (a bag weighs about 25 Kg). He sells the bamboo charcoal to a resort in the vicinity, the Ankobra Beach Resort, and also to local charcoal retailers. He sees good potential for the commercialization of bamboo charcoal in Ghana. The main challenge he sees is low recovery, which he explained makes bamboo charcoal more difficult to produce in comparison with conventional wood charcoal. He remarked 'the bamboo reduces in volume drastically during carbonization'. He finds it demotivating that the harder-to-produce bamboo charcoal has to be sold at the same price as the conventional wood charcoal.

5. Concluding remarks

From the Ghanaian experiences presented, it is seen that though there is good potential for the upscale and commercialization of bamboo charcoal in Ghana and Africa at large, more needs to be done to fully tap the potential. It is necessary to create further awareness of the available bamboo charcoal technologies, including recommended kiln options. It is also necessary to encourage private sector uptake of the technologies with appropriate fine-tuning for optimum charcoal recovery.

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