

Bamboo Resources Utilization: A Potential Source of Income to Support Rural Livelihoods

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Abstract In this paper, we examine the potential of bamboo as a source of income and better livelihood for rural communities. We look at the importance of bamboo from a global perspective with special attention to its economic, social and ecological values. Using this approach, we observed that, bamboo is very ubiquitous, has a global presence and it is used for various purposes from toothpicks to dresses and construction of houses. We also found that, it is a lucrative business from which rural people with the proper and adequate skills and market value chains, could adopt to come out of the poverty trap.

Keywords: Bamboo, rural communities, livelihood, poverty, biodiversity, forests

Cite This Article: Sythud Phimmachanh, Zhang Ying, and Mukete Beckline, "Bamboo Resources Utilization: A Potential Source of Income to Support Rural Livelihoods." *Applied Ecology and Environmental Sciences*, vol. 3, no. x (2015): 176-183. doi: 10.12691/aees-3-6-3.

1. Introduction

According to [27,38,42], globally, about 836 million people still live in extreme poverty. Though extreme poverty rates have been cut by more than half since 1990, one in five people in developing regions still live on less than \$1.25 a day, and there are millions more who make little more than this daily amount, plus many people risk slipping back into poverty [10,27,38,42]. The overwhelming majority of these people are in South Asia and sub-

Saharan Africa especially in small, fragile and conflict-affected countries [10,38].

In its regional forecasts for 2015, the World Bank, [42] exposed that poverty in East Asia and the Pacific would fall to 4.1 per cent of its population, down from 7.2 per cent in 2012; Latin America and the Caribbean would fall to 5.6 per cent from 6.2 in 2012; South Asia would fall to 13.5 per cent in 2015, compared to 18.8 per cent in 2012; Sub-Saharan Africa declines to 35.2 per cent in 2015, compared to 42.6 per cent in 2012, Figure 1 [42].

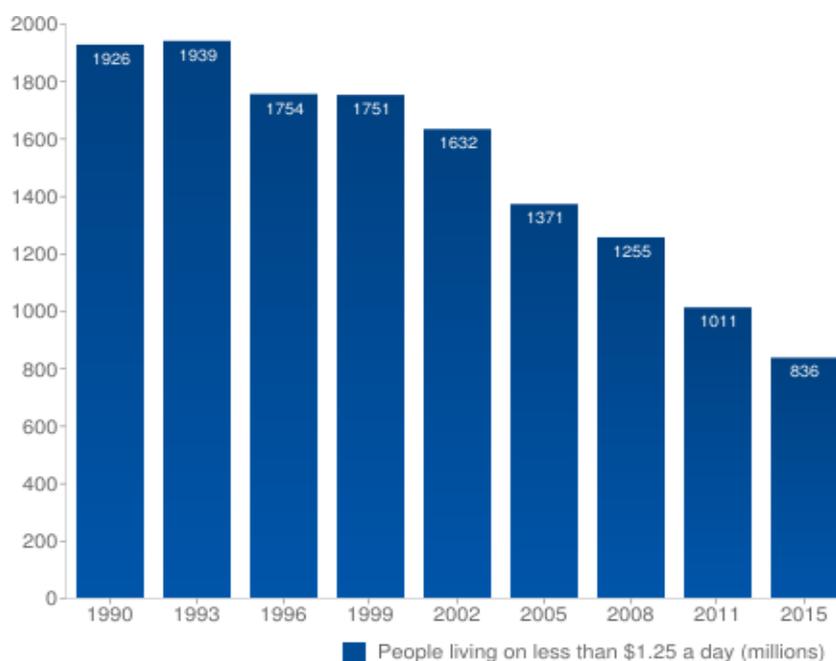


Figure 1. Number of people living on less than \$1.25 a day worldwide, 1990-2015 (millions). (Source: The Millennium Development Goals Report 2015)

Poverty is more than the lack of income and resources to ensure a sustainable livelihood. Its manifestations include hunger and malnutrition, limited access to education and other basic services, social discrimination and exclusion as well as the lack of participation in decision-making. Economic growth must be inclusive to provide sustainable jobs and promote equality [29,38,42]. Poverty alleviation strategies and sustainable development plans especially in rural communities, is a major challenge for many governments worldwide [13,39]. Some of these, include the sustainable management of forest resources and non-timber forest products (NTFPs). As rural populations continue to rise, the demand for forest products and income-generation requirements from forest dependent people also rise. Many countries are turning to non-timber forest products as a potential source of income to support rural livelihoods [6,44].

Bamboo in particular, has become a popular non-timber forest product as it is used by rural communities in the developing world for food, building materials, cash income, furniture, and crafts [35]. Forest resources are experiencing increasing pressure due to the growing world population and improving living standards. Bamboo is the most important non-wood forest product and in India it is known as the 'poor man's timber' while in China, it is the valuable raw material for the booming bamboo industry [6].

During the last 15–20 years, bamboo has developed as an exceptionally valuable and often superior substitute for wood. Bamboo-based panels and boards are hard and durable and may successfully substitute for hardwood products [22]. It is almost replacing wood in many industrial applications and thereby saving and restoring the world's forests. It is also a major construction material in many countries, particularly in rural areas as it can be used for almost all parts of houses, including posts, roofs, walls, floors, beams, trusses and fences. People also use bamboo to produce mats, baskets, tools, handles, hats, traditional toys, musical instruments and furniture as well as in the food sector, where bamboo shoots are a delicacy Table 1 [6].

Table 1. Top 10 Exporters of Bamboo Globally, 2009. (Source: Millennium Cities Initiative (MCI), [22])

Country	Volume of Global Exports (%)
China	57.3
Indonesia	14.8
Vietnam	4.6
EU-27	3.0
USA	1.7
Philippines	1.6
Thailand	1.0
Singapore	1.0
Myanmar	0.8
Malaysia	0.8

Bamboo has a tremendous potential for economic and environmental development and international trade. This is due to the fact that, bamboo grows much faster than timber, requiring less intensive management and expertise. Thus bamboo offers significant advantages to low-income rural communities with little access to investment capital

or technology. Its potential to raise living standards is being recognized, with several countries working to find ways to utilize bamboo resources for sustainable development. This would probably add greatly to the rural agricultural economy in general and act as poverty alleviator for the rural poor in particular through the processing and sale of bamboo goods [6,35].

In this study, we carry-out a literature survey to assess how the utilization of forest resources such as bamboo, could help improve on the livelihoods of rural communities. Our general assumption is that, should governments adopt and promote the sustainable utilization of bamboo forest resources, this will in turn influence effective utilization, adequate management and proper marketing strategies.

The paper has been divided into three sections with the first looking at the biophysical and ecological description of bamboo. In this section, we discuss the global distribution and ecological properties while relating this to its economic potentials. In the second section, we explore the probable importance of bamboo as a non-timber forest product (NTFP) with important economic and development potentials. In the third section, we highlight the implications of bamboo to the rural agricultural economy in general and rural poverty alleviation in particular. We then conclude that, the involvement of rural communities in bamboo cultivation, management and marketing, could help improve on their livelihoods hence poverty alleviation.

2. Biophysical and Ecological Description of Bamboo Resources Utilization

Bamboo belongs to the *Gramineae* family which includes about 90 genera, over 1200 species and which possess a unique rhizome-dependent system [6,20,33]. These are found in diverse climatic zones occurring across Africa, Asia, Australia, India and the Americas [23]. Bamboo forests, cover an estimated area of 37 million hectares (ha), equivalent to almost 4% of the world's total forest coverage [7]. Some species are also known to grow successfully in mild temperate zones in Europe and North America [6,17].

China has the largest bamboo resources in the world, about 500 species where bamboo culms and shoots are the two mostly used parts [18,31]. While culms have special properties and are used in handicrafts, furniture, pulp and paper, shoots are a traditional edible vegetable and delicacy [28,31]. China's bamboo forests are found mostly in the south spread over some 4.84 million ha. Of these, about 3.19 million ha are natural bamboo forests while bamboo plantations cover an area of about 1.65 million ha [31].

In India, natural bamboo forests are estimated to be 10.03 million ha and about two thirds of the total bamboo area is located in northeast India [17,18]. Thirty-five percent of the total bamboo removed is used for making pulp, while housing and rural uses account for 20% each [2,30]. In the Philippines, bamboo is estimated to range between 39200-52700 ha with 20500-34000 ha located in forest lands, 2236 ha on government plantations, 3037 ha in private plantations and 13434 ha forming natural stands in private lands (natural bamboo stands growing sporadically or in patches in backyards and riverbanks within private lands) [24,44]. Bamboo in the Philippines,

is used mainly by rural households for fencing, simple furniture, agriculture and simple household tools [24].

Africa has about 43 species of bamboo covering about 1.5 million hectares [22,44]. Forty of these species are primarily distributed in Madagascar while the remaining three species are found in mainland Africa. Ethiopia has over one million hectares of highland and lowland bamboo resources. The coverage of lowland bamboo is estimated to be 1000000 ha, while highland bamboo coverage is estimated to be 300000 ha [19,37]. This implies about 86% of the African bamboo resource is found in Ethiopia where it serves as a subsistence material for rural communities. Rural people are largely dependent on raw bamboo for construction, fencing, household furniture, household utensils like cups, local pipes, and vessels for carrying and storing, and as a source of domestic energy [22,44]. According to a survey conducted by Kelbessa et al., [19], an increasing number of households are realizing the economic potential of bamboo cultivation and these households have started to cultivate bamboo around their homesteads. Cultivation is primarily for domestic use by the operator and as a source of supplementary cash income since there only exists a very limited local market for bamboo handicrafts, which is not further developed or organized [19,37].

3. Economic Potentials of Bamboo

The importance of bamboo as an NTFP with important economic and development potentials, is globally accepted [6,34]. It plays a major role in the development of many countries with over 2.5 billion people globally depending on it for survival and livelihood [16]. In 2012, the domestic market for bamboo and rattan products in major producing countries was estimated at US\$ 34.2 billion, with an additional US\$ 2.5 billion of international trade in bamboo and rattan products [18].

Global export of bamboo and rattan products reached its record high of US\$ 2,557 million in 2008 but slumped sharply by about 25% in 2009 due to the financial crisis. In 2012, the world export of bamboo and rattan commodities was about US\$ 1,881 million, of which 29% was industrialized bamboo products and 25% was bamboo woven products [16,18].

Most bamboo and rattan products are exported to the world from within Asia, accounting for 84% of the world exports in 2012 and Europe, Asia and North America collectively made up 93% of world imports. In 2012, China contributed about 66% of bamboo and rattan of the international market, followed by the EU with a market share of 11% and Indonesia, 9%. The EU, the USA and Japan are the top three importers of bamboo and rattan products in the world and in 2012 they collectively accounted for 72% of the world total imports. Other significant importers of bamboo and rattan products were Canada, Singapore, Australia, Russia and Korea [18,22]. In 2012, the export value of bamboo and rattan products from INBAR members to the world reached US\$ 1,562 million, accounting for 83% of the world total, while the import valued at US\$ 145 million, which accounted for 9% of world imports. In 2012, the export value of bamboo and rattan products from Asia reached US\$ 1,597 million, accounting for 85% of global export value. It was followed by Europe, with an export value of US\$ 216 million, about 14% of Asia's total, or 12% of global exports [18,36].

According to China's State Forestry Administration bamboo development plan (2013-2020), the total value of bamboo forests' output is expected to reach \$32 billion by the end of 2015, up 66.5% from 2011 and \$48 billion by 2020 (a huge increase from US\$ 34 million in 2003). Some 10 million people are estimated to be directly involved in bamboo industries, and rural households' incomes in bamboo industries will be \$330 per person or 20% of net rural income in the country's bamboo resource areas [18,36].

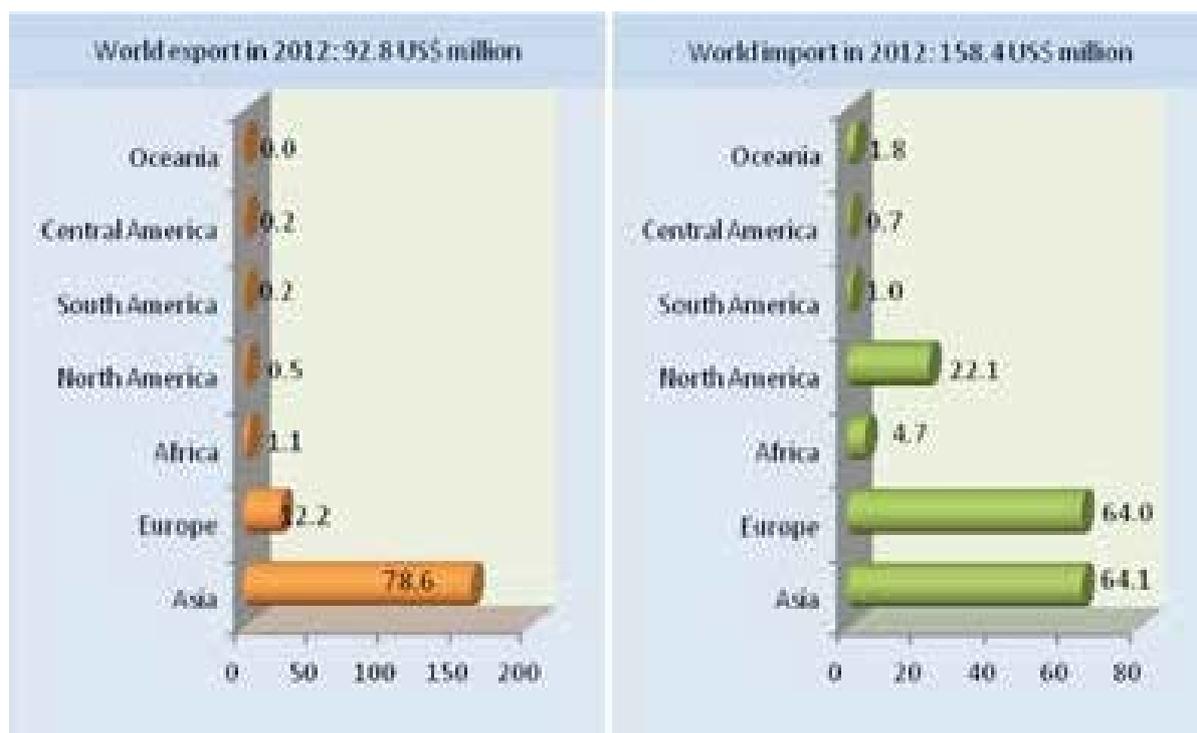


Figure 2. Trade of bamboo raw materials in 2012 (US\$ million) (Source: International Network for Bamboo and Rattan, 2015)

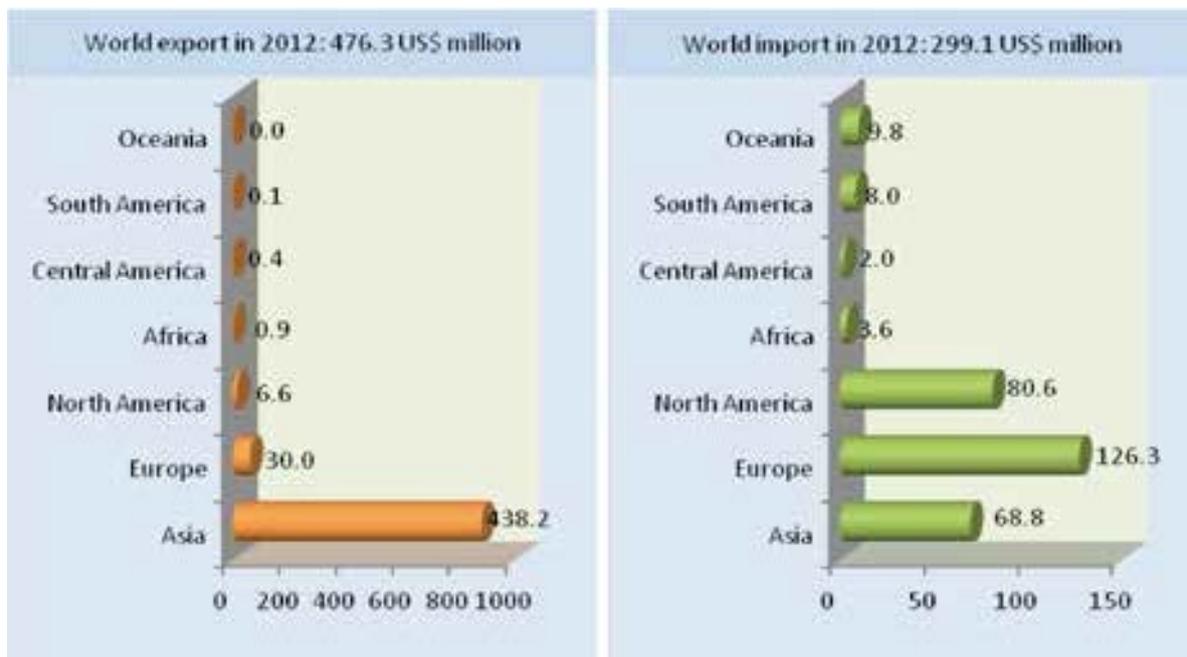


Figure 3. Trade of bamboo woven products in regions in 2012 (US\$ million) (Source: International Network for Bamboo and Rattan, 2015)

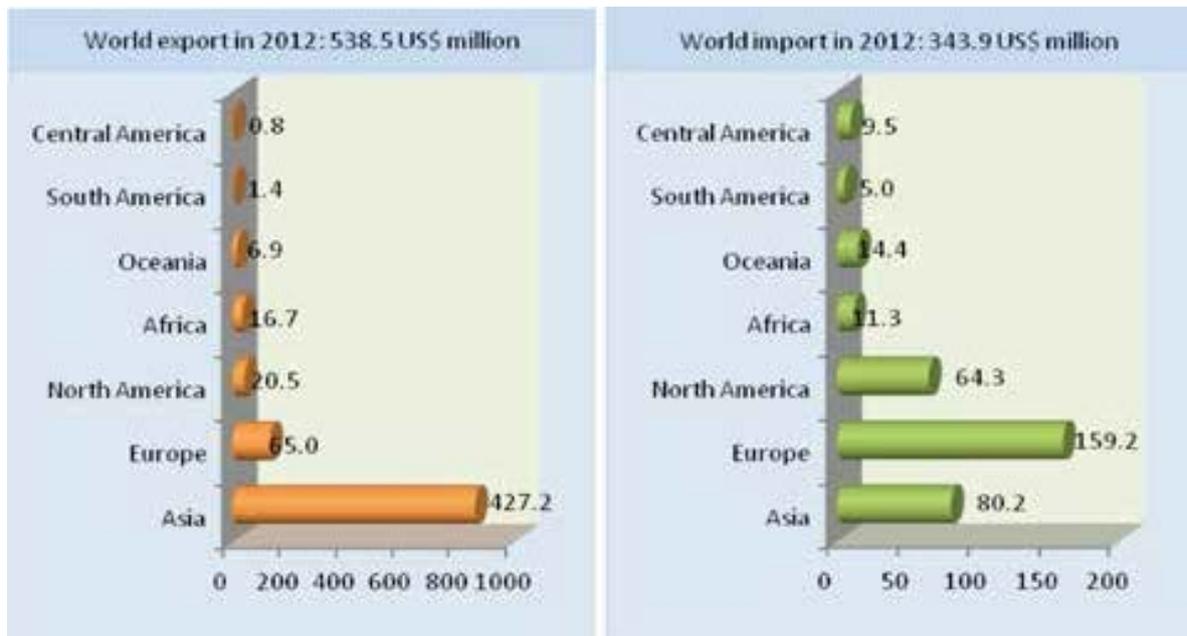


Figure 4. Trade of industrialized bamboo products in regions in 2012 (US\$ million) (Source: International Network for Bamboo and Rattan, 2015)

With a restructuring of the bamboo processing industry in many countries around the world, its importance as an NTFP with economic and development potentials, is getting global attention [14,32,34]. For instance in Tanzania, bamboo has improved the lives of several thousand people and is also being used by these communities to reverse land degradation [11,17]. Over 100 bamboo nurseries have been created during which about 1000 individuals have received training in a specially-created Bamboo Training Center that also saw micro-enterprises being set up. These activities have created new income streams in several rural areas, where communities produce crafts and desks for local schools. Charcoal briquette production and selling that generate income and slow deforestation employs over 5000 women, many of them single mothers, who now have stable incomes [17,18]. In Ecuador, bamboo grants have sparked

a number of public-private partnerships that make furniture, flooring, crafts and construction products [12,17,18]. These models have now also been shared with neighboring regions in Northern Peru, with some 2000 people now employed. These value chains and enterprises, produce affordable and earthquake and flood resistant housing which reduces risks to climate change and transforms coastal and peri-urban areas with better quality homes for low-income communities [12,17].

Similarly, a Philippines government's presidential decree Executive Order 879, has specified the establishment of a Philippine Bamboo Industry Development Council to support the sector's growth. This Executive Order 879 requires that, 25% of school desks are made from laminated bamboo. This large institutional market is already having an effect on demand, and the government plans to reforest 50000 ha with more bamboo by 2020 to

help meet demand. The current supply is at 40million while demand stands at 60million poles per year [18].

The Jamaican Ministry of Industry, Investment and Commerce (MIIC) is leading the initiative to kick-start the bamboo sector where it is seen as the key to bringing income to poor communities. Alongside the national trade development strategy, Jamaica has put in place new supply chains for bamboo charcoal that range from growing, transforming, packaging and exporting to nearby US markets. Similarly, the Rwandan government has developed a bamboo road map and has begun growing bamboo on a commercial basis [3]. Additionally, in the United States, several companies are growing, harvesting and distributing bamboo species such as *Phyllostachys nigra* and *Phyllostachys edulis*.

In Ghana's Ashanti region, three organizations most especially the Bamboo Bikes Limited (BBL), use bamboo for the production of bicycles [22]. Bamboo Bikes Limited (BBL) based in Kumasi, was profiled in September 2008 and incorporated in 2009, with actual production beginning in January 2011 [22]. In Laos, the bamboo processing factory in Vientiane, occupies the third position in the employment sector with a turn-over of about 18400tons of bamboo per year [14,40]. This gives an estimated annual production for the internal market net worth more than US\$ 7 million with annual bamboo production reaching some 50000 tons in 2008 [7].

4. Bamboo Resources Utilization

The wide range of uses and great versatility qualifies bamboo to be a multiple-use alternative to timber [4]. This would probably add greatly to the rural agricultural economy in general and act as poverty alleviator for the rural poor in particular [14,38,43]. Through the processing of bamboo goods and products and incorporating many other economic uses, bamboos can boost the economy of the country and facilitate the sustainable development of many rural communities [35].

Bamboo is varied and adaptable with a wide range of anatomical, structural and chemical properties. It can substitute technologically and commercially not only wood, but also plastics, steel and cement and composite materials in structural and product applications. This is through improvements in processing technologies, product innovation and the application of scientific and engineering skills. The expectation is that, bamboo can be an important vehicle for sustainable and widespread development, augmenting economic opportunity, income and employment, in particular in relatively underdeveloped areas of the globe. Bamboo is also an eco-friendly alternative which is a material that lends itself easily to simple processing technologies [18,26]. For instance, if further enhanced through the application of modern engineering techniques, it can be processed into modern products (engineered bamboo). These products may successfully compete with wood products in price and performance. Use of bamboo in composite panels and boards overcomes differences in quality related to the culms and allows the production of homogeneous products. Engineered bamboo may well replace wood, steel and concrete in many uses [6,22].

Though the agricultural sector still remains the largest consumer of bamboo products, from sowing to stocking of

grains, bamboo articles still have wide usage. Bamboo is used as a primary building material in housing construction for three main types of bamboo housing: traditional houses, which use bamboo culms as a primary building material, traditional bahareque bamboo houses, in which a bamboo frame is plastered with cement or clay and modern prefabricated houses made of bamboo laminated boards, veneers and panels [6]. It is estimated that globally, over one billion people live in traditional bamboo houses especially in South East Asia [6]. These buildings are usually cheaper than wooden houses, light, strong and earthquake resistant, unlike brick or cement constructions. New types of prefabricated houses made of engineered bamboo have certain advantages. For example, they can be packed flat and transported long distances at a reasonable cost. They are better designed and environmentally friendly and bamboo materials are widely available and can be cultivated at a low cost [6,16].

In most countries, bamboo can also be found in urban homes as pieces of decoration, furniture or handicrafts and is an essential feature in any celebration that requires a structure, be it marriage or religious festivities [26,35]. In rural households of Myanmar and Laos, is also used in construction of fences and as a source food [35]. Bamboo shoots are succulent and nutritious with a 100 g portion containing 0.5 to 0.77 g fibre, 81 to 96 mg calcium, 0.5 to 1.7 mg iron, 3.2 to 5.7 mg vitamin C, 0.07 to 0.14 mg vitamin B1, 1.3 to 2.3 g protein, 4.2 to 6.1 g carbohydrates, 42 to 59 mg phosphorus and 1.8 to 4.1 g glucose. Some species also have significant amounts of potassium and vitamin A. Bamboo shoots may contain up to 17 amino acids, including in particular saccharopine, speramic acid and glutamic acid [6].

Bamboo also has the potentials to serve as renewable energy source (bio-fuel) which can be exploited if bamboo is sustainably harvested and marketed. The processing of charcoal from bamboo, could make handling and transporting efficient enough to make it an economically interesting small scale industrial activity. Moreso, as a CO₂ neutral source of energy, it can replace fossil fuels. With adequate management or harvesting of the fast growing bamboo and the subsequent replacement with higher value trees, this will sustainably increase the forest value in both monetary terms and with respect to biodiversity [25]. Bamboo charcoal can replace the traditional charcoal made from trees, thus decreasing deforestation. In 2009, Nigeria exported bamboo charcoal valued at about US\$7 million making it the top exporter globally [22]. Also, in Ghana, the International Network for Bamboo and Rattan (INBAR), the Forestry Research Institute of Ghana (FORIG) and Bamboo and Rattan Development Programme (BARADEP) have piloted a programme in Tandan in Ellembele District and Daboase in the Western region to produce bamboo charcoal. The programme works with the Micro Small Enterprise Association at Daboase. As of November 2011, 505 tons of bamboo charcoal had been produced from the programme [22]. Additionally, through pyrolysis, bamboo can be converted into bamboo oil and gas. Changing the pyrolysis parameters can change the product shares depending on the purpose and market conditions. The extracts contain valuable elements used in pharmaceutical products such as creams, beverages and bamboo gas can be used as a substitute for petroleum. Activated charcoal is

used as a deodorant, purifier, disinfectant, medicine, agricultural chemical and absorbent of pollution and excessive moisture [6,7].

Several bamboo-producing countries, such as China and India, use bamboo in pulp, paper and more recently cloth. Bamboo paper has practically the same quality as paper made from wood. Its brightness and optical properties remain stable, while those of paper made from wood may deteriorate over time. The morphological characteristics of bamboo fibres yield paper with a high tear index, similar to that of hardwood paper. The tensile stiffness is somewhat lower compared with softwood paper while the strain strength is between that of hardwood and softwood papers. The quality of bamboo paper may be improved by refining the pulp [6]. Bamboo flooring is a quality product that can be used widely and has a large, global consumer market. It has certain advantages over wooden floors due to its smoothness, brightness, stability, high resistance, insulation qualities and flexibility. Bamboo flooring has a soft natural luster and maintains the natural gloss and elegance of bamboo fibre. This flooring is attractive to the demanding markets in Europe, Japan and North America. The estimated annual production of bamboo flooring in China was 17.5 million m² in 2004 with exports accounting for some 65 percent of total production [5].

Due to their ubiquitous nature, bamboo filled areas, witness an increase in plant and animal diversity coupled with an extensive subterranean system of rhizomes and roots. For example, the rhizomes of *Phyllostachys bambusoides* are reported to travel about 3.6 m per year while other species may generate a rhizome network that spans up to 1000 m². This network, typically binds some 6 m³ of soil especially on riverbanks and hill slopes against soil erosion. The spreading foliage of bamboo helps reduce the destructive onslaught of tropical rains on topsoil. Its leaf litter that can reach a thickness of about 10

cm per year also helps absorb the impact of rain on the ground and facilitate absorption and soil moisture retention [6].

Bamboo protects exposed areas and provides the microclimates for growth and regeneration of biodiversity. Most bamboo-dependent birds and mammals are endemic to the Atlantic Forest of eastern Brazil. At least 27 species of birds are considered to be associated with bamboo in the Atlantic Forest with some species living almost entirely in large bamboo stands. Many may migrate to other ecosystems, but depend on bamboo for feeding and breeding. Most of the bird species such as *Bambusicola thoracicus*, *Claravis godefrida* and *Sporophila frontalis* feed on bamboo nodes, internodes and the insects on foliage. Some species feed extensively on bamboo seeds and do not reside in bamboo forests during non-seeding periods [1,9,21]. The best-known animals dependent on bamboo are the giant panda (*Ailuropoda melanoleuca*) and red panda (*Ailurus fulgens*) with a diet that almost exclusively consists of bamboo shoots and leaves. Several other mammals and birds live in symbiotic relationships with bamboo forests e.g. the southern bamboo rat (*Kannabateomys amblyonyx*) which lives in groves of *Guadua angustifolia* and some introduced bamboo species [6,9,34]. Bamboo just as rattan, can rapidly restore degraded lands, bring back life to the soil and restore the landscape, it is thus a pioneer species for long term reforestation. By restoring degraded lands and forests, soaking up carbon and supplying energy to millions of rural communities, bamboo contributes to major reductions in carbon emissions. In China alone, the plant is projected to store more than one million tons of carbon by 2050 [16]. Bamboo is thus beneficial to biodiversity, soil and water conservation as well as climate change mitigation [34]. An overview of bamboo products, is presented in Table 2.

Table 2. Overview of bamboo products

Number	Shoots	Culms
1	Medicines	Building material
2	Food	Pegs for plantation development
3	Cosmetics	Fencing posts
4		Pots for seedlings
5		Benches in farm houses and schools
6		Window blinds, tables, chairs, desks
7		Pulp for paper, mats, fans, caps, pens and pencils
8		Ornamentals
9		Walling in riverine houses
10		Fuel e.g. charcoal, gas
11		Environmental protection
12		Stakes for food crops e.g. yams, huckleberry
13		Flooring, arts, craft and household decoration
14		Frames and scaffolding in building industry

Table 3. Major areas of application of bamboo products

Income Generation	Agriculture	Household
Medicines	Pots for seedlings	Medicines
Source of food	Fencing posts	Source of food
Cosmetics	Pegs for plantation development	Cosmetics
Pegs for plantation development	Stakes for food	Fencing posts
Ornamentals	containers, planks, baskets	Window blinds, tables, chairs, desks
Window blinds, tables, chairs, desks	Winnowers and plows	Fuel e.g. charcoal, gas
Fuel e.g. charcoal, gas	stocking of grains	Flooring, arts, craft and household decoration
Flooring, arts, craft and household decoration	sowing of grains	Frames and scaffolding in building industry
Building material		Building material
Winnowers and plows		Winnowers and plows
baskets, containers, planks		

Bamboo production is increasing in importance as an income generating alternative for villagers and many local governments have drafted bamboo development programmes. For example, the government of Huaphan Province in Laos, has developed a Provincial Bamboo Sector Development Strategy 2011-2015 [36]. This has helped local stakeholders (government, villagers and private sector) to develop four promising bamboo value chains, based on sustainable use of natural forests mainly. The four bamboo value chains are: fresh shoots for domestic market, dried shoots for Vietnamese market, handicraft for domestic, tourism, Thai market, Chinese markets as well as European and American market middlemen, slats and sticks for Vietnamese market. In 2014, a total income of 370000 US\$, was generated and received by 2300 households in 60 villages (160US\$ per household, a significant complementary cash income). Based on lessons learned and achievements so far (in terms of forest management, producer organization, business model), the Huaphan provincial government is currently defining a Provincial Bamboo Strategy for 2016-2020 [36].

In a related study, Viloune and Sounthone [41] found that, before their study on economics of sustainable bamboo in Nam Pheng Village of northern Laos, 36 out of 42 families were short of rice for 4-6 months of the year. Two years into the project, rice shortage occurred in only 12 out of the 42 families and lasted for only 1-2 months prior to bamboo harvesting. Although the income gains from this activity are second to income from other activities, it provides cash that helps cover daily expenses of a household to reduce poverty [18].

5. Conclusion

The involvement of rural communities in bamboo cultivation, management and marketing, generates rather good income for them. Bamboo processing as an income generating or business activity is largely un-developed and it is primarily based around handicraft and other household processing, especially in the rural areas. Therefore, as many countries should continue to develop administrative strategies in order to guide an enabling business climate benefiting from the local and global bamboo market demand. Also, apart from the dependence on natural bamboo resources, considerable household planting for local use and marketing would go a long way to improve rural livelihoods.

Though the current understanding of the bamboo value chain is still limited and certain gaps of information still exist in many countries, a wider involvement of stakeholders, governments and rural communities would help bridge these knowledge gaps.

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