



The Inter-Africa Bamboo Smallholder Farmer's Livelihood Development Programme (Cameroon, Ghana, Madagascar, and Ethiopia)

**A Training Manual on
participatory Bamboo
Resource Stewardship for
Communities in Cameroon**



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PREFACE

Bamboo grows almost everywhere, even on soils with low fertility in tropical, subtropical and mid-temperate zones. Bamboo is a multipurpose plant which is currently used in our day to day life. It plays both direct and indirect roles in the livelihood of people around us. Bamboo influences livelihood directly via its socio-economic potential and indirectly through the role it plays in environmental protection. Bamboo has a great socio-economic impact on the sustainable development of many countries. Nowadays in Africa and particularly in Cameroon, experiences in bamboo products are still limited to bamboo furniture from handicraft even though the last 20 years has been a turning point in bamboo industrialized products. Indeed bamboo is now seen as a timber substitute. Its rapid growth rate and capacity for sustainable harvesting increases the demand for its products. Recent developments have created new employment opportunities in the bamboo handicraft sector (Bamboo farmers, bamboo collectors, bamboo culm sellers, bamboo culm transporters, bamboo processors, bamboo product sellers).

Bamboo has enormous potentials for socio-economic development; this gives place to the development of an international bamboo trade and market. It is exported worldwide as raw material, semi-finished and finished product. The bamboo sector can bring extra revenue to African countries via the development of some industries for bamboo processing into a variety of industrialized products. Bamboo is also used in the pharmaceutical domain for the production of drugs and cosmetic products. Its shoots are equally used in Asia as a vegetable (food). Bamboo positively impacts the environment. It can replace wood and as such reduces pressure on the demand for timber, thereby encouraging forest protection. Moreover, bamboo contributes to soil protection and has a great capacity to sequester carbon through its canopy and litter, hence reducing soil evaporation and erosion, limiting landslides and contributing to the restoration of soil fertility. Bamboo also purifies water and provides a source of energy. It can be used to produce both wood fuel and charcoal for cooking and heating.

I. INTRODUCTION

The demand for natural resources in Cameroon grows daily but the supply endangers resource sustainability. This is especially when the livelihoods of millions of the local population depend on these resources for medicine, energy, and other socio-economic and cultural aspects. Non-Timber Forest Products (NTFPs) have long been an important component of the livelihood of forest-dwelling people by providing shelter, food, and income. At the household level, forests directly provide about 8 million rural and poor Cameroonians with traditional medicines, food, domestic energy and construction materials¹. Bamboo has long been regarded as one of the neglected Non-Timber Forest Products (NTFPs) in Central Africa², despite its taxonomy, its rapid growth rate, and its vital economic and ecological importance to humans. Bamboo is renewable and can be harvested³, as some species grow a meter per day and attain maturity within five years⁴. Stewardship can be defined as the sustainable management and use of natural resources by communities to enable future generations need.

In order to promote participatory bamboo resource stewardship at the community

level, we need to raise awareness on bamboo by introducing the plant to the local communities (**Module I: Introduction to Bamboo**), explain and demonstrate the importance of bamboo resources to these communities (**Module II: Importance of Bamboo Resources for the Community**) and provide these communities with guidelines on bamboo resource conservation (**Module III: Guidance on the Management and Sustainable Harvesting of Bamboo Resources**).

Module I is designed to provide information on the taxonomy and growth of bamboo in the world in general and more specifically in Cameroon. Module II will illustrate the socio-economic and environmental benefits of bamboo. Module III answers the following questions: who are Bamboo smallholder farmers? Why should Bamboo smallholder farmers care about Bamboo? What are the purposes of participatory Bamboo resource stewardship? Why should we practice bamboo sustainable management and harvesting techniques? This manual can be used as reference material for trainers, trainees, and bamboo smallholder farmers while learning or working with bamboo.

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1. Topa, G., Karsenty, A., Megavand, C. and Debroux, L. 2009 *The rainforests of Cameroon: experience and evidence from a decade of reform*. In: *Directions in development. Environment and sustainable development*. World Bank, Washington, DC.
 2. Tabot Tabot, Ebenezer 2006. *Strengthening forward and backward linkages in the Rattan and Bamboo sectors in Africa: the case of South West Region of Cameroon*. Paper presented at ITTO/ICBR/INBAR International Workshop on Sustainable Development of Global Rattan Sector, 1st Bamboo and Rattan Standardization Training Workshop, 23–27 July, Beijing, China.
 3. Wu, F. Z., Yang, W. Q., K. Y. Wang, N. Wu and Y. J. Lu. 2009. "Effect of stem density on leaf nutrient dynamics and nutrient use efficiency of dwarf bamboo." *Pedosphere* 19: 496–504.
 4. Benton, L. T., O. Cronin, J. Frith, Jonkhart and W. Junqi. 2011. *Market Potential of Bamboo and Rattan Products*. International Network for Bamboo and Rattan Working Paper 63. International Network for Bamboo and Rattan, Beijing, China

1. Main objective of the training manual

The aim of this training manual is to raise awareness of bamboo smallholder farmers on sustainable participatory conservation and management strategies of bamboo resources in the bamboo rich regions of Cameroon.

2. Specific objectives of the training

1. To inform bamboo smallholder farmers of the taxonomy, growth and ecological distribution of bamboo species in Cameroon.
2. To build the capacity of bamboo smallholder farmers on the importance of bamboo resource stewardship.
3. To engage bamboo smallholder farmers on bamboo sustainable management and harvesting techniques.

3. Expected Outcome

1. Bamboo smallholder farmers are informed of different bamboo plant species and know the different bamboo rich regions in Cameroun.
2. The capacities of bamboo smallholder farmers are developed to promote participatory bamboo resource stewardship.
3. Bamboo smallholder farmers use sustainable management tools and harvesting techniques on bamboo resources in Cameroun.

4. Target groups

This training manual targets smallholder farmers (Men, Women and Youths) from bamboo rich regions of Cameroon to serve as a source of inspiration in their communities during and after the implementation of the project in order to contribute to environmental protection through the use of bamboo.



II. METHODOLOGY

The methodology used will be participatory and will involve the participants taking full responsibility. Depending on the different modules, interactive presentations will be given. Participants will work either individually or in groups by answering oral/written questions in workshops designed from their real-life experiences, specially oriented to their knowledge on bamboo and their contributions to the fight for bamboo sustainable management. Many activities will be based on participants' experiences using questionnaires and discussions. In some cases, there will be collective reflections (brainstorming session) and comments on possible case studies. In addition to these, a practical phase will enable participants to learn how to harvest bamboo culms and how to sustainably manage bamboo farms.

1. Tools needed

Didactic support: printed documents (ToR, training manual, PowerPoint presentation).

Tools: Flip chart, post it, markers, conference paper, digital camera, video projector, laptop, Dictaphone and saw.

2. Content of the training manual

This training manual is focused on three (3) modules organized as follow

1. Module I: Introduction to Bamboo.

- WThe bamboo plant,

- Bamboo species,
- Botanic description of bamboo species mostly found in Cameroun,
- Geographical and ecological distribution of bamboo species in Cameroon,
- Bamboo reproduction methods.

2. Module II: Importance of Bamboo Resources for the Community.

- Bamboo self-employment opportunities,
- Bamboo exportation opportunities,
- Bamboo processing opportunities,
- Bamboo agriculture opportunities,
- Bamboo pharmaceutical opportunities,
- Bamboo nutrition opportunities,
- Bamboo and carbon storage,
- Bamboo impact on soil restoration and stabilization,
- Bamboo as a source of energy (bioenergy),
- Bamboo and biodiversity conservation.

3. Module III: Guidance for Management and Sustainable Harvest of Bamboo Resources.

- Bamboo smallholder farmers,
- Reasons why Bamboo smallholder farmers should practice participatory

Bamboo resource stewardship,

- Bamboo culm selection to be harvested,
- Bamboo culm harvesting,
- Bamboo culm storage.

3. Evaluation of the training

At the end of the training, evaluation forms will be distributed to participants. This

evaluation will be focused on the training organization (strengths and weaknesses), the logistics, the working conditions, the relevance of different modules, the interests of participants, the animation style and the suggestions of participants. These sheets will be analyzed and used to improve each module in order to better meet the expectations expressed.

III. MODULE I: INTRODUCTION TO BAMBOO

1. The bamboo plant

Bamboo is not a tree. It belongs to the grass family that is why all bamboo plants have similar biological features as grasses especially the nodes found on bamboo culms. Bamboo is actually a giant grass belonging to the family Poaceae (Gramineae) and from the tribe Bambuseae of the subfamily Bambusoideae⁵. Bamboo is recorded to be the fastest-growing land plant on the earth since culms of some species of four years can reach 40 m in height and 30 cm in diameter⁶. Furthermore,

bamboo has an extremely wide range distribution with a great variety of habitats. In addition, bamboo is an adaptable plant, some species being deciduous, others are evergreen, and especially, some species seem to be able to change their habit when necessary⁷.

2. Bamboo species

It is estimated that about 1600 bamboo species⁸ globally, consisting of 75-107 genera worldwide. The following 20 bamboo species are recorded as the best bamboo

5. Zhu, S., Ma, N., Fu, M. 1994. *Compendium of Chinese Bamboo: 8-9*. China forestry publishing house, Beijing.

6. Rao, A.N., Rao, R.V., Williams, J.T., (Eds.). 1998. *Priority Species of Bamboo and Rattan*. IPGRI/INBAR.

7. McNeely, J.A. 1995. *Bamboo, Biodiversity and Conservation in Asia*. In: Rao V.R., Ramanuja Rao I.V. (Eds.), *Bamboo, People & The Environment. Proceedings of the 5th International Bamboo Workshop and the 4th International Bamboo Congress, Ubud, Bali, Indonesia 19-22 June 1995. Vol. 2: Biodiversity and Genetic Conservation*. INBAR. *Weeds of Hawaii's Pastures and Natural Areas; an identification and management guide*. Manoa, Hawaii, USA: College of Tropical Agriculture and Human Resources, University of Hawaii.

8. INBAR 2019. *A manual for bamboo forest biomass and carbon stock assessment*

species in the world and have a high priority for large scale cultivation, depending on the objective and end use of the crop: *Bambusa textilis*, *Bambusa tulda*, *Cephalostachyum pergracile*, *Gigantochloa apus*, *Gigantochloa levis*, *Gigantochloa pseudoarundinacea*, *Guadua angustifolia*, *Melocanna baccifera*, *Ochlandra* sp, *Phyllostachys edulis*, *Thyrsostachys siamensis*⁹.

3. Botanic description of bamboo species mostly found in Cameroon

Bambusa vulgaris: This is a clumping bamboo species with erect culms measuring up to 18m in height and having a thick diameter of up to 7cm at the base. The nodes are prominent; the lower ones often with a ring of adventitious roots and the internodes measuring up to 45 cm in length, with about 38 internodes on a culm. The leaves and culms are bright green when young, bright yellow when mature and then turn to brown with age.



Bambusa vulgaris

Yushina alpine: This is a non-clump-forming bamboo species with erect culms measuring up to 15 meters in height, growing from a short rhizome. The culms are up to 5 cm in diameter, having internodes of up to 24 cm in length, with about 42 internodes on a culm. The leaves and culms are bright green when young, dark green when mature and then turn to brown with age.



Yushina alpine:

Phyllostachys aurea: This is a non-clump-forming bamboo species with erect culms measuring up to 12 meters in height, equally growing from a short rhizome. The culms are about 3 cm in diameter, having internodes of up to 18 cm in length, with about 35 internodes on a culm. The leaves and culms are bright green when young, dark green when mature and then turn to brown/ yellow with age.



Phyllostachys aurea

9. INBAR 2019. A manual for bamboo forest biomass and carbon stock assessment. Julia KAGAN/updated April 25, 2019, <https://www.investopedia.com/terms/n/networking.asp>

4. Geographical and ecological distribution of Bamboo species in Cameroon

The geographical distribution of bamboo species depends on climatic conditions. Bamboos need a warm climate for their growth, and thus, they are widely distributed in the tropical, subtropical and temperate regions of all continents except Antarctica and Europe¹⁰, precisely in three zones; the Asian Pacific zone, the American zone and the African zone¹¹. Cameroon can be divided into four geographical regions based on climate and topographic criteria, these are; the southern zone, the Congo-Guinean forest zone, the coastal zone and the northern zone¹². The mountainous Cameroon Highlands zone is found along the volcanic chain from Mt. Cameroon though the Northwest to Adamaoua and includes unique Afro-montane forests above 2000m, and rainfall between 1500 to 2600 mm varying with relief and altitude. The average temperature in the south is 25°C, 21°C on mountain ranges and plateau, and 32°C in the drier north¹³.

In Cameroon many bamboo species are exotic species and were introduced by the colonial masters: (Germany) for soil conservation and agriculture¹⁴. Cameroon has significant reserves of indigenous bamboo, and has excellent conditions for growing other exotic species. The plant

provides a practical and rapid solution for numerous natural resource problems and poverty challenges faced by many African countries. We have both indigenous and exotic bamboo species making a total of more than eight species in Cameroon. Three bamboo species indigenous to Africa and found in Cameroon are; *Yushania alpina*, *Oxytenanthera abyssinica* and *Puelia atractocarpa*, and the dominant species used across the country are exotic species. The most common is *Bambusa vulgaris* locally known as “Chinese,” “Indian,” or “large green” bamboo¹⁵. The results of the bamboo inventory made by the Cameroonians’ Forest and Wildlife Ministry in three regions of Cameroon (South, Littoral and Centre) brought out almost the same results as those mentioned above with the exception of *Yushania alpina*. This is because this species grows mostly in mountainous areas as is the case in the Western high lands of Cameroon more precisely in the Menoua Division.

The results of the Cameroon national survey in the South, Littoral and Centre regions show that about 121 580 922 rhizomes can be found in these regions representing a total volume of about 2 453 856.581 m³ with Four main species; *Bambusa vulgaris*, *Bambusa vitata*, *Bambusa arundinaceae* and *Oxytenanthera abissinica*¹⁶. *Yushania alpina*, *Bambusa vulgaris* and *Phyllostachys aurea* are common in the West region.

10. Lobovikov, M., D. Schoene, and L. Yping. 2011. *Bamboo in climate change and rural livelihoods. Mitigation and Adaptation Strategies for Global Change* 17: 1–16.

11. Yigardu M, A. Asabeneh, T. Zebene. 2016. *Bamboo Species Introduced in Ethiopia Biological, Ecological and Management aspects. Ethiopian Environment and Forest Research Institute. ISBN: 978-99944-950-2-3.*

12. Letouzey, R. 1985. *Carte Phyogeographique du Cameroun 1:500 000. I. d. I. R. Agronomique. Toulouse, France.*

13. Jonkers W.B.J. and Foahom B. 2009. *Sustainable management of rainforest in Cameroon. The Tropenbos-Cameroon Programme, Kribi. TropenbosCameroon Series 9.*

14. Ingram V. and J. C. Tieguhong, 2013. “Bars to jars: Bamboo value chains in Cameroon,” *Ambio*, vol. 42, no. 3, pp. 320–333

15. Ingram V. J. C., E. M. Tieguhong, J. P. Nkamgnia, and M. Ngawe. 2010. “The bamboo production to consumption system in Cameroon,” *CIFOR Work. Pap. no. 50*, p. x-pp.

16. MINFOF. 2016. “Rapport D’Inventaire Du Bambou De Chine Dans Quatre Regions (Centre , Littoral , Sud Et Sud-Ouest) a Fort Potentiel Du.”

Yushania alpina is dominant in the West region of Cameroon. From Bertoua in the East to Ngounda land Meiganga in Adamaoua up to Garoua in the Northern

region we have Oxytenanthera abyssinica, Puelia atractocarpa and Microbambus macrostachys¹⁷. This information is illustrated below in table 1

Table 1: Ecological zones of bamboo species repartition in Cameroon

Scientific Name	Local /other Name	Status	Ecological Zone	Localisation in Cameroon
Bambusa vulgaris Bambusa vitata	China bamboo	Introduced	DENSE FOREST AND COSTAL ZONES	South West, Centre, South, East, Littoral. ¹⁸
Ochlandra travancorica		Introduced		Centre and South ¹⁹
Puelia atractocarpa		Local		South ²⁰
Oreobambos Buchwaldii	China Bamboo	Africa		
Yushania alpina Oxytenanthera	China Bamboo	Africa	HUMID SAVANNA	West, North West ²¹
Abyssinica		Local		
Phyllostachys aurea	China bamboo	Introduced		

5. Bamboo reproduction

Even though most bamboo resources grow naturally, great attention has been paid to domesticate bamboo given the opportunities it offers to the poor rural populations. However, not all farmers have knowledge of bamboo cultivation. Although there are few cultivation practices and trade (national and international) of bamboo in Africa in general and Cameroon in particular, many bamboo products are used domestically in this part of the world and can be very significant

in both household and local economies. Bamboo can be propagated using two reproductive methods, through seeds and by vegetative propagation methods. Seed propagation methods are rarely used because of the irregular flowering of most of the bamboos (can take up to about 100 years). Again, bamboo seeds have poor viability (between one and six months) and the non-availability of these seeds during the year makes propagation through seeds

17. Ingram V. and J. C. Tieguhong, 2013. "Bars to jars: Bamboo value chains in Cameroon," *Ambio*, vol. 42, no. 3, pp. 320–333

18. Clayton WD, Govaerts R, Harman KT, Williamson H, Vorontsova M. 2014. *World Checklist of Poaceae*. Richmond, UK: Royal Botanic Gardens, Kew.

19. Ingram V. J. C., E. M. Tieguhong, J. P. Nkamgnia, and M. Ngawe. 2010. "The bamboo production to consumption system in Cameroon," *CIFOR Work. Pap*, no. 50, p. x-pp.

20. Bystriakova, N. & V. Kapos. 2006. *Bamboo diversity: The need for a Red List review*. *Biodiversity* 6(4):12–16. [dx.doi.org/10.1080/14888386.2005.9712780](https://doi.org/10.1080/14888386.2005.9712780)

21. Ingram V. J. C., E. M. Tieguhong, J. P. Nkamgnia, and M. Ngawe. 2010. "The bamboo production to consumption system in Cameroon," *CIFOR Work. Pap*, no. 50, p. x-pp.

less popular. Vegetative methods are the use of vegetative parts of bamboo plants such as rhizomes, culms and branches.

Therefore, vegetative propagation is the most popular and effective of the methods.



Bamboo naturally propagated



Bamboo seeds²⁻²



vegetative propagation

Keyfacts

- Bamboo is not a tree; it belongs to the grass family.
- Bamboo is usually referred to as a giant grass.
- Bamboo is the fastest-growing land plant on the earth.
- Bamboo is an adaptable plant.
- Bamboo is estimated to have about 1250 species in the world.
- Among these 1250 bamboo species, 20 species are recorded as the best bamboo species in the world.
- Bamboo species mostly found in Cameroun are *Bambusa vulgaris*, *Yushina alpine* and *Phyllostachys aurea*.
- Bamboo geographical distribution depends on climatic conditions. In Cameroon, many bamboo species are exotic species and were introduced by the colonial masters: Germany, for soil conservation and agriculture.
- Cameroon has both indigenous and exotic bamboo, both estimated to be more than eight species.
- Three bamboo species indigenous to Africa and found in Cameroon are *Yushania alpina*, *Oxytenanthera abyssinica* and *Puelia atractocarpa*.
- The most common bamboo in Cameroon is *Bambusa vulgaris*.
- The results of the Cameroon national survey in the South, Littoral and Centre regions show that about 121 580 922 rhizomes can be found in these regions representing a total volume of about 2 453 856.581 m³ with four main species; *Bambusa vulgaris*, *Bambusa vitata*, *Bambusa arundinaceae* and *Oxytenanthera abissinica*.
- The ecological zones of bamboo species repartition in Cameroon are the dense forest and costal zones (South West, Centre, South, East, and Littoral.) and the humid savanna.
- Bamboo grows naturally but can be propagated using two reproductive methods (seed and vegetative propagation).

22. Image source: NHK World, <https://youtu.be/fmxW59spdss>

IV. MODULE II: IMPORTANCE OF BAMBOO RESOURCES FOR THE COMMUNITY

1. Bamboo self-employment opportunities

Bamboo has a great socio-economic impact on the sustainable development of many countries. These are some socio-economic opportunities which the country can optimize. Nowadays, people still have

the experience of bamboo products to be limited to bamboo furniture from handicraft, meanwhile the last 20 years was a turning point in bamboo commercial industrialized products. The following images illustrate bamboo craft work done in Cameroon and what has been done so far in other African countries like Ghana.

Bamboo craft products done in Cameroon



Bamboo chairs



Bamboo handle tool



Bamboo Bar



Bamboo house



Bamboo musical instruments



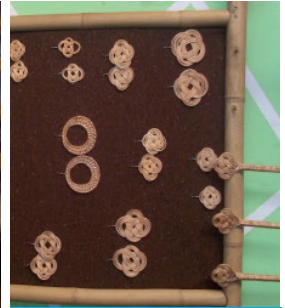
Bamboo flower stand



Bamboo bed



Bamboo cup



bamboo picture frame



bamboo use for house decoration



Bamboo semi-industrial products done in Ghana



Bamboo door



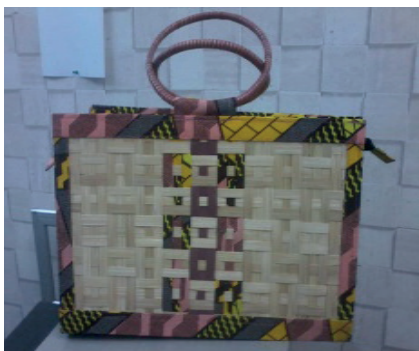
Bamboo charcoal



Bamboo toothpick



Bamboo executive desk



Bamboo bag



Bamboo wheel chair

Photo source: INBAR Ghana

In fact, bamboo is now seen as a timber substitute. Its rapid growth cycle and capacity for sustainable harvesting increases the demand for its products. This recent development creates new employment opportunities such as Handicrafts (Bamboo farmers, bamboo collectors, bamboo culm sellers, bamboo culm transporters, bamboo processors, bamboo product sellers) and can be the case for Industrial processing. According to Hans Friederich, Director General of INBAR (March 2018), “China’s bamboo industry is worth \$30 billion and employs almost ten million people” whereas in Vietnam at least 800,000 jobs at \$50 per job in the bamboo sector are created.

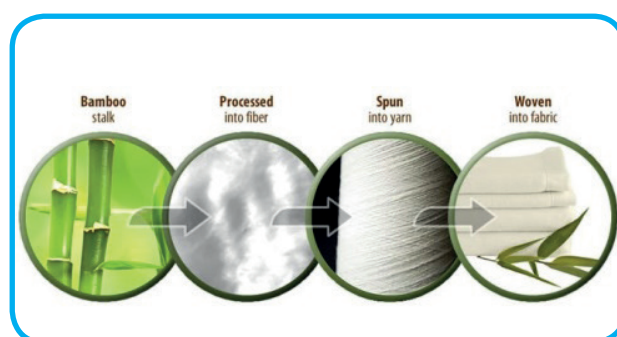
2. Bamboo exportation opportunities

Bamboo has enormous potential for socio-economic development; this gives place for the development of an international bamboo trade and market. Bamboo is exported worldwide as raw material, semi-finished and finished products. According to INBAR’s trade database, the annual export of bamboo in 2000 was valued at about US\$2.5 billion. China, Indonesia and Viet Nam were the major bamboo producers and exporters in Asia. The total value of exports of raw bamboo is about US\$89 million. China exported about US\$25 million worth of raw bamboo. This was followed by Indonesia (US\$10.6 million, 12%) and Viet Nam (US\$7.7 million, 8.6%). Some African countries such as Nigeria, Ghana, Ethiopia and Kenya are also involved in bamboo trading even though their statistics are less compared to that of Asian countries. This

is due to lack of knowledge on bamboo management and utilization as the main obstacles for the development of a well-organized trade in Africa.

3. Bamboo processing opportunities

The Bamboo sector can bring extra revenue to African countries like Cameroon via the development of some industries for processing bamboo into a variety of products. It is the case with bamboo bathing products, bamboo vinegar, bamboo



Bamboo textile production

plywood, bamboo scrimber, bamboo structural lumber, bamboo textiles (image 16²³), bamboo laminated furniture, building panels, bamboo charcoal, bamboo paper and pulp among others.

4. Bamboo agriculture opportunities

Bamboos grow well in high rainfall areas having mean annual rainfall ranging from 1, 250 to more than 5, 000mm. However, it also occurs in Dry Deciduous Forest of low rainfall areas (750 to 1, 000mm), they

23. Image source: fibre2fashion.com

24. Nath, V., R. S. Pal, and S. K. Banerjee. 2008. “Bamboo: Its Distribution, Production, Habitat and Agroforestry Potential.” *Indian Forester* 134(3):387–96. Retrieved (<http://www.indianforester.org>).

withstand varying temperatures starting from -5° to 46°C ²⁴. Bamboo grows almost everywhere, and even on soils having low fertility. This is due to bamboo's high biomass accumulation and abundant litter fall, which helps in maintaining and improving the soil's physical, chemical and biological properties²⁵. In terms of nutrient availability, the amount of nutrient inputs through leaf litter is in this order: N, Ca, K, Mg and P²⁶, therefore bamboo litter greatly influence soil fertility. Thus bamboo can be used as a bio fertilizer in farms. Again, bamboo is considered to be the most suitable species for the practice of agroforestry especially on degraded areas²⁷. Bamboo in an agricultural system will reduce soil erosion especially that caused by run-off to favour water infiltration and retaining soil minerals. Bamboo-based agroforestry systems in this context hold great promise in adding the supply of bamboo production in Cameroon without negatively affecting agricultural land.

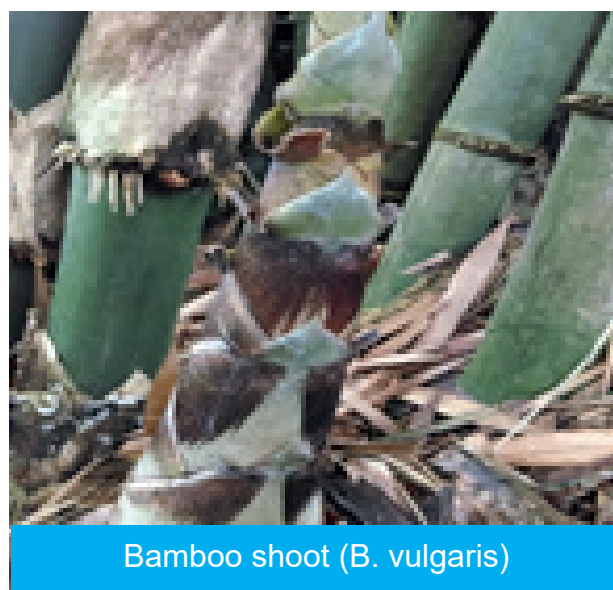
5. Bamboo pharmaceutical opportunities

Bamboo is also used in the pharmaceutical sector for the production of drugs and cosmetic products. Bamboo salt is used as Ingredient for Toothpaste, Soap, face mask pack, bakery, confectionery, vagina detergent, meanwhile Bamboo leaves are used to resolve phlegm, epilepsy, lung

inflammations, mucus in children, fever, cerebral infections, stomach heat and finely milled bamboo powder is used as an exfoliant²⁸.

6. Bamboo nutrition opportunities

Bamboo shoots are used in Asia as a vegetable. Bamboo shoots are low in fat content but contain considerable amounts of carbohydrate, potassium and dietary fibers²⁹. Their shoots generally contain tyrosine, arginine, histidine, and leucine as amino acids. The presence of high fibre and phytosterols in bamboo shoot reduces fat and cholesterol levels of blood making them one of the most sought after health foods among patients with lifestyle-related disorders³⁰. With 17 different types of amino



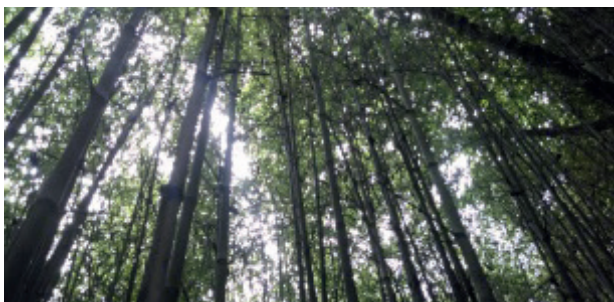
Bamboo shoot (*B. vulgaris*)

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25. Tewari, S. et al. 1993. "Bamboo Based Agroforestry Systems." 24. Retrieved (<http://www.frienvivis.nic.in/WriteReadData/UserFiles/file/Content-Page/Books/Bamboo/Bamboo-Based-Agroforestry.pdf>).
 26. Toledo-Bruno, AG et al. 2017. "Ecology of Litterfall Production of Giant Bamboo *Dendrocalamus Asper* in a Watershed Area." 3(4):363–72.
 27. Nath, V., R. S. Pal, and S. K. Banerjee. 2008. "Bamboo: Its Distribution, Production, Habitat and Agroforestry Potential." *Indian Forester* 134(3):387–96. Retrieved (<http://www.indianforester.org>).
 28. Rahul Shukla, Sumit G, Sajal S, P K Dwivedi, Ashutosh Mishra. 2015. "Medicinal Importance of Bamboo." *International Journal of Biopharm & Phytochemical Research* 1(1), Jan(DECEMBER 2011):8–15. Retrieved (<http://www.indianforester.org>).
 29. Choudhury, Debangana, Jatindra K. Sahu, and G. D. Sharma. 2012. "Value Addition to Bamboo Shoots: A Review." *Journal of Food Science and Technology* 49(4):407–14.
 30. Nongdam, P. and Leimapokpam Tikendra. 2014. "The Nutritional Facts of Bamboo Shoots and Their Usage as Important Traditional Foods of Northeast India." *International Scholarly Research Notices* 2014:1–17. Retrieved (<http://www.hindawi.com/journals/ism/2014/679073/>).

acids, bamboo shoots contain about ten types of minerals like Cr, Zn, Mn, Mg, Ni, Co, Cu, etc³¹. Hence, Bamboo shoots can be used to address malnutrition in developing countries due to its potential for being used for health promotion and for its therapeutic benefits³².

7. Bamboo and carbon storage

Bamboo develops the fastest growing canopy for re-greening³³, with a growth rate ranging from 30 to 100 cm per day in growing season³⁴. Hence, it has a great capacity to sequester carbon. *Bambusa* sp. and “Other *Phyllostachys* sp” have carbon stocks equivalent to carbon accumulation rates in the order of 15–25 Mg C/ha/year³⁵. During these processes, bamboo generates a lot of oxygen compared to some woody trees. The carbon stored in Chinese bamboo forests is projected to increase from 727 million tonnes in 2010 to 1018 million tonnes in 2050 nearly 40 percent in 40 years³⁶.



Bamboo canopy (*Yushina alpina*)

8. Bamboo impact on soil restoration and stabilization

Given that bamboos are plants which are able to grow on degraded soils with poor fertility, One hectare of bamboo produces 5-7 tonnes of leaf litter per year³⁷. Bamboo fresh litter contains 0.74% N and 0.103% P which when decomposed significantly increases soil microbial with C, N and P contents³⁸. These processes of nutrient cycling under bamboo canopy contribute to soil fertility restoration. Again, under the bamboo canopy, sun rays are less intensive, thereby protecting the soil from wind erosion and its roots attach soil particles together to reduce water erosion and landslide. Bamboo's extensive underground root and rhizome system has a significant capacity to bind the topsoil³⁹. Puerto Rican researchers who experimented with several plant species, found bamboo to be one of the most effective in controlling landslides. Its rapid growth and strong root systems make bamboo a powerful soil protection tool, that is why Ghana is using bamboo to 're-green' dump sites and the quarries of former mining areas, and Ethiopia's Sustainable Land Management Programme is promoting bamboo as a strategic resource to control erosion and restore degraded upper catchments.

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9. Bamboo as a source of energy (bioenergy)

Bamboo can be used to produce both wood fuel and charcoal for cooking and heating, as well as to generate electricity using biomass gasification technology. Bamboo charcoal has a calorific value similar to that of wood charcoal but is much less polluting⁴⁰. Bamboo charcoal can replace timber charcoal, this will reduce deforestation action. It is also an alternative to fossil fuels.

10. Bamboo and biodiversity conservation

Bamboo is essential for the survival of some animals like giant pandas (*Ailuropoda melanoleuca* and *Ailurus fulgens*), bat

(*Tylonycteris pachypus*), mountain gorillas (*Gorilla gorilla beringei*) and mountain bongos (*Tragelaphus euryceros ssp isaaci*) that feed on bamboo species. Bamboo makes up to 90% of mountain gorilla's diet in some seasons. Others animals like antelopes, rats and snakes depend on bamboo shelter⁴¹. In Madagascar, lemurs, bamboo frogs and the world's rarest tortoise (*Geochelone yniphora*) also depend on bamboo⁴². In the Amazon area, huge areas of forest are entirely dominated by bamboo. Spectacled bears (*Tremarctos ornatus*) and mountain tapirs (*Tapirus pinchaque*) eat considerable amounts of bamboo and up to 5% of all bird species in this area rely on this plant.

Keyfacts

- Bamboo has a great socio-economic impact on sustainable development.
- The Bamboo sector can bring extra revenue to African countries like Cameroon via the development of some industries for bamboo processing.
- Bamboo can be processed into various products such as; bamboo bathing products, bamboo vinegar, bamboo plywood, bamboo scrimber, bamboo structural lumber, bamboo textiles, bamboo laminated furniture, building panels, bamboo charcoal, bamboo paper and pulp.
- Bamboo manufactured products should not be limited only to handicraft furniture in Cameroon.
- Cameroon is encouraged to turn to bamboo commercial industrialization.
- Bamboo is exported worldwide as raw material, semi-finished and finished products.
- The annual export of bamboo in 2000 was valued at about US\$2.5 billion.

40. International Network for Bamboo & Rattan. 2014. "Bamboo : A Strategic Resource for Countries to Reduce the Effects of Climate Change." Policy Synthesis Report 1–28. Retrieved (http://www.inbar.int/wp-content/uploads/2017/02/INBAR-Policy-Synthesis-Report1_Bamboo-Climate-Change.pdf).

41. According to Jose kalpers IGCP, 2006

42. According to Sanbluch Topham UNEP (2009).

Keyfacts

- Bamboo grows almost everywhere and even on soils with low fertility. This is due to bamboo's high biomass accumulation and abundant litter fall (5-7 tonnes of leaf litter per year) which helps in maintaining and improving soil physical, chemical and biological properties, and thus greatly influencing soil fertility. Therefore bamboo can be used as a biofertilizer in farms.
- Bamboo in agricultural systems will reduce soil erosion especially the one caused by run-off, favouring water infiltration and retaining soil minerals.
- Bamboo is also used in the pharmaceutical sector for the production of drugs for illnesses like phlegm, epilepsy, lung inflammations, mucous in children, fever, cerebral infections, stomach heat and the production of cosmetic products like toothpaste, Soap, and face mask packs.
- Bamboo shoots can be used as a vegetable. Bamboo shoots are low in fat content but contain considerable amounts of carbohydrate, potassium and dietary fibers. They contain 17 different types of amino acids, and ten types of minerals like Cr, Zn, Mn, Mg, Ni, Co, and Cu. Therefore, they serve as healthy food for diabetic patients.
- Bamboo shoots can be used to address malnutrition, for health-promotion and in therapeutic industries.
- Bamboo develops the fastest growing canopy, thus has been reported to accumulate considerable amounts of carbon stocks. During these processes, bamboo generates a lot of oxygen compared to some woody trees.
- Carbon stored in Chinese bamboo forests is projected to increase from 727 million tonnes in 2010 to 1018 million tonnes in 2050, which is about 7.3 tonnes per year.
- The processes of nutrient cycling under bamboo canopy contribute to soil fertility restoration. Again, under bamboo canopy sun rays are less intensive thereby protecting the soil from wind erosion and its roots attach soil particles together to reduce water erosion and control landslides.
- Ghana is using bamboo to 're-green' dump sites and the quarries of former mining areas, and Ethiopia's Sustainable Land Management Program is promoting bamboo as a strategic resource to control erosion and restore degraded upper catchments.
- Bamboo can be used to produce both wood fuel and charcoal for cooking and heating, as well as to generate electricity.
- Serving as an alternative to fossil fuels and timber charcoal, it reduces deforestation actions.
- Bamboo is essential for the survival of some animals like giant pandas, bats, mountain gorillas, mountain tapirs and mountain bongos who feed on bamboo species. Other animals like antelopes, rats and snakes depend on bamboo while lemurs, bamboo frogs and the world's rarest tortoise use bamboo as shelter.

V. MODULE III: GUIDANCE FOR MANAGEMENT AND SUSTAINABLE HARVEST OF BAMBOO RESOURCES.

1. Bamboo smallholder farmers

Smallholder farmers are farmers who own or/and cultivate on less than 2.0 hectare of land. They are small-scale farmers, pastoralists, forest keepers and fishers. They are characterized by family-focused motives, using mainly family labour with the main part of production used for family consumption. Bamboo smallholder farmers are small-scale farmers who cultivate or own bamboo on their farm.

2. Reasons why Bamboo smallholder farmers should practice participatory Bamboo resource stewardship -

Bamboo smallholder farmers should care about bamboo because bamboo activities generate income, create jobs and protect the environment. Bamboo can restore degraded landscapes in order to increase cultivable land (arable land) for smallholder farmers. Bamboo smallholder farmers are those having bamboo resources on their lands naturally. These resources could be increased and improved by the establishment of a bamboo nursery for the production of young bamboo plants which can be sold to those in need for planting. Bamboo smallholder farmers are potential bamboo culms sellers who are going to sell bamboo culms for construction, handicraft and energy purposes. Bamboo smallholder farmers can also play the role of bamboo culm collectors who move from one bamboo

smallholder farmer's farm to the other in order to collect bamboo culms which are stocked in established bamboo warehouses or sold directly to owners of these shops, bamboo craftsmen, etc. Some of these bamboo smallholder farmers can become bamboo culm transporters. They could transport bamboo culms from bamboo rich regions in Cameroon to towns (Yaoundé, Douala, Bafoussam, Bertoua, or Kribi) in order to sell as raw material for processing and exportation (if Cameroon's national bamboo programme is well managed). Furthermore, these bamboo smallholder farmers can become bamboo craftsmen and processors if trained. Moreover, bamboo smallholder farmers can come together as cooperatives to sell bamboo as raw material (culms), semi-finished and/or finished products in the national or international market. The above-mentioned reasons will contribute to the livelihood development of bamboo smallholder farmers.

3. Bamboo culm selection for harvesting

Bamboo selection is very important both for bamboo sustainable management and to produce good quality bamboo products. Bamboo can grow to full length in less than 2 years, reason why it is considered as the fastest-growing plant on earth and records growth rates of up to one meter per day for some species. Attaining its full length does not mean it can be harvested and used because at this stage, the inside of the bamboo fibers has not fully developed.

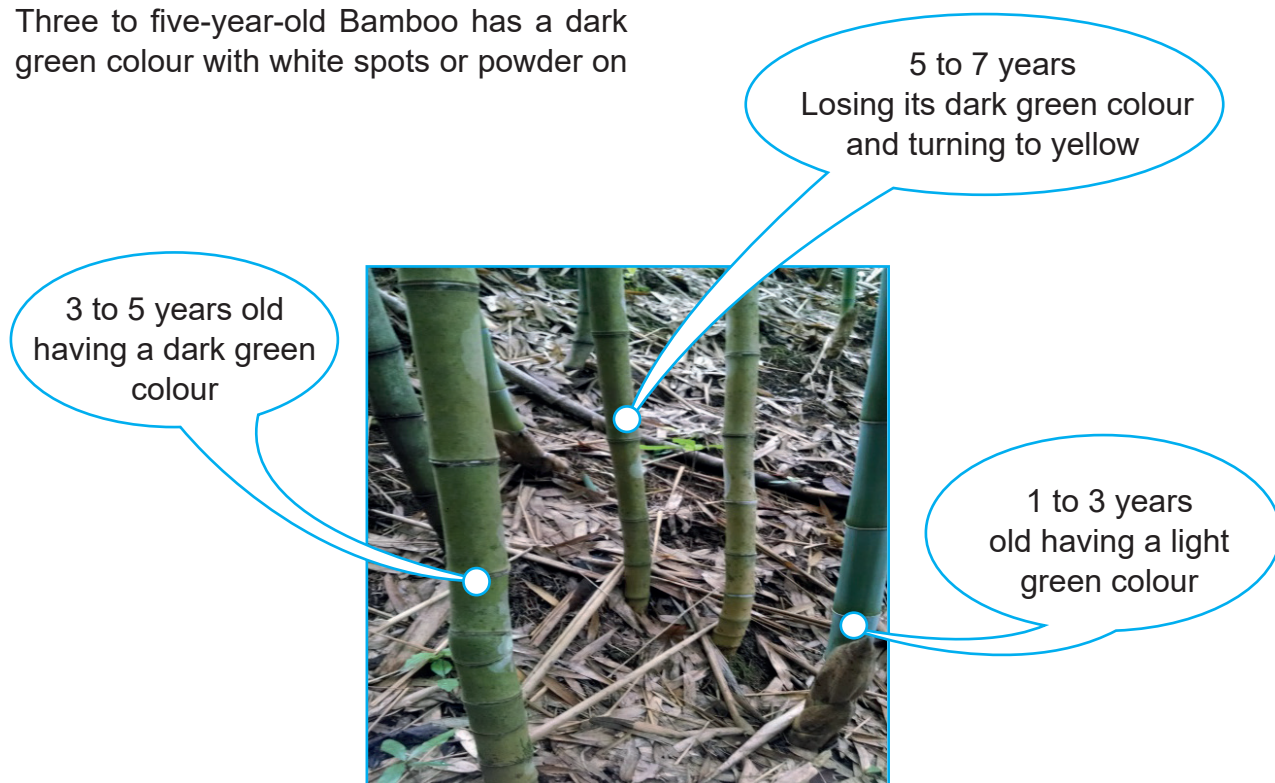
There are three main criteria which can be used to identify and select a mature bamboo. The main criteria for selecting bamboo are culm size, culm age and culm colour.

Bamboo culm size varies from one species to another. Young bamboo (1 to 3 years old) is shiny, smooth and has a bright green colour. At this stage, it is not ready to be used.

Three to five-year-old Bamboo has a dark green colour with white spots or powder on

the culm indicating the beginning of lichens. This is the sign that bamboo is mature and can be harvested.

Bamboo from 5 to 7 years old and even more is susceptible to animal attacks and starts to die. In this case, old bamboo will start to lose its dark green colour turning brown with lichens and developing cracks that can be clearly observed on the culm.



Yushina alpine different growing stage

4. Bamboo culm harvesting

Harvesting should not be done during the rainy season because during this period bamboos grow well and have high moisture and starch content which makes them susceptible to fungal and insect attacks. Again, when harvesting mature bamboo, we need to take care not to damage new bamboo shoots and plants that emerge during the rainy season as this will hinder regeneration. Therefore, the dry season is

the best period to harvest bamboo.

Also, when harvesting bamboo, we need to take into consideration that new culms are produced towards the periphery of the clump as observed in the case of clumping species. Therefore harvesting of mature bamboo culms should be done from the center to the periphery of the clump. Furthermore, when harvesting *Bambusa vulgaris* for example, we need to harvest only 70% of all mature culms in the given

clump not 100% in order to ensure natural regeneration.

Culms should be cut as low as possible (height), between the first or second node above the ground using a saw or cutlass, leaving only one internode above the ground. After harvesting all bamboo culms needed, bamboo culm branches should be removed cautiously without damaging the culm using a knife or cutlass. After harvesting, the culms could be cut using a saw or cutlass in order to facilitate its transportation to the working area.

5. Bamboo culm storage

Bamboo culms should be stored in a ventilated shelter and not in a closed area. When storing, bamboo is usually stacked either vertically or horizontally. Vertical stacking gives less chance to fungal infection and it is best for storing small quantities of

bamboo. Horizontal stacking works better for large quantities of bamboo culms. In this case, we need to stack bamboo on large platforms and place a thick plastic sheet under stacks to prevent fungal infections. The bamboo culms should be stacked based on their size, diameter and quality.



Bamboo vertical storing (photo source: INBAR)

Keyfacts

- Smallholder farmers are farmers who own or/and cultivate on less than 2.0 hectare of land
- Smallholder farmers are characterized by family-focused motives, using mainly family labour for farming with the main part of production destined for family consumption.
- Bamboo smallholder farmers are small-scale farmers who cultivate or own bamboo on their farm.
- Bamboo smallholder farmers should care about bamboo because it is an income generating activity that creates jobs, and protect the environment.
- Bamboo can restore degraded landscapes in order to increase cultivable land.
- Job creation by the establishment of a bamboo nursery for the production of young crops/plants for commercial purposes.

Keyfacts

- Other jobs like bamboo culm sellers, bamboo culm collectors, bamboo culm transporters, bamboo craftsmen and processors can be created.
- Bamboo selection is very important both for bamboo sustainable management and to produce good quality bamboo products.
- Bamboo can grow to full length in less than 2 years, but that does not mean we can harvest and use at this stage.
- There are three main criteria which can be used to identify and select a mature bamboo, these are culm size, culm age and culm colour.
- Harvesting should not be done during the rainy season because during this period bamboos grow well and have high moisture and starch content which makes them susceptible to fungal and insect attacks.
- When harvesting mature bamboo, we need to take care not to damage new bamboo shoots at the periphery (this will hinder re-generation).
- Harvesting mature bamboo culm should be from the center to the periphery of the clump in the case of clumping species such as *Bambusa vulgaris*.
- Culms should be cut as low as possible, between the first or second node above the ground using a saw or cutlass.
- Culm branches should be removed cautiously without damaging the culm using a knife or cutlass.
- In order to facilitate culm transportation to the working area, a saw or cutlass could be used to cut the bamboo culm.
- Bamboo culms should be stored in a ventilated shelter not in a closed area and stacked either in a vertical or horizontal position.
- Vertical stacking gives less chance of fungal infection but horizontal stacking works better for large quantities of bamboo culms.
- The bamboo culms should be piled in stacks based on their size, diameter and quality.



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