Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)
Available online at www.inia.es/forestsystems
doi: http://dx.doi.org/10.5424/fs/2014232-03012

Forest Systems 2014 23(2): 294-299
ISSN: 2171-5068
eISSN: 2171-9845

Resource Communication. Resource potential of bamboo, challenges and future directions towards sustainable management and utilization in Ethiopia

Getachew Desalegn[1]* and Wubalem Tadesse[2]

[1] *Forest Products Utilization Research Case Team. Forestry Research Center. Ministry of Environment and Forest. Addis Ababa, Ethiopia.* [2] *Ministry of Environment and Forest. Addis Ababa, Ethiopia*

Abstract

Aim of study: Bamboo, the fastest growing and high yielding perennial plant of the world has more than 1500 species and 1500 versatile socio-economic uses and ecological services. Ethiopia has two indigenous bamboo species namely *Yushania alpina* and *Oxytenanthera abyssinica*, covering about one million ha with a wide distribution. The objective of this paper is to highlight the potential of bamboo resources, challenges including biodeterioration damage, opportunities and future research directions towards its sustainable management and rational utilization.

Area of study: Bamboo resources of Ethiopia.

Material and methods: Reconnaissance survey was done to some parts of the bamboo growing potential areas in Ethiopia besides the literature review.

Main results: The bamboo resource, despite its socio-economic and environmental benefits, currently, in most areas has been under high pressure due to land use changes, bamboo mass- flowering, poor processing with low value addition, and damage by biodeteriorating agents (termites, beetles and fungi). The preservative tests on Ethiopian bamboos revealed low natural durability and highlighted the paramount importance of appropriate protection measures such as Tanalith and vehicles used motor oil to increase durability, service life and rational utilization of bamboo-based products and structures as potential alternative construction and furniture material.

Research highlights: Therefore, integrated research and development interventions involving different propagation and managements techniques, harvesting age and season, processing, value addition including proper seasoning and preservation technologies and marketing are recommended to fill the information and technological gaps on sustainable management and rational utilization of these fast growing and multipurpose bamboo resources in Ethiopia.

Key words: Bamboo; challenges; management; socio-economic and environmental significance; utilization.

Introduction

Bamboos according to archeological evidence appeared 200 million years ago on this planet and have diverse socio-economical, environmental and ecological importance (goods and services) at local, national, regional and global levels. It is a perennial plant, belongs to the *Poceae* (*Gramineae*) family including about 1,500 species and provides more than 1,500 industrial, construction and other versatile uses. No plant is known in the tropical zone, which could supply so many technical advantages as bamboo. Among bamboo's environmental and socio-economic advantages are the wide distribution, availability, rapid growth and renewability, easy handling and desirable properties, environmental-enhancing resource, source of versatile and useful products and means of income for millions of people. The global bamboo market generates about $12 billion/year for more than 600 million people that can grow to more than $20 billion in year 2015 (Ghavami, 2001; Ahmad and Kamke, 2003; Sastry, 2004; Wong, 2004; Bowyer *et al*., 2005).

Bamboo's growth is more rapid than any other plant on the planet (about 1.2 m height in 24 hours period in Japan), even faster than Eucalyptus species that can be annually self-renewable and harvestable if managed pro-

* Corresponding author: getachewmaa@yahoo.com
Received: 13-08-12. Accepted: 21-03-14.

This work has one Supplementary Table that does not appear in the printed article but that accompany the paper online.

perly. Growth to full height and diameter is completed in one growing season of 3-6 months' time. It has maturity age of about 3-7 years for construction and furniture purposes and short rotation life that can be harvested in 3-5 years versus 10-50 years rotations for most softwood and hardwood tree species. Bamboo has mean annual biomass increment of 10-30% versus 2-5% for trees (LUSO Consult, 1997; Rao and Rao, 1998; Ensermu, *et al*., 2000; Kassahun, 2000; Ahmad and Kamke, 2003; Sastry, 2004; Bowyer etal., 2005; Kigomo, 2007).

Bamboo benefits about half of the world population and is "green" building material. A man can live without meat but life would be hard without bamboo (Sastry, 2004; Bowyer *et al*., 2005). Rural people of Ethiopia largely depend on raw bamboo culms for different construction, furniture and income generating purposes. The income from bamboo culms and products selling has out ways more than twice of the crops from the same plot of land and eucalyptus wood lots (Personal communication). Framers of the Shedem locality in Bale Zone of Ethiopia generate 47% of their annual income from harvesting and selling of bamboo culms (Arsema, 2008). However, Ethiopia is not yet properly tapping the socio-economic and environmental advantages of the "green gold and poor man timber" bamboo resource. Therefore, the objective and focus of this article is to highlight the potential of bamboo resource, its distribution in Ethiopia, challenges, opportunities and future directions/intervention strategies for its sustainable utilization.

Material and methods

Importance and uses of bamboo reources in Ethioipa

Ethiopia has two indigenous bamboo species namely *Yushania alpina* K. Schum *(*Arundinoideae) and *Oxytenanthera abyssinica* (A.Rich.) Munro (Bambusoideae). *Y. alpina* (Highland bamboo) is hollow and monopodial (leptomorph-spreading/running and single-stemmed form) while *O. abyssinica* (lowland bamboo) the monotypic genus confined to Africa is solid and sympodial (pachymorph- clumping form) (Phillips, 1995; Kassahun, 2000; MacLachlan, 2002; Hall and Inada, 2008; Inada and Hall, 2008; Yigardu and Mengistie, 2009).

There are also about 10 introduced bamboo species namely *Dendrocalmus gigantus, Bambusa balcoa, Bambusa vulgaris* var. Green, *Bambusa vulgaris* Striata, *Bambusa tudla*, *Dendrocalmus asper*, *Dendrocalmus brandisii*, *Dendrocalamus hamitoni*, *Dendrocalmus mebraceous*, *Guada amplexifolia* and *Phyllostachys pubescence*, etc (Yigardu and Mengistie, 2009) where some of them adapted and others are still under investigation.

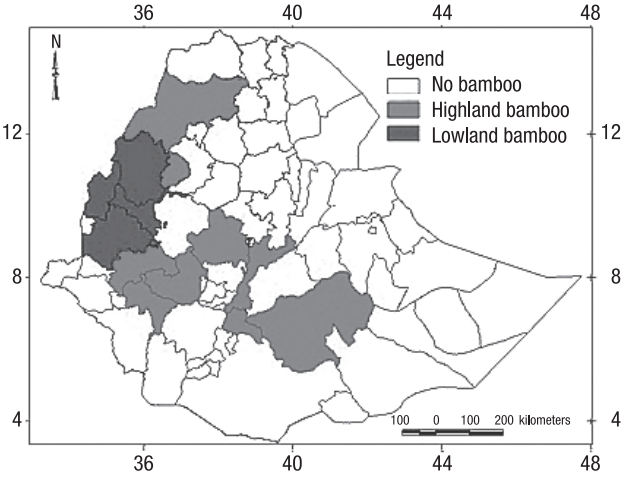

Figure 1. Distribution of bamboo resources in Ethiopia (Tsefaye Hunde, 2006).

Ethiopia has about one million ha of bamboo resource. *Y. alpina* is estimated to cover over about 20% or 300,000 ha out of which 19,000 ha planted by farmers (Fig. 1). The lowland bamboo covers an area of 700,000-850,000 ha accounting over 80% of the land covered with bamboo resources. These species are the highest (67%) bamboo resource in Africa (Phillips, 1995; Kassahun, 2000; Melaku *et al*., 2005; Yigardu and Mengistie, 2009).

Reconnaissance survey was done to some parts of the bamboo growing potential areas in Ethiopia besides the literature review. *Y. alpina* was assessed at Hagere Selam, Injibara, Tikure Inchini sites and *O. abyssinica* at Asossa, Dedessa and Pawe. Bamboo is widely distributed in the country (Fig. 1 and Annex 1).

The distribution of *Y. alpina* natural forests and manmade plantations in Ethiopia includes major places/localities of central and southern, south-western and north-western parts of the country namely Gojam, Shewa, Kefa, Gamo-Gofa, Sidamo and Bale (Phillips, 1995; LUSO Consult, 1997; Maclachlan *et al*., 2002; Ensermu *et al*., 2000). *Y. alpina* occurs in scattered populations on mountains from southern Sudan and Ethiopia southwards to Malawi. Out of Ethiopia, it is available in Kenya, Southern Sudan, Congo, Zaire, Rwanda, Uganda, Burundi, Tanzania, Cameron, Malawi and Zimbabwe (Phillips, 1995; Hall and Inada, 2008).

Currently, the resource base in some areas has been under high pressure (improper utilization such as bush fire and converting to other land use systems) while in others under some promotion (regeneration, development and management). Some industries are under establishment with a plan to process, value add and marketing of products in Ethiopia and abroad. Due to its fast growth, short rotation, high production per unit area and versatile uses, and on the other hand, shortage of wood, bamboo becomes important as alternative and/or supplementary to wood in the country.

Y. alpina grows with *Podocarpus falcatus* in upland and with *Juniperus procera* in drier forests. It grows in altitudes above sea level (a.s.l) of 2200-4000 m, 1500-2000 mm rain fall and 10-20°C temperature. It attains a mean height and base diameter of 12-20 m and 8-20 cm, respectively. Grows with a density of 6000 stems/ha under natural conditions (without management interventions) and having about 51 tone/ha above ground biomass with mean annual increment of about 8.6 tones/ha oven-dry matter and mass flowering occurs 15-40 years (Phillips, 1995; Ensermu *et al*., 2000; Kassahun, 2000; Hall and Inada, 2008; Demissew *et al*., 2011).

O. abyssinica natural forests of Ethiopia are available only in the western parts of the country along major river valleys and in areas bordering the Sudan and include major places and localities namely Tigray, Gonder, Gojam and Welega (Phillips, 1995; Ensermu *et al*., 2000). *O. abyssinica* is distributed throughout tropical Africa outside the humid forest zone, from Senegal east to Eritrea, and south to Angola, Mozambique and northern South Africa. Thus, out of Ethiopia, it is available in Senegal, Eritrea, Malawi, Angola, Mozambique, South Africa, Zimbabwi and Zambia (Inada and Hall, 2008).

O. abyssinica grows within deciduous, savanna woodlands of western Ethiopia associated with grasslands. It grows in altitudes of 500-1600 m a.s.l, 1150 mm rain fall and 20-27°C temperature. It is a hardy species that can grow on poor volcanic soils, about 600 mm rain fall and above 35°C temperature. It attains a mean height and diameter of about 6-8 m and 4-8 cm, respectively. It grows with a density of 8000 stems/ha under natural conditions with a death rate of 4000 culms/ha and having about 70 tone/ha above ground biomass with mean annual increment of about 10 tones/ha (Phillips, 1995; Ensermu *et al*., 2000; Kassahun, 2000; Inada and Hall, 2008).

Results and discussion

Current challenges and perspectives of bamboo resources in Ethiopia for a sustainable management and use

Bamboo resource in Ethiopia is under high pressure that led to depletion and it remained getting less attention. There exists very limited local market for bamboo handicrafts processed manually and exists only a few specialized enterprises that produce bamboo furniture and sell with high price. Poor processing and low value addition occurs, though there are about 500 furniture producers in the country out of which 58 in the capital city Addis Ababa.

Lack of awareness of stakeholders about the socio-economic importance of bamboo resource and absence of linkage among policy makers- different institutions (Research- Extension- Academia- Governmental and Non-Governmental Organizations) - Framers- Industries-Retailers are among the problems. In adequate technologies and database on bamboo management, processing, manufacturing, marketing, clums characterization and rational utilization are among the major challenges. Expansion of agricultural land, investments and changing bamboo stands to other land uses, open grazing, settlements, fire hazards are also important challenges.

Biodeteriorating agents are among the major driving factors against bamboo groves, products and services. More than 40% of bamboo destroyed due to biological agents' damage during use and storing in untreated conditions (Salam and Deka, 2007). According to Getachew and Melaku (2012) field/grave-yard tests conducted on bamboo culms (stakes) natural durability and effectiveness of preservatives in Ethiopia at Bako, Addis Ababa, Adami Tulu and Pawe areas indicated that durability of bamboo is low, but treatability with protecting preservative against (termites, beetles and fungi) was very good. The results also highlighted the paramount importance of bamboo culms proper drying (seasoning) and applying of preservation measures to increase service life of bamboo and bamboo-based products and structures, and to promote maximum utilization of the bamboo resources as alternative construction and furniture material source (Table 1). Preservative treatments such as Tanalith and used/spent motor oil of vehicles treatments have increased service life of bamboo culms by about 2-6 times compared to the un-treated controls (Getachew and Melaku, 2012).

Table 1: Mean deterioration (%) of Bamboo (*Y. alpina* and *O. abyssinica)* stakes of Ethiopia up to 12th months field exposure in terms of (i) species by origin, (ii) along the culms height, (iii) graveyard sites and (iv) preservatives applied against subterranean termites and fungi

Biodeteiorating agents/ Species by origin	Species by origin (i)						Position along culms height (ii)			Graveyard sites (iii)				Preservative treatments (iv)				
Species by origin	Hagere Selam	Injibara	Tikue-Inchini	Asossa	Dedessa	Pawe	Bottom	Middle	Top	Adami Tulu	Addis Ababa	Bako	Pawe	Tanalith E at 3%	Tanalith E at 6%	Borax- Boric acid	Used motor oil	Control
Termite	15	15	20	12.5	17.5	7.5	12.5	17.5	15	10	0	20	30	7.5	2.5	25	12.5	25
Fungi	10	10	10	7.5	7.5	7.5	7.5	10	10	12.5	2.5	15	5	2.5	2.5	17.5	12.5	7.5

Source: Getachew and Melaku, 2012.
Note: 0%- indicates 100% resistant to subterranean termite and/or fungal attack.

In some areas bamboo resources left to decay and degrade due to lack of proper management and utilization. Fast deterioration resulted in frequent harvesting that in turn imposed high pressure on the remaining stock and selected timber species. Current utilization of bamboo in the country has been limited mainly due to the stated shortcomings but also good prospects for future proper management and utilization. The establishment of the new Ministry of Environment and Forest could be good opportunity to establish strong Institutions and device policy for forest and bamboo resources development and proper utilization.

Major product uses and service categories of bamboo in Ethiopia and elsewhere include:

Products: Household utensils, furniture and handicrafts, construction, industrial/structural applications (Plywood, panel, laminated floor boards, pulp and paper, high quality panel products: medium density fiber board-MDF, strand boards-OSB, ply boards, bamboo curtains), food, feed, beverages and juice, biomass-based energy source, medicinal values and source of cash income for many people (LUSO CONSULT, 1997; Rao and Rao, 1998; Ensermu *et al*., 2000; Kassahun, 2000; Getachew and Wubalem, 2004; Dransfield and Widjaja, 2004; Bowyer *et al*., 2005; Salam and Deka, 2007; Yigardu and Mengistie, 2009). All the stated products and structures including young edible shoots need proper handling, processing and protection masseurs specific to each product and structure.

Services: Services of bamboo as a living plant includes ornamental, horticulture, environmental protection including soil conservation, ecological and agroforestry benefits and services.

Conclusions

Bamboo has been used for different purposes (source of products and cash income, environmental/ ecological significance and other services) in the country without adequate knowledge of its regeneration, management and culms durability in service, with no proper seasoning and no application of protection measures and without proper processing and not much value addition. Bamboo can be used as an alternative and potential raw martial source for the emerging cottage, particle board and fiber board and pulp and paper industries of Ethiopia.

In brief, bamboos sustainability and rational utilization enquires the following intervention measures/ strategies in Ethiopia:

— Networking among stakeholders and devising proper strategies for better resource conservation, protection and development

— In-situ and ex-situ conservation of bamboo

— Generating different propagation techniques

— Generating and application of utilization technologies

— Proper processing, value addition and marketing of bamboo based products

Therefore, integrated research and development interventions involving different propagation and managements techniques, harvesting age and season, processing, value addition including proper seasoning

and preservation technologies and marketing are recommended to fill the information and technological gaps on sustainable management and rational utilization of these fast growing and multipurpose bamboo resources in Ethiopia.

Acknowledgements

We would like to thank Gemechu Kaba and Worku Fekadu for their strong assistance during reconnaissance survey, culm sample selection for natural durability and protection measures tests as well as data collection. We thank also the late Fitsum Gebre Wahid for his assistance during reconnaissance survey.

References

Ahmad M, Kamke FA, 2003. Analysis of Calcutta bamboo for structural composite materials: surface characteristics. Wood Science and Forest Products. Springer-Verlag. Wood Sci Technol 37 (2003): 233-240.

Arsema A, 2008. Value chain analysis for bamboo originating from Shedem Kebele, Bale Zone. MBA. Faculty of Business and Economics, School of Graduate Studies, Addis Ababa University, Ethiopia.

Bowyer J, Howe J, Guiller P, Fernholz K, 2005. Bamboo flooring. Environmental sliver bullet or faux savior? Dovetail partners, INC.

Demissew S, Tesfaye D, Kassahun B, Mehari A, Yared K, Negash E, Sintayehu E, 2011. Mass flowering and death of bamboo: a potential threat to biodiversity and livelihoods in Ethiopia. Journal of Biodiversity and Environmental Sciences (JBES). Vol. 1, No. 5, pp: 16-25.

Dransfield S, Widjaja EA, 2004. Bamboos. The overstory number 137. 1st World Congress of Agroforestry. 27 June-02 July, 2004.

Ensermu K, Tamrat B, Alemayehu G, Gebremedhin H, 2000. A socio-economic case study of the bamboo sector in Ethiopia: An analysis of the production-to-consumption system, Addis Ababa, Ethiopia.

Getachew D, Melaku A, 2012. Increasing service life through controlling biodeterioration damage and rational utilization of bamboo species culms in Ethiopia as construction and furniture material. In: Forestry and Forest Products in Ethiopia: Technologies and Issues. Wubalem Tadesse, Getachew Desalegn and Abraham Yirgu (Eds). Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Getachew D, Wubalem T, 2004. Socio-economic importance and resource potential of Non-timber forest products of Ethiopia. In: Genetic conservation of Non-Timber Forest Products in Ethiopia (Wuablem Tadesse and Mabboga, eds). Proceedings of the First National Workshop on Non-timber forest products in Ethiopia. 5-6 April 2004, Addis Ababa, Berhanena Selam Printing Enterprise, Addis Ababa, Ethiopia. pp: 13-36.

Ghavami K, 2001. Cement composites reinforced with bamboo and Vegetable fibers. In: Key note lecture "first international conference on concrete and development". 30 April-3 May 2001, Tehran, Iran.

Hall JB, Inada T, 2008. *Sinarundinaria alpina* (K.Schum.) CS Chao & Renvoize. In: Louppe D, Oteng-Amoako AA & Brink, M (eds.), Plant Resources of Tropical Africa 7(1). Timbers 1. PROTA Foundation, Wageningen, Netherlands/Backatyus Publishers, Leiden, Netherlands/ CTA, Wageningen, Netherlands. pp: 508-512.

INBAR (International Network for Bamboo and Rattan), 2010. Study on utilization of lowland bamboo in Benishangul Gumuz Region, Ethiopia.

Inada T, Hall JB, 2008. *Oxytenanthera abyssinica* (A Rich.) Munro. In: Louppe D, Oteng-Amoako AA & Brink M (eds.). Plant Resources of Tropical Africa 7(1). Timbers 1. PROTA Foundation, Wageningen, Netherlands/ Backatyus Publishers, Leiden, Netherlands/CTA, Wageningen, Netherlands. pp: 412-415.

Kassahun E, 2000. The indigenous bamboo forests of Ethiopia: An overview. Ambio, vol 29 No 8. pp: 518-521. Allen Press on behalf of Royal Swedish Academy of Sciences.

Kigomo BN, 2007. Guidelines for growing bamboo. KEFRI guideline series: No 4. Kenyan Forestry Research Institute. Nairobi, Kenya.

LUSO CONSULT, 1997. Study on sustainable bamboo management: Second Interim Report. Technical cooperation (GTZ). Eschborn, Germany.

Maclachlan M, 2002. Manual of Highland Trees and Shrubs. Revised and expanded. Paper for the development of "dega" areas in Region 3, SIM Forestry Study Project, Injibara, Awi Zone, Region 3, Ethiopia.

Melaku A, Negussie J, Brhanu O, 2005. *Oxytenantheria abyssinica* bamboo stems as reinforcement steel bar in concrete. Ethiopian Journal of Natural Resources. 2005. 7(1): 95-109.

Phillips S, 1995. Poaceae (Gramineae). In: Edwards S & Hedberg I (eds.), Flora of Ethiopia and Eritrea, Volume 7, Addis Ababa, Ethiopia and Uppsala, Sweden. pp: 3-6.

Rao AN, Rao VR (eds.), 1998. Bamboo- conservation, diversity, ecogeography, germplasm, resource utilization and taxonomy. Proceedings of training course cum Workshop, Kunming and Xishuanbanna, Yunnan, China.

Salam K, Deka NKR, 2007. Training manual on nursery raising, commercial plantation, preservation and primary processing of bamboo. Cane and Bamboo Technology Centre, India.

Sastry C, 2004. Bamboo and human development. Development express. Canadian International Development Agency: Policy Branch. Canada Communication Group. Canada.

Tesafaye Hunde, 2006. Status, distribution and biology of bamboo resources in Ethiopia. Paper presented at Forum for Environment public meeting, Addis Ababa.

Wong KM, 2004. Bamboo the amazing grass. A guide to the diversity and study of bamboos in Southeast Asia. Rimba Ilmu Botanic Garden, Institute of Biological Sciences, Faculty of Science, University of Malaya.

Yigardu M, Mengistie K, 2009. Status of bamboo resource development, utilization and research in Ethiopia: a review, Vol.11(1): 63-81. Ethiopian Journal of Natural Resources. Ethiopian Society of Soil Science, Addis Ababa, Ethiopia.

Annex 1. Supplementary information on major distribution of highland and lowland bamboo species (*Yushania alpina* and *Oxytenantheria abyssinica*) by Regional States, Zones and specific localities in Ethiopia

Bamboo species	Regional State	Zone and Specific locality name
Yushania alpina (highland bamboo)	Oromiya	Jima (Agaro, Gera)
		Bore/Gujji/HagereSelam
		Western Shewa (Ambo,Tikure-Inchini, Shenen, Jibat Mountain)
		Bale/Harena forest and Shedem Kebele
		Western Aris (Degaga, Munesa, Shashemene)
	Amhara	Awi-zone/Inijibara, Gojam/Choke mountains, South Wello (Denkoro forest) and South Gonder (Debere Tabor), Debresina/Wofwasha
	Southern Nations, Nationalities and Peoples (SNNPRS)	Sidama/Agere selam
		Bonga (Ameya, Wushwush)
		Kefecho Shekech (Ameya, Baha-Chapa, Gada, Gecha-Masha, Andracha, Chencha/Arbaminch, Mizan Teferi/ Kulish, Dawaro)
		Gurage /Indibir-Jembero
Oxytenantheria abyssinica (lowland bamboo)	Benishangul Gumuze	Assosa (Anbesa Chaka, Kurmuk)
		Kamashi, Mambuk, Mandura, Bambasi, Dibate, Guba, Begi,Demi, Pawe, Sherkole
	Gambella	Gambella
	Southern Nations, Nationalities and Peoples	Gamo, Gaelebena Hamer Bako, Benchi and Maji, Majina Goldiya.
	Oromiya	West Walega (Begi, Nejo, Gimbi, Guten, Didessa Valley, Kelem)
		North of Nekemte/Hinde
	Amhara North	Gonder (Metema, Metema/Dansha/ Humera, Chilga, Wegera)
	Tigray	Shire

Sources: Phillips, 1995; Kassahun, 2000; Melaku *et al*., 2005; Tsefaye Hunde, 2006; Yigardu and Mengistie, 2009; INBAR, 2010.
Note: List is not exhaustive.
SNNPRS - Southern Nations, Nationalities and Peoples Regional State.
Notes: Regeneration and ownership of high land bamboo includes mainly natural bamboo stands and in association with the natural forests, mixed woodlands, farmers' /community bamboo lots, while lowland bamboo includes natural stands and mixed woodlands.