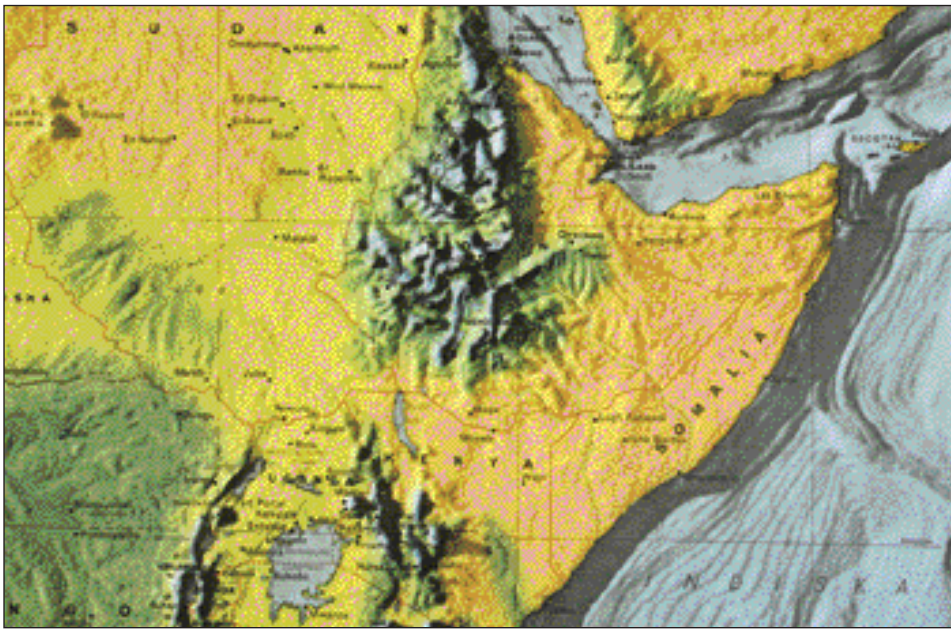
Article

Kassahun Embaye

The Indigenous Bamboo Forests of Ethiopia: An Overview

Agricultural land expansion is almost eliminating the bamboo forests of Ethiopia, and the biological diversity associated with them. Several bamboo species are endemic to Africa and mainly found in Ethiopia. Consequently, their preservation is of international concern. Urgent and effective action is required to secure their future existence and for their use in systems managed on a sustainable basis. Utilization driven production could ensure their sustainability. Lack of awareness about their multiple use and a paucity of scientific knowledge about their production and main properties are impediments for conservation and utilization. Concerted efforts are needed to generate and adopt the required knowledge and technology in order to promote bamboo forest cultivation in Ethiopia as an economically viable crop, which is of environmental interest.



The location and physiography of Ethiopia.
A landscape characterized by undulating terrain and steep slopes is inherently vulnerable to degradation in the absence of vegetation. Rainfall in the highlands of Ethiopia is both high (> 1000 mm yr^{-1}) and torrential.

INTRODUCTION

Situated in the eastern highland of tropical Africa, Ethiopia has a wide area covered with natural bamboo forests. However, this asset together with its biological diversity (1), is being decimated due to high population pressure, weak economic growth (2), and slow technological development, adoption, and distribution (3). This situation compels rural people to clear forest areas to expand agricultural land, in order to procure materials essential for construction and fuelwood.

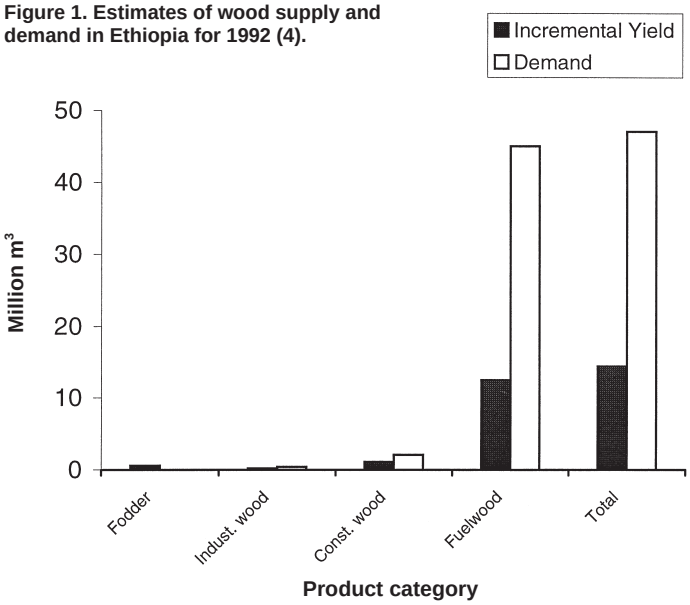
Reversing this situation by increasing land productivity by improving agricultural practices, by the use of wood substitutes, and by implementing projects to revegetate denuded areas have so far proved to be no easy proposition (3).

In the recent past, natural forests have disappeared leaving undulating landscapes bare (6) and exposed to the destructive actions of natural forces such as rain, sun, and wind.

Numerous reports have documented the problems that follow deforestation (2, 6). However, suggestions for practical solutions to effectively reverse the course of forest destruction in Ethiopia, even partially, are scarce. What are available in the archives and libraries are documents of various forest projects that were initiated and apparently terminated, leaving no report on their accomplishments. Today the only successful effort worth noting is the introduction of *Eucalyptus* species which practically saved the capital city of Addis Ababa from having to move from its present geographical position (7).

If species had been selected from the indigenous vegetation, the probability of identifying an equally fast growing and more ecologically friendly species would have been high, given the availability of a rich biological diversity. Bamboo, the fastest growing perennial plant, would have been the obvious candidate. This trend for introducing new species continues. More and more exotics are being introduced, while indigenous species like bamboo which could grow even faster and could serve similar purposes are being destroyed. In the past, bamboo forests were located in the more inaccessible areas, which protected them from destruction. The highland bamboo forest at Masha, southwestern Ethiopia, and the lowland bamboo forests at Assosa, Metekel, and Manbuk, in western Ethiopia are examples. These forests are now decreasing rapidly as new roads are being built. The rate of clearance is accelerating as more of the forest is cleared

Figure 1. Estimates of wood supply and demand in Ethiopia for 1992 (4).



for agricultural land expansion, or burned to increase grass growth rates for grazing and to drive out and kill allegedly harmful insects, reptiles and mammals. Large-scale export-crop production is taking place in fragile ecosystems for short-term gains, e.g. forest clearance for coffee, tea and cotton plantations in southern and southwestern Ethiopia, and urban expansion. These activities are emerging as real and potential threats to the unique biological resources, that were formed over a long evolutionary period. Resources are being wasted despite a demand for inherent products which can be used for construction, industry, energy, and food (Fig. 1; Table 1). The gap between wood demand and supply is continuously growing, and this is threatening the remaining meager forest resources of the country.

Bamboo has a high potential value, as has been learned from tropical Asia (8–10). The need to utilize this resource wisely on a sustainable basis and to conserve it for future generations, may top the agenda list for tomorrow, but this could be too late. Decisive practical action is needed today, before indigenous bamboo species disappear entirely. These species require further research to develop them as useful commodities and as essential tools in environmental conservation. In the localities where they occur, and in places where they could be easily established, they could be a source of positive economic development.

Research on the production physiology of Ethiopian bamboo species is being carried out at the Department of Short Rotation Forestry, Swedish University of Agricultural Sciences, Uppsala, and the Wondo Genet College of Forestry, Ethiopia. The results so far are promising. The high potential of Ethiopian bamboo species together with the large-scale problems of deforestation now occurring, warrant more extensive research on all aspects of bamboo and demands concerted efforts by all concerned bodies.

ETHIOPIAN BAMBOO AS A RESOURCE IN RELATION TO AFRICA AND THE WORLD

Ethiopia has 2 indigenous bamboo species: the African Alpine Bamboo (*Yushane alpina* K. Shumann Lin; synonym: *Arundinaria alpina* K. Schumann) and the monotypic genus lowland bamboo *Oxytenanthera abyssinica* (A. Richard) Munro. These species are also found in some other African countries, but nowhere else outside the African continent. They are indigenous to Ethiopia and endemic to Africa, confined to the sub-Saharan region. More than 1500 bamboo species are found in the world (11), covering 14 mill. ha of land (12). About 80% of these species are found in tropical and subtropical Asia (13). Africa has only 43 species occurring on 1.5 mill. ha (14). Of these, 40 are mainly found in Madagascar while the remaining 3 are in mainland Africa. Ethiopia has about 1 mill. ha of high- and lowland bamboos (15), the latter being more dominant (850 000 ha). Thus, 67% of African bamboo resources and more than 7% of the world total are found in Ethiopia.

Bamboo Growth Characteristics

Bamboos are perennial woody grasses belonging to the Poaceae (Gramineae) family and Bambuseae subfamily (11). Since most bamboos have a tree morphology and attain tree size at maturity they are named tree-grasses (16). The main stem of the aboveground part of the plant is the culm, while the underground part constitutes the rhizome and root system. When mature the culm of the Ethiopian highland bamboo is hollow, while that of the lowland bamboo is solid. The rhizome is the structural foundation of the plant on which the culm depends for its mechanical anchorage, growth, vigor and spacing (8). The thin and fibrous roots, which spring from the rhizome nodes, are responsible for the absorption of water and nutrients (1). Rhizomes are structured as a leptomorph (monopodial), giving rise to single-stemmed culms apart from each other or a pachymorph (sympodial), developing into groups of clustered culms; clumps (8). In fully developed forests the Ethiopian lowland bamboo is a pachymorph while the highland bamboo is a leptomorph. Each year the bamboo population increases by 5–10 shoots per clump (17).

Bamboo is the fastest growing perennial plant (8, 14). Once the rhizome-root system is well established, new bamboo shoots attain full height (6–8 m) and diameter (4–8 cm) within 2–3 months (8). They are mature, strong and ready to be utilized after 2–3 years (18). Culm and rhizome growths are affected by internode expansion, which before developing are telescoped into 2 to 3 cm in the bud (1). Bamboo flowers towards the end of its lifetime (14 to 50 years in some species) and then dies soon after. For this reason bamboo flowering is considered as a "disease" by Ethiopians who live in the bamboo growing areas.

The average annual stem increment of the unmanaged natural bamboo forests of Ethiopia is 8.5–10 tonnes (t) of oven-dry matter per ha (15). This is a higher production rate than reports from bamboo forests in tropical Asia and elsewhere (12, 13). It is thus possible to harvest about 3 mill. t yr^{-1} of oven-dry biomass on a sustainable basis from the 1 mill. ha of bamboo in Ethiopia; assuming selective felling of culms 3 or more years of age. This could be used to supply part of the particle board, fiberboard, pulp, furniture, construction, and energy requirements of the nation.

Bamboo Utilization

Bamboo provides goods and services useful to mankind. It is a source for food, fodder, furniture, building materials, paper, particle board, energy, and medicine. It also plays a vital role in environmental amelioration, biodiversity preservation, soil conservation and waste purification (16, 19, 20).

The present use of bamboo in Ethiopia is low, mainly limited to *tukul* (hut) construction, fencing, and to a lesser extent for the production of furniture, containers for water transport and storage, baskets, agricultural tools, beehives, household utensils and various artefacts (16, 19). This low level of utilization is due to bamboo's susceptibility to biological and physical deterioration. The durability of bamboo products is believed to be short. Al-

Table 1. Forest products imported into Ethiopia, 1993–1998 (5).

Item, Quantity (m^3)	Year					
	1993	1994	1995	1996	1997	1998
Sawnwood	494	360	3185	1300	12 000	10 000
Veneer sheets	194	104	104	100	2800	2800
Plywood	90	63	2	100	7400	7400
Particle board	22	457	500	500	3600	3600
Pulp (Mt)	5621	3895	4397	5700	6700	6800

Table 2. Population, deforestation and landholding trends in Ethiopia (3).

Year	Population (million)	Deforestation (1000 ha yr^{-1})	Rural population ha^{-1}
1984	41.5	425	2.5
1985	42.8	500	2.6
1986	44.3	575	2.6
1987	45.7	650	2.6
1988	47.2	725	2.7
1989	48.6	800	2.7
1990	50.2	875	2.8
1991	51.7	950	2.8
1992	53.4	1025	2.9

though various treatments are available to increase its service-life, people are unaware of these technologies. Bamboo is still considered as a perishable material and, hence, useless, which has led to its neglect as a useful renewable resource. Its potential for industrial use has yet to be popularized, and accepted by both potential investors and growers. Practical demonstrations are the most effective ways of convincing people, and research and development directed towards this end is urgently needed. Viable markets for potential bamboo owners have to be created, by promoting bamboo-based investments, underpinned by the existing natural bamboo forest. Expansion and proper management of both plantations and natural bamboo forests will follow, driven by market forces. However, workable incentives and appropriate support, in the form of extension services, will be needed to accelerate this process. Links in the bamboo production, management, processing, manufacturing, end-product distribution, and utilization chain, have to be established, strengthened and maintained, using functioning markets. Emphasis is again on the urgency for research and development of bamboo use in Ethiopia.

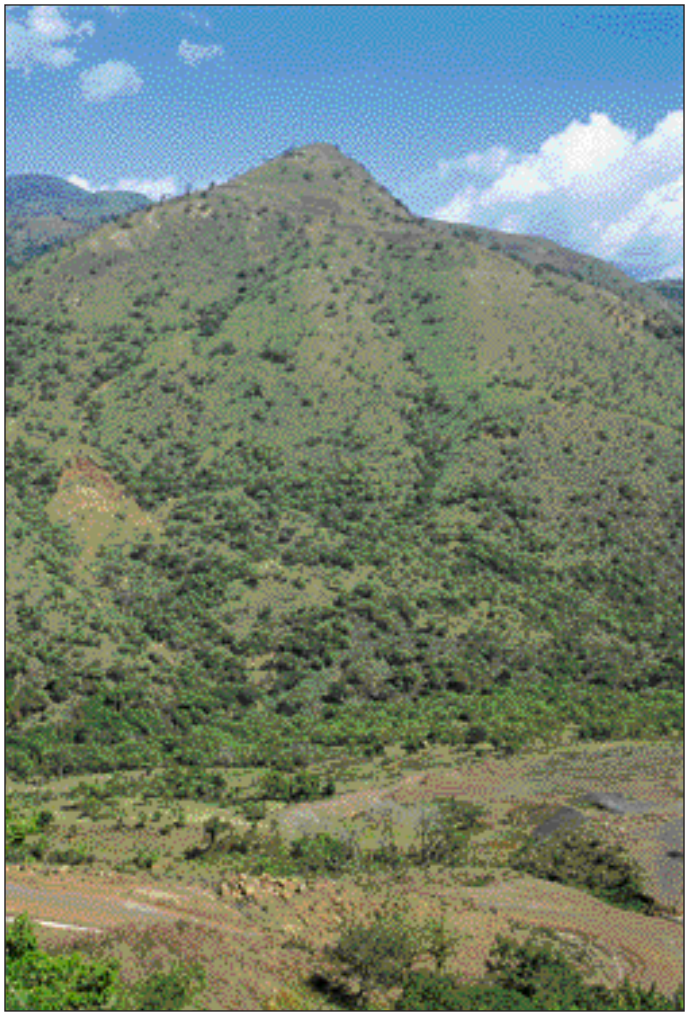
Good lessons for bamboo utilization are available from tropical Asia. In Nepal, bamboo is used in more than 180 ways (21). More than 300 machine-intensive bamboo-processing factories have been established from 1985 to 1992 in peninsular Malaysia (22). Bamboo is widely used in large quantities for pulp and paper production in India (9), China (10), Indonesia (23) and other Asian countries. Bamboo pulp is high grade, and the chemical recovery problems arising from a high silica content have now been solved by desilification (24). In Burma, bamboo is extensively used as a roofing material (25). Good quality activated carbon can also be produced from bamboo (26). Excellent quality particle board that meets Type 1, British standard, requirements is produced from bamboo (27).

Bamboo is also used in Asia, at household and cottage-industry levels, to produce mats, scaffoldings, ladders, sticks, handtools, brushes, pipes, umbrellas, toys, sports goods, musical instruments, spears, arrows, rafts, fishing rods, caps, baskets, flower pots and many other items (11, 21, 24). In this way, rural people can satisfy their own needs and supplement their income. Bamboo is also the preferred material for shade construction in plant nurseries, and for props to support the growth of agricultural crops like banana, tomatoes, and flowers.

Bamboo shoots are a popular food in Asia, and the nutritional value is comparable to those of many commercial vegetables (28). They are also consumed in Ethiopia by the rural people living near the bamboo forests, albeit less popular. Boiled rhizomes are also eaten in these areas. There are reports indicating that "enset" (*Ensete ventricosum*) helped the Ethiopian people to limit the effects of drought and famine. Bamboo could also, probably, be used to supplement food requirements in Ethiopia. A panel held under the theme *Drought in Ethiopia* on 19 August 1999, in Addis Ababa, recommends, among other things, drought resistant crops and income-generating activities to resist and minimize the effects of recurring drought (29). As a multipurpose, drought resistant species, bamboo (particularly the lowland species) is suitable for these objectives.

Deforestation is one of the most serious environmental hazards in Ethiopia (30). The country lost 77% of its forest land between 1955 and 1979 (31), and this decline has continued to the present. The major consequences are losses in protective cover, soil erosion, flooding, water-quality deterioration, drought, and all the synergetic negative effects of these losses.

Because it is a fast growing plant, which is adaptable to low-quality sites (particularly lowland species) bamboo has the capacity to redress many of the problems in large areas of Ethiopia. It has high soil conservation potential. The rhizomes and roots grow in all directions forming a complex network of up to more than 1 m depth belowground, which effectively holds soil particles together, thereby, preventing soil erosion and promoting water percolation. The aboveground part of bamboo helps to reduce erosion caused by rain, by interception, and also shelters the soil from wind erosion. Bamboo litterfall improves soil structure and fertility (32). Bamboo has effectively restored the vegetation cover in denuded lands in the Philippines (17).



A typical landscape in the Ethiopia highlands. It is almost devoid of vegetation, and therefore lacks the possibility to capture, convert, store and transform, adequately, solar energy into goods and services essential for economic growth and environmental improvement. Photo: L. Christersson.

Bamboo is also planted as an ornamental species owing to its grace, attractive foliage, and easy-to-shape clump (33). The high growth rate of bamboo is of course closely associated with high water and nutrient consumption. This makes it suitable for vegetation filter purposes (34), a biological means of waste purification, whereby most of the pollutants in the waste are used for biomass production through the plant-growth process. Increased biomass production means that carbon sequestering is enhanced and oxygen release increases. These are not unique characteristics for bamboo, but it does excel most species in growth rate. These qualities all make it an ideal species for urban plantations as hedges, as a buffer near waterbodies and surrounding waste deposits. This is in addition to its uses in production, e.g. to supply biofuel and products for construction and furniture industries for urban populations.

Research Needs

Developing countries such as Ethiopia, which are suffering from the adverse consequences of deforestation, cannot afford to see their remaining renewable natural resources decimated, by paying lip-service to their protection, production and wise use. The

sensible thing for Ethiopia to do is to foster protection as well as the production and utilization of bamboo through considered management for industrial, household, soil conservation and environmental protection. It may, therefore, be essential to revamp the relevant existing institutions and to open new ones if necessary (Fig. 1). Protection, development and utilization efforts must be guided by knowledge generated by relevant research. The ecology of the low- and highland bamboos should be further investigated, and ways to improve the natural forests using various management practices and treatments need to be determined. The physiology of the crop should be known. Appropriate techniques and methods of propagation by seed and vegetative means must be identified, and management and harvesting techniques should be made available to potential investors (local or otherwise) at affordable cost, if the full potential growth and value of the bamboos are to be achieved. Well-defined bamboo research should be commenced without delay to obtain the required knowledge and technology. The ongoing bamboo research in Sweden and Ethiopia is a step in the right direction, which should be followed up by further investigations of the various aspects of bamboo in Ethiopia.

CONCLUSION

Bamboos are versatile renewable resources, with a high potential for socioeconomic development and for environmental improvement. The values of bamboo are being satisfactorily utilized by tropical Asian countries. However, in Ethiopia this resource is not only totally neglected by its potential beneficiaries, but is also being decimated for agricultural land expansion under burgeoning population pressure. The principal cause for the destruction of bamboo, and the main constraint for its cultivation as a useful crop, is ignorance; i.e. a lack of scientific knowledge on its growth, management, harvesting, processing, and utilization potential. It should be the duty and responsibility of all concerned individuals and organizations to protect bamboo species and to discuss and fully appreciate their multifaceted uses. Appropriate strategies have to be designed to this end. Potential markets should be created for bamboo owners by, e.g. promoting investments in bamboo-based industries like particle board, fiberboard, pulp and paper, and cottage industries. In this respect, a great deal can be learned from the Asian experience.

Once a potential market is established, protection and expansion of bamboo as a useful crop will follow. Knowledge about propagation, management, and utilization will facilitate the momentum for development. Ongoing research on indigenous Ethiopian bamboos is encouraging, but needs to be expanded and strengthened. Appropriate incentives and extension services could also help to overcome inertia and speed up the process of bamboo cultivation, management, and utilization. Government and nongovernment bodies endeavoring to strengthen socioeconomic development and environmental protection, through forest resources protection, development, and utilization could use this strategy as a starting point.

References and Notes

1. Wimbush, S.H. 1945. The African alpine bamboo. *Emp. Forest J. 24*, 23–39.
2. Newcombe, K.J. 1989. An economic justification for rural afforestation: The case of Ethiopia. In: *Environmental Management and Economic Development*. Schramm, G. and Warford, J.J. (eds). John Hopkins for the World Bank, Baltimore, Md., pp. 117–138.
3. Mamo, A. 1995. Environment, population and agricultural development in Ethiopia. In: *Proc. Conference on Ethiopian Agriculture: Problems of Transformation*. Aredo, D. and Demeke, M. (eds). Addis Ababa, Ethiopia. Department of Economics, Addis Ababa University and Ethiopian Economic Association., Addis Ababa, Ethiopia. pp. 65–86.
4. *Ethiopia: Forestry Action Program*. 1994. Final Report, vols. I-III, Ministry of Natural Resources Development and Environmental Protection, Addis Ababa, Ethiopia.
5. FAO 2000. FAO database for forest products. *http://apps.fao.org/cgi-bin/nph-db.pl?* subset = forestry.
6. Legesse, N. 1992. *Indigenous Trees of Ethiopia: Biology, Uses and Propagation Techniques*. Addis Ababa University, Addis Ababa, Ethiopia.
7. Pohjonen, V. 1989. Establishment of fuelwood plantations in Ethiopia. *Silva Carelica 14*. University of Joensuu, Finland. pp. 1–388.
8. Liesse, W. 1985. *Bamboos: Biology, Silvics, Properties and Utilisation.* GTZ, Eschborn, Germany.
9. Adkoli, N.S. 1991. Bamboo in the Indian bamboo industry. In: *Proc. Fourth International Bamboo Workshop on Bamboo in Pacific Asia*. FORSPA publication 6, technical document GCP/RAS/134/ASB, FORSPA, Chiangmai, Thailand and IDRC, Ottawa, Canada, PP 251–255.
10. Yang Yuming and Zhang Hongjian. 1994. Prospects for bamboo-based products as replacement for wood in Yunnan. In: *Proc. Fourth International Bamboo Workshop on Bamboo in Pacific Asia*. FORSPA publication 6, technical document GCP/RAS/134/ASB, FORSPA, Chiangmai, Thailand and IDRC, Ottawa, Canada, pp. 273–277.
11. Ohrnberger, D. 1999. *The Bamboos of the World*. Elsevier, Amsterdam.
12. Jiping, L. 1987. An outline of bamboo resources and research in the world. In: *Farm Forestry Training Courses on Bamboo Production and Utilisation.* Jiping, L. (ed.). Nanjing Forest Univ., Nanjing, Chaina, pp. 82–95.
13. Sharma, Y.M.L. 1987. Inventory and resource of bamboos. In: P*roc. Int. Bamboo Workshop on Recent Research on Bamboo*. Rao, A.N., Dhanarajan, G. and Sastry, C.B. (eds). Hangzhou, China. The Chinese Academy of Forestry, China and International Development Research Centre (IDRC), Ottawa, Canada, pp 4–17.
14. Kigomo, B.N. 1988. Distribution, cultivation and research status of bamboo in Eastern Africa. *KEFRI, Ecol. Ser. Monogr. 1*, 1–19
15. *Study on Sustainable Bamboo Management*. 1997. Final report. Luso Consult, Hamburg, Germany.
16. Kelecha, W.M. 1980. *The Bamboo Potential of Ethiopia*. Forestry and Wildlife Conservation and Development Authority, Addis Ababa, Ethiopia. Monograph, 14 pp.
17. Bumarlong, A. and Yagi, H. 1984. Rehabilitation of denuded forest lands in the Philippines using bamboos. *JIRCAS Int. Symp. Ser. 1*, 72–77.
18. Virtucio, F.D. 1990. *Pulp Yield and Physico-mechanical Properties of Six Philippine Bamboo Species and the Implications on Optimal Harvesting Age*. Ecosystem Research and Development Bureau, Philippines.
19. Getahun, Amare. 1992. *Bamboo and Reeds in Ethiopia.* Ethiopian Forestry Action Plan (EFEAP), Ministry of Agriculture, Addis Ababa, Ethiopia. Monograph 8 pp.
20. Ayre-Smith, R.A. 1963. The use of bamboo as cattle feed. *E. Afr. Agr. Forest J. 29*, 50–51.
21. Poudyal, P.P. 1991. Utilisation of bamboo in the Kathmandu Valley of Nepal. In: *Proc. Fourth International Bamboo Workshop on Bamboo in Pacific Asia*. Forestry Research Support Programme for Asia and Pacific (FORSPA) publication 6, technical document GCP/RAS/134/ASB, FORSPA, Chiangmai, Thailand and IDRC, Ottawa, Canada, PP 259–262.
22. Mohmod, A.L., Abdul, R.O. and Hong, L.T. 1992. The present state and problems of bamboo utilisation for rural development activities in Peninsular Malaysia. *Bamboo J. 10*, 10–19.
23. Widjaja, E.A. 1980. Country Report: Indonesia. In: *Proc. Workshop on Bamboo Research in Asia*. Lessard, G. and Chouinard, A. (eds). IDRC, Ottawa, Canada, PP 63–68.
24. Oye, R. 1980. Country Report: Japan. In: *Proc. Workshop on Bamboo Research in Asia*. Lessard, G. and Chouinard, A. (eds), IDRC, Ottawa, Canada, PP 47–56.
25. Sein, W. 1982. *Use of Bamboo Shingles as a Low Cost Roofing Material.* Leaflet. Forest Research Institute, Forest Department, Ministry of Agriculture and Forests, Burma.
26. Hirai, T., Takekawa, M., Shirozu, M. and Calaro, A. 1992. *Processes for Producing Activated Carbon from Bamboo and Activated Carbon Produced Thereby*. Philippines patent document no.26129-C. Bureau of patents, trademarks and technology transfer, Philippines.
27. Teck, C.L., Nasir, N.M. and Kassim, J. 1991. Urea particleboard from *Bambusa vulgaris* Schrad In: *Proc. Fourth International Bamboo Workshop on Bamboo Research in Pacific Asia*, Chiangmai, Thailand. (November 27–30, 1991). pp 255–257.
28. Suwannapinut, Wisut and Thaiutsa, Bunvong. 1990. Food compositions of some Thai bamboo shoots. *Thai J. Forestry 9*, 67–72
29. Walta Information Centre News. 1999. Panel recommends short and long-term plan to resist drought. *htpp://www.telecom.net.et~walta/html/news.htlm*. 21 August 1999.
30. Kebrom, T. 1999. Land degradation problems and their implications for food shortage in southern Wello, Ethiopia. *Environ. Mgmt 23*, 419–427.
31. *Forestry for Community Development*. 1982. Ministry of Agriculture, Addis Ababa, Ethiopia. Monograph.
32. Christanty, L., Mailly, D. and Kimmins, J.P. 1996. Without bamboo the land dies: biomass, litterfall and soil organic matter dynamics of a Javanese bamboo talum-kebun system. *Forest Ecol. Mgmt 87*, 75–88.
33. Tewari, M.C. and Bindhi, Singh. 1979. Bamboo their utilisation and protection against biodeterioration. *J. Timber Devel. Ass. India 25*, 12–23.
34. Perttu, K.L. 1993. Biomass production and nutrient removal from municipal wastes using willow vegetation filter. *J. Sust. Forest 1*, 57–70.

35. The support of Professor Lars Christersson in editing and improving the manuscript, and providing the photos is profoundly appreciated.
36. First submitted 30 Nov 1999. Accepted for publication after revision 3 April 2000.

Kassahun Embaye obtained his BSc in forestry, with honors, from Aberdeen University, Scotland, in 1987 and MSc in environmental forestry from the University College of North Wales, Bangor, UK, in 1990. He is an assistant professor at Wondo Genet College of Forestry, Ethiopia. He is now on study-leave pursuing his PhD at the Department of Short Rotation Forestry, Swedish University of Agricultural Sciences, Uppsala, Sweden. His research focuses on indigenous bamboos of Ethiopia, production and management. His address: Department of Short Rotation Forestry, P.O. Box 7016, SE-750 07 Uppsala, Sweden.
E-mail: Kassahun.Embaye@lto.slu.se