INDONESIAN JOURNAL OF SOCIAL AND ENVIRONMENTAL ISSUES (IJSEI)
Journal Homepage: https://ojs.literacyinstitute.org/index.php/ijsei
ISSN: 2722-1369 (Online)
Review Article

Volume 4	Issue 2	August (2023)	DOI: 10.47540/ijsei.v4i2.934	Page: 150 – 159

The Socioeconomic and Environmental Benefits of Bamboo Forest in Ethiopia: A Review

Rusha Begna Wakweya
Ethiopian Forestry Development, Jimma Center, Ethiopia
Corresponding Author: Rusha Begna Wakweya; Email: rushabegna@gmail.com

ARTICLE INFO

Keywords: Bamboo; Benefit; Environmental; Socio-Economic.

Received : 17 May 2023
Revised : 11 August 2023
Accepted : 13 August 2023

ABSTRACT

Bamboo plays a significant role in many socioeconomic aspects of life all over the world. Ethiopia, one of the African countries, is known for its high potential of bamboo forests. This paper aims to review the socioeconomic and environmental importance of bamboo forests in Ethiopia. The study used a critical review-based combination of searching for keywords such as bamboo, socioeconomic, environmental, benefit, Ethiopia, and inclusion and exclusion criteria to find relevant information. The results of this review indicated that bamboo has a substantial role in social, economic, and environmental purposes. However, the lack of awareness and consistent information about the socioeconomic benefits of bamboo forests in Ethiopia has been affecting its utilization for socioeconomic importance. Therefore, there is a need for awareness creation, such as training and development of bamboo markets and microenterprise industries in Ethiopia for socioeconomic and environmental benefits. The results of this paper can help farmers, extension workers, and policymakers by providing information on the conservation and proper utilization of bamboo forests for different socioeconomic and environmental purposes.

INTRODUCTION

Bamboo is a multi-use plant that is used for nutrition, firewood, building, and irrigation canals. It is estimated that about 2.5 billion people use bamboo worldwide and locally, generating about $4.5 billion in revenue. Another $2.7 billion is estimated to be contributed by bamboo product exports. In developing countries, bamboo provides a source of income for 3 million people, mostly women and children, who do the bulk of the gathering(Kalanzi et al., 2018).

According to estimates, bamboo has helped around half of the world's population in terms of social, economic, and environmental factors, including as a construction material. Humans can live without food, but life would be challenging except for bamboo (Desalegn & Tadesse, 2014).

Bamboo has a significant potential to end poverty, protect the environment, and promote sustainable economic progress. For “food, fuel, health, and financial security”, especially in poor nations, millions of people rely on Non Timber Forest Products (NTFPs) every day (Hoogendoorn & Benton, 2014). Bamboo has been considered as the most significant and popular Non Timber Forest Products (NTFPs) (Dessie et al., 2022). Moreover bamboo contributes an essential role in supporting the livelihoods of rural households and protecting the environment (Kumar & Sastry, 1999).

With around sixty-seven percent of Africa's and seven percent of the world's bamboo plant, Ethiopia represents one of Africa's major bamboo resource centers (Endalamaw et al., 2013; Mekonnen et al., 2014; Yang, 2018). Two types of homegrown bamboo classes are found in the country including: *Yushania alpina* (Embaye et al., 2005) and *Oxytenanthera abyssinica* (Kaushal et al., 2020); (Embaye et al., 2005). Approximately 23 new bamboo classes out of seven different species were imported meanwhile 2008 in addition to the two native species (Bessie et al., 2016).

Ethiopian rural residents rely heavily on unfinished bamboo calms for a variety of home furnishings, construction projects, and income-

generating endeavors. The revenue from selling bamboo stalks and other items exceeded that of the equal plot of crops grown on similar land in addition to the sales of eucalyptus trees. With an extended history of use, bamboo is more adaptable than other trees, common to different areas, and also has positive social, economic, and environmental impacts. Because it is a great wood alternative, inexpensive to create and use, and environmentally friendly, it is becoming more and more significant in today's global forest economy (Sabastian et al., 2017). Additionally, because the global forest is diminishing, suitable replacement species are required (Mulatu et al., 2016). The bamboo product from industry in international trade has increased from four hundred fourteen million dollars in 2009 to five hundred forty-seven million dollars in 2013 (Partey et al., 2017).

However, due to a lack of awareness among stakeholders and a lack of relationship among different Governmental and Non-Governmental Organizations like Research institutions, Agricultur al Extension experts, policymakers, and other organizations the socioeconomic significance of farmer's income and the low economy of the country, the socio-economic, and environmental importance the bamboo plants were not well documented in Ethiopia (Andargatchew, 2008).

Moreover, the income gained from the bamboo forest in Ethiopia is insignificant, whereas the utilization is low and not sustainable, unlike that of other nations like China, India, and Taiwan (Endalamaw et al., 2013; Kindu & Mulatu, 2010). According to some bamboo experts, the insufficient data on bamboo resources has made it difficult to manage bamboo forests effectively and constrained their ability to provide more social, economic, and environmental returns over the world (Chen et al., 2016; Lobovikov et al., 2012; Nath et al., 2015).

To date, very few scientific research has been done to clarify the socioeconomic significance of bamboo. For instance, Abebe et al. (2021), have studied the socioeconomic importance of bamboo resources in the Lower Beles River Basin, in north-western Ethiopia. However, the study is limited to specific locations and only the lowland bamboo. or highland bamboo. Recently, the social, economic, and environmental importance of bamboo in Ethiopia has not been well documented (Boissière et al., 2020), causing the community to perceive bamboo as a less important plant (Lin et al., 2019). Therefore, this paper aims to review the social, economic as well as environmental benefits of bamboo forests in Ethiopia.

Over 1,500 classes and 90 families of bamboo grow all over 36 million ha of tropical and subtropi cal and between latitudes 460 and 470, up to 4,000 meters above sea level (Lobovikov et al., 2007). Among these 40 species were found in Africa on over 1.5 million ha of land Kigomo (1988), and Ethiopia has two species. According to Embaye (2003) around one million hectares, or 67% of Africa's and 7% of the entire world's bamboo forests, are covered with Ethiopian bamboo. *Oldeania alpina* (K.Schum.) and *Oxytenanthera abyssinica* (A. Rich) Munro are the two species of Ethiopian bamboo that fall under these two genera (Kindu & Mulatu, 2010). These endemic species are only found in the sub-Saharan region of Africa, where they are native to Ethiopia (Embaye, 2000). In Ethiopia's southern, southwest, central, and northern highlands, where elevations range from 2,200 to 4,000 meters, the highland bamboo thrives (Mulatu et al., 2016). In contrast, lowland bamboo is found in Jawi Gagusa and Ankesha in the Hawwi Zone and in Kuara, Metema, Tach Armachiho, and Adarkay in the North Gondor Zone (Bereket & Daniel, 2008). Oldeania is a sizable genus of spreading, thornless, and frost-resistant bamboo that can be found in Taiwan, the Himalayas, and Africa. Although the monotypic genus Oxygenate is only found in Africa.

In Ethiopia's south, south-west, central, and north-west highlands, the highland bamboo (Yushania alpine) frequently grows naturally The highland bamboo (Yushania alpine) usually grows naturally in Ethiopia's south, south-west, central, and north-west highlands (Mulatu et al., 2016). Contrary to highland bamboo, lowland bamboo is only found in Ethiopia's western highlands, which are generally moist and wet desert agroclimatic zones.

MATERIALS AND METHODS

This paper is based on inclusion and exclusion criteria on the benefits of bamboo for the social, economic, and environmental spheres. To get relevant information combination of searching keywords such as bamboo, socio-economic, environmental, benefit, Ethiopia, and were used.

Moreover, appropriate journal articles from Scopus, Web of Science, Directory of Open Access Journals, and Google Scholar databases were included based on search keywords. In contrast, papers that did not discuss the benefits of bamboo in these areas and grey literature and technical reports were excluded.

RESULTS AND DISCUSSION

Socio-Economic Importance of Bamboo

In regions where it grows naturally and has been cultivated by humans, bamboo has a variety of economic, ecological, and social benefits. Bamboo is used in a variety of ways that significantly improve rural income and decrease unemployment (Muchiri et al., 2007). According to Singh et al. (2004) and Nath et al. (2009), bamboo is used for different purposes including for consumption, building materials, housing, and bonds to domestic articles and use in farming, fisheries, transportation, and in small-scale/kitchen industry.

As a result, bamboo constitutes one of the non-timber forest products that support the livelihood of thousands of poor and impoverished people worldwide. Highland bamboo is used to build windmills, plumbing, containers for water, caps, flooring, home furnishings, sticks for walking, fluted ornamentation, home utensils, feed for animals, and agricultural equipment in Ethiopia. It is also used to make divisions for baskets, honey beehive visors, flooring, and equipment (Kelbessa et al., 2000). The silica found in the stem of bamboo is perceived to be used as a medicine for a lot of diseases (Kibwage & Misreave, 2011).

Economic Benefit of Bamboo

There are two native classes of bamboo in Ethiopia, which include *oxygenate Abyssinia* (A. Richard) Munro, a species of lowland bamboo, and *Yushania alpina* (K. Schumann) Lin, a mountainous bamboo, both of which occupy over a million hectares(Barnabas et al., 2020). With a projected rise in the consumption of wood fuels and charcoal by 2030, economic returns from bamboo-processed wood fuels and charcoals are also expected to rise (Partey et al., 2017). Bamboo is already contributing to household income security in SSA. In Ethiopia, a survey of 345 households showed bamboo income contributed up to 11% of the annual cash income of households Mekonnen et al. (2014), which shows investment in bamboo production could be a poverty reduction strategy for many SSA countries. Bamboo generates revenue through the sale of items taken from forests or grown in plantations on selected forest land-living, as well as through traditional use of goods made from bamboo. In several nations, the production of bamboo is transitioning from small handy crafts and household items to industrial products like laminated boards, panels, pulp, paper, mats, prefabricated homes, cloth, and the shoots of bamboo (Lobovikov et al., 2007).

A large portion of the jobs created by the complete integrated supply chain for bamboo goods are in or close to rural villages, and many women are employed there (Daba, 2016). Because of the lack of or inadequate documentation of bamboo's economic benefits to Ethiopia, the general population believes that bamboo is a poor commodity (Lin et al., 2019). From an economic point of view, bamboo is worthless when compared to other agricultural yields like sesame, sorghum, maize, or cotton (Atmadja et al., 2019).

The Ethiopian bamboo industry has only been the subject of a few research so far. According to Kelbessa et al. (2000), identified that bamboo is a valuable income-generating resource at the areas of socioeconomic and environmental levels. Bamboo goods' utilization, marketing, and trade are still in their infancy and make little economic impact in Ethiopia. It can only be used to build shelters, fencing, furniture, and other things (Embaye, 2003). However, more recently in the Amhara Region's Agewu -Hawwi Zone, a market for bamboo culms and other bamboo products has emerged. Most of the landless men purchase bamboo from farmers and use it to make mats, furniture (such as chairs, sofas, and baskets), and other items that they construct and sell by the side of the road. Bamboo is the key source of revenue for several households (Dessie et al., 2022).

Akwada and Akinlabi (2016), examined the socio-economic and environmental impact of bamboo utilization for the development of infrastructure in South Africa. Their research demonstrates that almost all of the people who grow bamboo for business purposes get access to amenities like homes, roads, power, schools, and hospitals as well as clean water supplied by pipes. The local community and the people are benefiting from these industries' efforts to promote community

development since they have enhanced their standard of living.

Chemical, civil, and landscape engineering are just a few of the engineering disciplines where bamboo has applications. Construction can use bamboo because it is a durable raw material. When compared to steel bamboo has 28000 pounds per square inch tensile strength, while steel has tensile strength of 23000 pounds per square inch. Besides it is an important mechanical material in earthquake architecture (Lopez, 2003). It also used in the production of pulp and paper, panel products, construction materials, high strength fiber mixtures, and a variety of contemporary novel bamboo products, including total bamboo for framework and building, bamboo walls and roofs, bamboo fencing, bamboo water containers, bamboo hats, arrows, and bamboo quivers (Kassahun, 2014).

Bamboo provides job opportunities for several rural people with low education and low economy in the form of raw and processed. The majority of smallholder farmers that have no land purchase and use it to make mats, furniture (such as chairs, sofas, and baskets), and other items that they construct and sell by the side of the road. Bamboo is a primary means of livelihood for many families. It can serve as building materials, edible plant components, and has a variety of other functions because of its quick rotation period (Mathewos, 2017). The status of bamboo utilization has been changing in several countries from low handcrafts and household items to industrialized, value-added products like covered boards, sheets, pulp, paper, mats, prefabricated homes, textiles, and bamboo shoots. It undergoes a high-tech industrial manufacturing process and wood replacement. Ethiopia's growing population led to a rise in the need for forest-related goods and services. Bamboo's ability to grow quickly makes it possible to meet the demand for goods made of wood and makes it more responsible for preserving forests (Mathewos, 2017). It serves as a timber replacement and is crucial in preventing environmental deterioration. Bamboo is a valuable species for responding to climate change through carbon sequestration, in addition to its immediate advantages and environmental services (Ibid).

The three most significant functions of bamboo that were highlighted were its usage as a construction material, a source of revenue, and furnishings. When it comes to construction and traditional furniture, bamboo plays a significant role in sustaining their socioeconomic life. It is mostly used for building homes, huts, fences, beehives, agricultural equipment, walking sticks, chairs, baskets, beds, and different artifacts. Due to the lack of woody species that are straight and correct (Abebe et al., 2021).

Bamboo is mostly used in the Kaffa-Shaka area among the southern nations and nationalities of Ethiopia to build homes, particularly roofing. Bamboo is used to make fencing to protect the crops from the livestock that graze. The main raw material used to construct the beehives that are hung in the specific trees to produce honey is bamboo. Other uses for bamboo include the manufacture of water-carrying Jerry cans, local pipes, coffee cups, and other household items (Consult, 1997). In Asossa of the Benshangul-Gumuz Region, bamboo is the primary building material used to upright homes, animal shelters, fences, firewood, and beehives. The bamboo shoots are crucial to the diet of Jawi people living in the Zone. It is also used as cattle feed in the area (Consult, 1997).

Bamboo is a valuable communal asset that provides nutrition and a home for local species like the endangered Bale Monkey (Mekonnen et al., 2010), and significantly pays for the resident livelihood (Andargatchew, 2008). Ethiopians frequently collect and trade raw bamboo culms for money. If it is used to manufacture equipment, intertwined into mats or fence, or fuel wood, value can be added (Mekonnen et al., 2014). Bamboo has a wide range of uses, and value-added processing highlights those uses and potential sources of earnings (Brias & Hunde, 2009). Bamboo not only provides a considerable source of revenue for rural Ethiopian households, but it also lessens the need to extract other, scarcer forest goods like lumber. Bamboo is a crucial NTFP that, in areas where it grows, offers harvesters a more consistent income than most agricultural crops, which only produce revenue on a yearly or seasonal basis (Andargatchew, 2008; Kelbessa et al., 2000; Sertse et al., 2011).

In Ethiopian timber, highland bamboo performs a significant ecological role and minimizes demands on deforestation. In response to widespread deforestation, the Ethiopian government has put in place restrictions to limit public access to and reliance on timber products; nevertheless, these

laws are rarely implemented because of resource shortages and mismanagement (Amede et al., 2001; Yemiru et al., 2010). It was strongly encouraged to use bamboo as an energy source and a substitute for collecting wood (Chernet, 2009; Embaye et al., 2005). Furthermore, it is useful in reducing soil erosion, improving soil fertility, enhancing water accessibility, as well as protecting the destruction of endangered habitats to wildlife (Kigomo, 1988; Sertse et al., 2011). Additionally, bamboo supports the regeneration of forests and serves as a significant carbon sink (Assaye et al., 2014).

Culm thinning is required to promote high caliber and effective stand growth in a mature Highland bamboo forest. In addition to promoting the growth of bamboo clumps, culm management produces a good that can be used by the locals as a building material, a source of fuel, or as a commodity for sale (Embaye, 2000). To fully achieve bamboo's potential for growth and maintain its sustainability over the long term, additional study and management attention are required. Bamboo is a valued resource that provides ecological and economic purposes (Sertse et al., 2011; Tadesse, 2006).

Historically Ethiopians have utilized bamboo for handicrafts, construction, water pipes, furniture, beehives, fences, and flooring (Embaye, 2000; Sertse et al., 2011). The majority of the bamboo used to make these items is taken from natural stands and sold in neighborhood markets. Since the quality is inferior and there isn't as much demand as there is for timber products, market prices are often low. However, bamboo generates an all-year income for harvesters who reside in bamboo-growing regions (Andargatchew, 2008; Brias & Hunde, 2009).

Bamboo is a significant and largely renewable resource, but harvesting methods and biophysical conditions can affect the quality and pace of development of bamboo. Uncertain economic conditions and environmental degradation currently pose a risk to bamboo and the people who depend on it (Embaye, 2000; Kelbessa et al., 2000). Ethiopia's economy has recently had one of the greatest growth rates in Africa, despite the fact that it is one of the world's poorest countries. (Samonas & Coss, 2014). The bamboo-using Ethiopian populations are typically remote, poorly integrated with prospective markets, and frequently lack management of their natural bamboo habitats (Andargatchew, 2008; Kelbessa et al., 2000).

Income Generation

Bamboo is the main source of income following livestock, crop production, and tree production. It is a crucial asset that has environmental and economic advantages. To fully achieve its future potential and secure long-term sustainability, it merits additional research and management consideration (Sertse et al., 2011; Tadesse, 2006).

In the past, rural populations in several Asian countries have used it for a variety of uses. Bamboo is a good alternative to wood because of several benefits including a quick rotation period, strong renewal capacity, and favorable qualities for widespread use that are comparable to or even better compared to those of hardwood (Majumdar & Selvan, 2018).

Global trade, bettering the environment, and growth in the economy are all greatly benefited using bamboo. Its potential to increase quality of life has been noted and various nations are attempting to use bamboo resources sustainably. In addition to helping the rural poor as a whole by lowering their current state of poverty, processing and selling goods made from bamboo is projected to considerably improve the rural economy of agriculture (Lobovikov et al., 2007).

Bamboo for Food

There is a significant increase in the need for natural and organic foods worldwide, especially bamboo shoots (Narmilan & Amuthenie, 2015). Local communities of many countries highly rely on edible bamboo species for their nutritional purpose (Nirmala et al., 2014).

Two native species of bamboo shoots are commonly eaten in Ethiopia. After undergoing a number of procedures or passing a test and washing off any non-nutritional substances like Cyanogen glucosides, bamboo shoots can be consumed. According to reports, bamboo shoots contain taxiphyllin, a cyanogenic glycoside that breaks down to form hydrogen cyanide, making them potentially dangerous if consumed raw or with insufficient processing. Nevertheless, with sufficient treatments to degrade the Cyanogen glucoside and eliminate the resultant hydrogen, the potential toxicity can be greatly diminished. Many nations' current bamboo shoot consumers are aware

of the dangers connected with intake (Zealand, 2009). However, scholars did not highlight, that the people of the northwest part have indigenous knowledge including Berta and Gumuz. According to Mekonnen et al. (2014), they use lowland bamboo shoots (*O. abyssinica*) as food and shoot of highland bamboo (A. alpina) is used for nutrition in Southern Ethiopia around Masha Zone (Fekadu et al., 2012).

The Berta and Gumuz ethnic groups of Ethiopia's Benishangul Gumuz Region in the northwest use lowland bamboo shoots (O. abyssinica) as food (Mekonnen et al., 2014), and shoot of highland bamboo (A. alpina) is used for nutrition in Masha Zone of Southern Ethiopia (Fekadu et al., 2012). Especially in food shortage places, bamboo shoots could likely be used to complement Ethiopia's food needs and maintain nutritional security throughout the entire nation (Mulatu et al., 2019)

Environmental Role of Bamboo

Bamboo is crucial for environmental protection. Bamboo plantation decreases climate change and has the potential to reduce the amount of carbon dioxide in the climate by up to thirty-five percent and provide additional oxygen (Atanda, 2015). The protection of Alpine ecosystems, habitats, and natural resources requires the use of bamboo.

Bamboo utilization and sales have significantly increased in recent years. People in rural areas, especially those with little additional assets or employment possibilities, rely on them for their subsistence and income needs due to their fast growth pattern, affordable for the extraction process, low price for manufacturing, and variety of usages (Majumdar & Selvan, 2018). In developed countries, bamboo serves as a protective structure to shield their farming communities and agriculture from continuous flooding. By forming a water barrier, bamboo roots help to reduce erosion. Due to bamboo's extensive nitrogen consumption, water contamination is decreased. Bamboo can be harvested and replanted without endangering the nearby forest. Bamboo is a highly productive renewable resource that is used to create a wide range of goods, including bamboo chipboard, agro-based medium-density fiberboards, and flakeboard for engineering and construction, as well as ply bamboo for floor tiles and wall paneling, as well as bamboo pulp for making paper and briquettes for burning. It is versatile and environmentally sustainable because to these variations. They have a biomass of 2% compared to wood's 10% to 30%, and they may be harvested in 3-5 years as opposed to the majority of softwoods' 10–20 years (Anon., 2015c).

Soil and Water Conservation

A dense canopy, a big root system, a thick layer of litter, and highly elastic culms are all attributes of bamboo forests. As a result of these qualities, bamboo forests have great potential for preventing landslides, controlling erosion, conserving soil and water, and preserving riverbanks (Song et al., 2011). It was discovered that bamboo can grow almost wherever that is tropical, subtropical, and moderate, where the yearly rainfall ranges from 1,200mm to 4,000mm and the temperature ranges from 160C to 380C. Between 770m and 1,080m above sea level is where bamboo can be found in the best environmental circumstances (Ram et al., 2010).

Various socioeconomic and cultural uses of bamboo are native to different African nations. For both rural and urban people in Ethiopia, bamboo can contribute to economic growth and employment opportunities. Over 1 million hectares of land were covered in terms of area. The nation as a whole accounts for 67% of the entire bamboo forest across Africa and 7% of the worldwide total, which is represented by the forest (Addis 2021). Despite its socioeconomic significance, Ethiopia has a low level of bamboo production and processing for a variety of uses. The absence of competent labor, disregard for the crop's worth, and technological issues with agronomic aspects like soil selectivity are a few of the causes of this. Moreover, there is a lack of knowledge and understanding of bamboo, particularly in terms of its contribution to rural households' ability to support themselves in a variety of agro-ecological environments in Ethiopia.

CONCLUSION

This paper reviewed the socioeconomic and environmental benefits of bamboo in Ethiopia. The review shows that bamboo provides different socioeconomic benefits such as a source of building supplies, conventional equipment, income, musical devices, food, medicine, handmade products, farm machinery, and different home amenities that are

essential for daily survival. A variety of interrelated factors affect the management of bamboo in sustainable manner. The majority of these issues are related to a lack of understanding regarding the growth, management, harvesting, and exploitation of bamboo, as well as its numerous purposes. Traditional/local ecological knowledge, acquired primarily via experience, is used to manage the bamboo resources, although this knowledge system by itself did not result in sustainable bamboo resource management. Therefore, to manage bamboo resources sustainably, the current knowledge must be combined with the science of the forestry system. Additionally, including bamboo management in curricula at organizations of higher learning that provide forestry and natural resource conservation programs might help in developing a skilled labor force with an understanding of and caring for bamboo.

To bridge the awareness and skills gap in bamboo management, it is vital to offer farmers and forestry professionals short-term training. Furthermore, to foster a knowledge of community among the local population and preserve the bamboo resources, a well-defined system of forest tenure will be essential. Finally, it's critical to enhance regulation and enforcement procedures and implement a regulated grazing system. Further investigation should be done to determine which low-important indigenous knowledge components have to be rejected, added to, and improved during the knowledge integration process.

REFERENCES

Abebe, S., Minale, A. S., & Teketay, D. (2021). Socio-economic importance of the bamboo resources in the Lower Beles River Basin, north-western Ethiopia. *Environment, Development and Sustainability*, 1-20.

Addis, A. (2021). *Determinants of Bamboo Production, The Case of Guagusa Shikudad Wereda, Amhara Regional State, Ethiopia* ST. Mary's University].

Akwada, D., & Akinlabi, E. (2016). Economic, social and environmental assessment of bamboo for infrastructure development. 5th International Conference on Infrastructure Development in Africa July in Johannesburg, South Africa,

Amede, T., Belachew, T., & Geta, E. (2001). Reversing the degradation of arable land in the Ethiopian Highlands. *Managing Africa's Soils; no. 23*.

Andargatchew, 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*.

Anon.(2015c).Anon.,http://bamboocentral.org/whybamboo.html. *Retrieved on the 2nd January 2015.*

Assaye, Y., Selassie, Y. G., & Ayele, B. (2014). Farmers' Perception on Highland Bamboo (Yushania alpina) For Land Resource Conservation in Banja District, Northwestern Ethiopia. *Woodpecker Journal of Agricultural Research*, *3*(1), 001-009.

Atanda, J. (2015). Environmental impacts of bamboo as a substitute constructional material in Nigeria. *Case Studies in Construction Materials*, *3*, 33-39.

Atmadja, S., Esthete, A., & Boissière, M. (2019). Guidelines on sustainable forest management in drylands of Ethiopia. In: FAO.

Barnabas, N. N., Kaam, R., Tchamba, M., Zapfack, L., Chimi, C., & Tanougong, A. (2020). Assessing the spatial distribution of bamboo species using remote sensing in Cameroon. *Journal of Ecology and the Natural Environment*, *12*(4), 172-183.

Bereket, H., & Daniel, K. (2008). Study on establishment of bamboo processing plant in Amhara Regional state. *Addis Ababa: AAiT, Post graduate program research*.

Bessie, S., Beyene, F., Hundie, B., Goshu, D., & Mulatu, Y. (2016). Land use/land cover change and its effects on bamboo forest in benishangul gumuz region, Ethiopia. *International Journal of Sustainable Development & World Policy*, *5*(1), 1-11.

Boissière, M., Atmadja, S., Benmakhlouf, S., Beyessa, M., Kassa, H., Hunde, T., & Assefa, F. (2020). Developing small-scale bamboo enterprises for livelihoods and environmental restoration in Benishangul-Gumuz Regional State, Ethiopia. *International Forestry Review*, *22*(3), 306-322.

Brias, V., & Hunde, T. (2009). Bamboo cultivation manual: Guidelines for cultivating Ethiopian highland bamboo. *East Africa Bamboo Project Document, UNIDO*.

Chen, D., Yu, X., Song, C., Pang, X., Huang, J., & Li, Y. (2016). Effect of pyrolysis temperature on the chemical oxidation stability of bamboo biochar. *Bioresource technology*, *218*, 1303-1306.

Chernet, T. (2009). Baseline Census Report. *Bamboo as sustainable biomass energy: a suitable alternative for firewood and charcoal production in Africa. INBAR*.

Consult, L. (1997). Study on sustainable bamboo management: Second Interim Report. *Technical cooperation (GTZ). Eschborn, Germany*.

Daba, M. (2016). Industrial, Carbon Sequestration and Climate Change Mitigation Potentials of Bamboo. *Journal of Scientific Research & Reports*, *12*(3), 1-8.

Desalegn, G., & Tadesse, W. (2014). Resource potential of bamboo, challenges and future directions towards sustainable management and utilization in Ethiopia. *Forest Systems*, *23*(2). https://doi.org/10.5424/fs/2014232-03431

Dessie, T. S., Yimer, A. M., & Ali, M. Y. (2022). Determinants of processors' bamboo utilization level: The case of Bahir Dar city and Injibara town, Ethiopia.

Embaye, K. (2000). The indigenous bamboo forests of Ethiopia: an overview. *AMBIO: A Journal of the Human Environment*, *29*(8), 518-521.

Embaye, K. (2003). *Ecological aspects and resource management of bamboo forests in Ethiopia* (Vol. 273).

Embaye, K., Weih, M., Ledin, S., & Christersson, L. (2005). Biomass and nutrient distribution in a highland bamboo forest in southwest Ethiopia: implications for management. *Forest Ecology and Management*, *204*(2-3), 159-169.

Endalamaw, T. B., Lindner, A., & Pretzsch, J. (2013). Indicators and determinants of small-scale bamboo commercialization in Ethiopia. *Forests*, *4*(3), 710-729.

Fekadu, M., Csaplovics, E., & Degeen, P. (2012). Household contribution of bamboo in Masha district, southern Ethiopia. *Forestry and Forest Products in Ethiopia*, 263.

Hoogendoorn, J. C., & Benton, A. (2014). Bamboo and rattan production and the implications of globalization. In *Forests and Globalization* (pp. 178-196). Routledge.

Kalanzi, F., Mwanja, C., Agaba, H., & Guuroh, R. T. (2018). Potential of bamboo as a source of household income in South Western Uganda. *vol*, *16*, 33-45.

Kassahun, T. (2014). Review of bamboo value chain in Ethiopia. *International Journal of African Society Culture and Traditions*, *2*(3), 52-67.

Kaushal, R., Singh, I., Thapliyal, S., Gupta, A., Mandal, D., Tomar, J., Kumar, A., Alam, N., Kadam, D., & Singh, D. (2020). Rooting behaviour and soil properties in different bamboo species of Western Himalayan Foothills, India. *Scientific reports*, *10*(1), 1-17.

Kelbessa, E., Bekele, T., Gebrehiwot, A., Hadera, G., & Ababa, A. (2000). A socioeconomic case study of the Bamboo sector in Ethiopia. *Addis Ababa, Ethiopia*.

Kibwage, J. K., & Misreave, S. E. (2011). Value chain development and sustainability of bamboo housing in Ethiopia.

Kigomo, B. (1988). Bamboo resource in the East African region. Bamboos Current Research, Proceedings of the International Bamboo Workshop,

Kindu, M., & Mulatu, Y. (2010). Status of bamboo resource development, utilization, and research in Ethiopia: A review. *Ethiopian Journal of Natural Resources*, *1*, 79-98.

Kumar, A., & Sastry, C. (1999). The international network for bamboo and rattan, Unasylva 198; Non-wood Forest Products and Income Generation. *Rome: Food and Agriculture Organization*.

Lin, J., Gupta, S., Loos, T. K., & Birner, R. (2019). Opportunities and challenges in the Ethiopian bamboo sector: A market analysis of the bamboo-based value web. *Sustainability*, *11*(6), 1644.

Lobovikov, M., Paudel, S., Ball, L., Piazza, M., Guardia, M., Wu, J., & Ren, H. (2007). *World bamboo resources: a thematic study prepared in the framework of the global*

forest resources assessment 2005. Food & Agriculture Org.

Lobovikov, M., Schoene, D., & Yping, L. (2012). Bamboo in climate change and rural livelihoods. *Mitigation and Adaptation Strategies for Global Change*, *17*(3), 261-276.

Lopez, O. H. (2003). *Bamboo: the gift of the gods*. O. Hidalgo-Lopez.

Majumdar, T., & Selvan, T. (2018). Carbon storage in trees of urban and peri-urban forests of Agartala, Tripura. *J Adv Res Appl Sci*, *5*(2), 715-731.

Mathewos, M. (2017). Multiple uses of bamboo species and its contribution to forest resource management in Ethiopia. *Journal of Resourses Development and Management*, *37*, 123-130.

Mekonnen, A., Bekele, A., Fashing, P. J., Hemson, G., & Atickem, A. (2010). Diet, activity patterns, and ranging ecology of the Bale monkey (Chlorocebus djamdjamensis) in Odobullu Forest, Ethiopia. *International Journal of Primatology*, *31*, 339-362.

Mekonnen, Z., Worku, A., Yohannes, T., Alebachew, M., & Kassa, H. (2014). Bamboo Resources in Ethiopia: Their value chain and contribution to livelihoods. *Ethnobotany Research and Applications*, *12*, 511-524.

Muchiri, M., Kamondo, B., Ochieng, D., Tuwei, P., & Wanjiku, J. (2007). Proceedings of the 3. KEFRI Scientific Conference. Forestry Research in Environmental Conservation, Improved Livelihoods and Economic Development.

Mulatu, Y., Alemayehu, A., & Tadesse, Z. (2016). Biology and management of indigenous bamboo species of Ethiopia. *Addis Ababa, Ethiopia*.

Mulatu, Y., Bahiru, T., Kidane, B., Getahun, A., & Belay, A. (2019). Proximate and mineral composition of indigenous bamboo shoots of Ethiopia. *Greener Journal of Agricultural Sciences*, *9*(2), 215-221.

Narmilan, A., & Amuthenie, S. (2015). Demand for Organic food Products in the urban areas of the Batticaloa District, Sri Lanka.

Nath, A. J., Das, G., & Das, A. K. (2009). Above ground standing biomass and carbon storage in village bamboos in North East India. *Biomass and bioenergy*, *33*(9), 1188-1196.

Nath, A. J., Lal, R., & Das, A. K. (2015). Managing woody bamboos for carbon farming and carbon trading. *Global Ecology and Conservation*, *3*, 654-663.

Nirmala, C., Bisht, M. S., & Laishram, M. (2014). Bioactive compounds in bamboo shoots: health benefits and prospects for developing functional foods. *International Journal of Food Science & Technology*, *49*(6), 1425-1431.

Partey, S. T., Sarfo, D. A., Frith, O., Kwaku, M., & Thevathasan, N. V. (2017). Potentials of bamboo-based agroforestry for sustainable development in Sub-Saharan Africa: a review. *Agricultural Research*, *6*(1), 22-32.

Ram, N., Singh, L., & Kumar, P. (2010). Bamboo plantation diversity and its economic role in North Bihar, India. *Nature and Science*, *8*(11), 111-115.

Sabastian, G. E., Yumn, A., Roshetko, J. M., Manalu, P., Martini, E., & Perdana, A. (2017). Adoption of silvicultural practices in smallholder timber and NTFPs production systems in Indonesia. *Agroforestry Systems*, *93*(2), 607-620.

Samonas, S., & Coss, D. (2014). The CIA strikes back: Redefining confidentiality, integrity and availability in security. *Journal of Information System Security*, *10*(3).

Sertse, D., Disasa, T., Bekele, K., Alebachew, M., Kebede, Y., Eshete, N., & Eshetu, S. (2011). Mass flowering and death of bamboo: a potential threat to biodiversity and livelihoods in Ethiopia. *Journal of Biodiversity and Environmental Sciences*, *1*(5), 16-25.

Singh, H. B., Puni, L., Jain, A., Singh, R., & Rao, P. (2004). Status, utility, threats and conservation options for rattan resources in Manipur. *Current Science*, 90-94.

Song, X., Zhou, G., Jiang, H., Yu, S., Fu, J., Li, W., Wang, W., Ma, Z., & Peng, C. (2011). Carbon sequestration by Chinese bamboo forests and their ecological benefits: assessment of potential, problems, and future challenges. *Environmental Reviews*, *19*(NA), 418-428.

Tadesse, M. (2006). Bamboo and rattan trade development in Ethiopia. *Bamboo for the Environment, Development and Trade*, *17*, 12.

Yang, J. (2018). An overview of global modern bamboo construction industry: A summary report of ICBS.

Yemiru, T., Roos, A., Campbell, B. M., & Bohlin, F. (2010). Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *International Forestry Review*, *12*(1), 66-77.

Zealand, A. N. (2009). Food Standards Australia New Zealand.