



Review Paper

## Bamboo forest in Ethiopia: roles, constraints and management strategies: review article

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Available online at: [www.isca.in](http://www.isca.in), [www.isca.me](http://www.isca.me)

Received 7<sup>th</sup> November 2020, revised 9<sup>th</sup> November 2022, accepted 5<sup>th</sup> February 2023

### Abstract

*The roles of the bamboo forest are very wide and it provides goods and services for mankind. In regions where bamboo takes place naturally and as a cultivated area as well shows a very significant role on a social, economic, and ecological basis, but the role of bamboo forest as an integral part of Ethiopia's economy has not been well-known. Thus, the central goal of the above-mentioned article was to review the sudden starring role, constraints, and management strategies of the bamboo forest in Ethiopia. Bamboo is a vital plant with substantial commercial, and environmental welfare, for instance, helpful to livelihoods, biodiversity preservation, and mitigating environmental problems. Also, bamboo has multipurpose such as bamboo shoots do not doubt nourishment from the plant source, and it uses for ecosystem services like purification, soil stabilization, and erosion prevention on hill slopes. Besides, bamboo plays a vital role in the socio-cultural and aesthetic values for furniture and musical instrument and decorative purposes for cultural houses. However, the major constraints of the bamboo resource are a lack of awareness of multiple usages followed by a lack of onsite conservation interventions and road infrastructures, inadequate technologies, and the absence of national and international market linkage and information in Ethiopia. Therefore, governmental and non-governmental organizations should promote bamboo resource cultivations and awareness creation for stakeholders to boost the sustainable management of bamboo with forests as a renewable resource in Ethiopia.*

**Keywords:** Bamboo, roles, constraints, awareness creation, management Strategies, Ethiopia.

### Introduction

Bamboo is a permanent plant close to the Poaceae and Bambusoideae subfamily<sup>1-3</sup>. In hot, semi-tropical, and mildly comfortable areas, it is the earliest woody grass widely distributed. It is also fast-growing with reported growth rates of 250 cm in 24 hours, a renewable, widespread, low-cost, plant in the family of grasses with great potential in environmental management and poverty alleviation<sup>4</sup>. Nearly around 1500 species of bamboo in some 90 genera of which only about 50 species are domesticated so far<sup>5</sup>. About 36 million hectares of bamboo are distributed in the world forest ecosystems in Asia, Africa, and America<sup>6,7</sup>.

In Africa, a small cover compared with Asia which is 1.5 million hectares has mainly distributed the Eastern part of Africa among 45 species and 14 genera of pheasant from 40 species and 3 species is in East African mainland<sup>8,9</sup>. Ethiopia's bamboo forest covers 7 percent of the world's total<sup>8,7,10,11</sup>. Bamboo is cultivated in Ethiopia nearly projected to be 1 million hectares or 67% of natural bamboo forests, which is the largest in Africa<sup>12,13</sup> and attracts interest from international markets<sup>14</sup>. And, two native classes of bamboo in Ethiopia were alpines as well as basin bamboo which is termed (*Yushania*

*Alpina*) and (*Oxytenanthera Abyssinica* A. Rich Munro) respectively are known which found in both highland and lowland areas in the country<sup>10,15</sup>. Highland bamboo covers 13.3 percent or 130,000 hectares whereas lowland bamboo accounts for 86.7 percent of 850,000 hectares in 1997<sup>16</sup>. Over the last two decades, however, the existing vast zones of the original bamboo reserve have been drastically depleted for agricultural purposes<sup>17</sup>.

The roles of the bamboo forest are very wide; at least 1,500 uses of bamboo have been known, but the consumption of this sufficient resource is limited to the domestic level, where they think bamboo is their second vital source of livelihood next to agriculture<sup>4</sup>. It has multipurpose; high economic and environmental value<sup>13</sup>. Bamboo has many benefits for rural livelihoods, such as local furniture, used as fodder for livestock and fuel-wood, building material, and also for soil conservation<sup>7</sup>. Bamboo is also used as the potential underdone source for the raising cottage, particleboard, engineered object as well as pulp and paper industries of Ethiopia<sup>18</sup>. More than 10 million Ethiopians are living in bamboo houses<sup>11</sup>. Hence, the bamboo forest is a plentiful resource in Ethiopia thus it has great potential for livelihoods as well as commercialization, which can drive rural development<sup>19,20</sup>.

Also, bamboo has comparatively frivolous, can be simply collected and transported without specialized equipment or vehicles. Its cracking is so easy for weaving, is so easy to handle, and simple for women. Bamboo harvesting mostly does not need experts' labor qualifications and can be started by rural deprived people at a minimum cost<sup>21</sup>. Even with a great guess approximately Ethiopia's bamboo market would-be, initial data nearly household use income reliance is lacking<sup>22</sup>. A small number of people earn money by cultivating, collecting, and processing the bamboo<sup>23</sup>. Yet, the current utilization of bamboo in Ethiopia rests under-developed with little cost<sup>20</sup>.

However, the use of bamboo resources is advanced and versatile on a global scale and has great potential to improve socio-economic and ecological growth, but it is still unrealized in Ethiopia<sup>12</sup>. Bamboo is still known as a useable material, which has resulted as a valuable renewable resource to its lack of care<sup>11</sup>. Bamboo is compared with other countries, the economic profit gained from this species is very low<sup>3,24</sup>. The bamboo forest has also been poorly managed and exploited. Only an insignificant number of people are involved in cultivating and handling bamboo in Ethiopia. The use of bamboo is limited to the domestic level. There is only a very inadequate market for bamboo arts that are not currently being advanced<sup>25</sup>. Even though some start in current applications as very in recent times, the use is so primary and the safety is so weak. Difficulties linked to the exhaustion of the bamboo forests for diverse uses arise for the reason that attaching less urgency to the resource. Statistics on the amount, distribution, and species variety have not been studied, and the speed of reduction of bamboo resources in Ethiopia is very narrow<sup>3</sup>. Therefore, the primary purpose of such a paper was to review the roles, constraints, and management strategies of the bamboo forest in Ethiopia.

## Methods

To realize the noted objectives, the secondary data were organized which was carried out from different documents in line with the topic through a depth review of related literature

from different sources. Furthermore, in this document data were obtained from the review of related literature on the web of peer-reviewed published articles, researches, and books which are ordered and aligned with stated objectives as structured in the given review literature section.

## Review of Related Literature

Natural bamboo forests grow in different regions in Ethiopia (Table-1). As Figure-1 indicated, *Yushania Alpina* (highland bamboo) grows in the northwestern, western, southern, and central parts of the country, whereas *Oxytenanthera abyssinica* (lowland bamboo) is broadly dispersed in the western and northwestern lowlands of the country<sup>2,15</sup>. High land bamboo conservation and tenure involve mainly natural bamboo stands and mixed woodlands, farmers'/community bamboo lots with natural forests, while lowland bamboo consists of natural stands and mixed woodlands<sup>10</sup>.

## The Roles of Bamboo Forest in Ethiopia

Bamboo provides goods and services useful to mankind<sup>26,27,2</sup>. Even so, the roles of bamboo have not been soundly known as a vital production of the country, it shows an exceptional impact on socio-economic, and ecologic areas where it takes place naturally with cultivated area<sup>7</sup>. For its regular uses such as poultry cages, vegetable baskets, incense sticks, skewers and chopsticks, woven blinds, as well as handiworks, bamboo has been widely recognized<sup>26</sup>. Besides, bamboo is the basis of food, fodder for castles, house equipment, construction tools, pulp, particleboard, energy, and medicines. Also, bamboo is a source of food, fodder, furniture, construction materials, pulp, particleboard, energy, and medicines (Figure-2). It also shows a vital contribution to environmental improvement, biodiversity conservation, soil maintenance, and waste purifying<sup>2</sup>. Besides, the usage of highland and lowland bamboo in the value web, because of their structural dissimilarities and their suitability for many operations<sup>29</sup>.

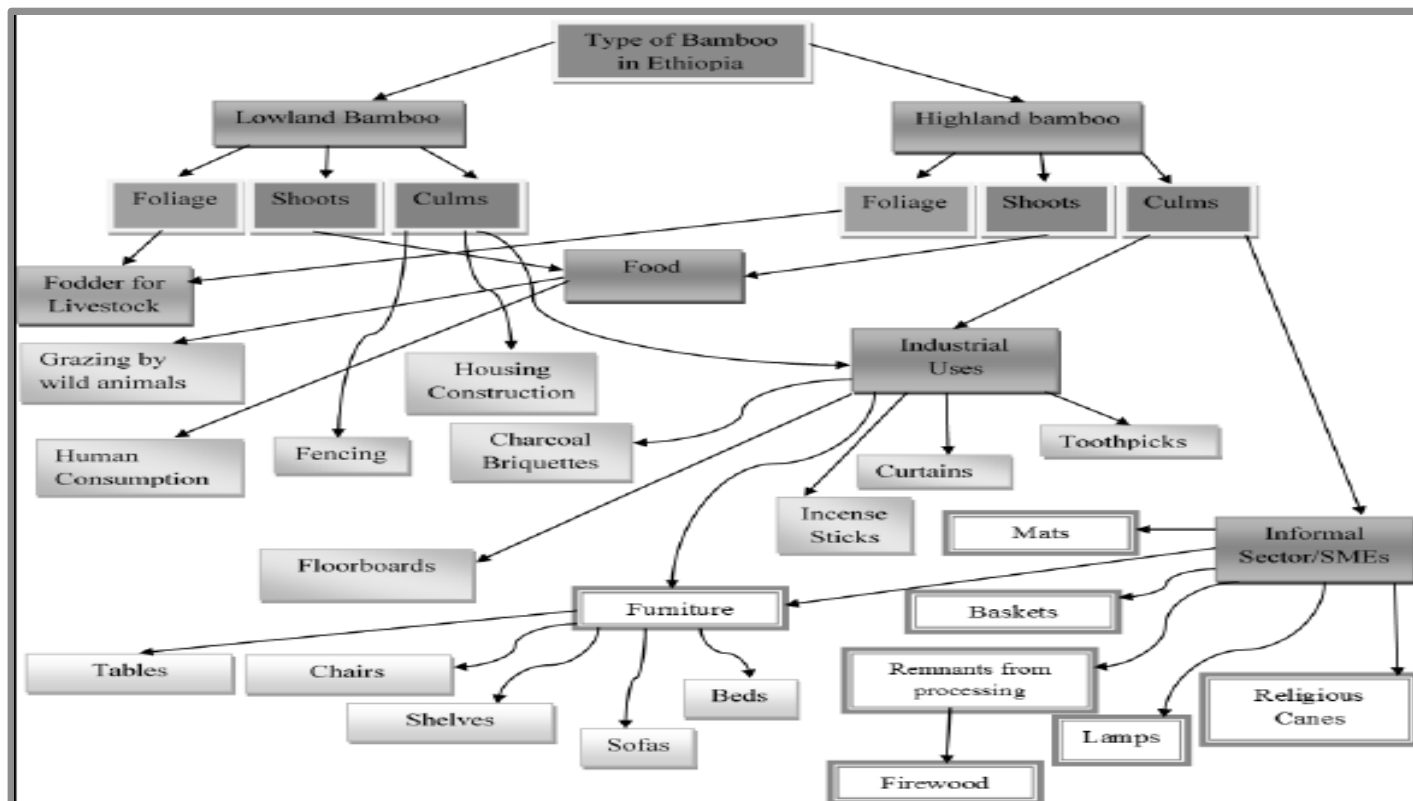


Figure-1: (a) *Yushania* or mountainous bamboo<sup>13</sup> together with (b) *Oxytenanthera abyssinica* or drought-resistant bamboo<sup>3</sup>.

**Table-1:** The major distributions of mountainous plus drought-resistance bamboo species (*Yushania Alpina* along with *Oxytenanthera Abyssinica*) by Regional States, Zones, and specific localities in Ethiopia<sup>18,52,53</sup>.

Bamboo species	Regional States	Zones and Specific locality name
<i>Yushania Alpina</i> (mountainous bamboo)	Oromiya	Jimma zone (Agaro, Gera), Bore (Gujji or Hagere Selam), Western Shewa (Ambo, Tikure-Inchini, Shenen, Jibat Mountain), Bale zone (Harena forest and Shedem Kebele), and Western Aris (Degaga, Munesa, Shashemene).
	Amhara	Awi-zone (Inijibara, Gojam/Choke mountains, South Wello (Denkoro forest), South Gonder (Debere Tabor) and Debresina/Wofwasha.
	Southern Nations, Nationalities, and Peoples (SNNPRS)	Kaffa zone (Adiyo, Talo and Bitu), Sheka and Benchi-Maji zone (Gada, Gecha-Masha and Andracha, Mizan Teferi, / Kulish), Gamo-Gofa zone (Chencha/Arbaminch), Dawaro zone (Loma, Dissa, Esra, Tocha and Mareka districts), Yem and Konta Special districts, Guragezone (Indibir-Jembero).
<i>Oxytenanthera Abyssinica</i> (drought resistant 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-Maji, Majina Goldiya, and Dawuro lowland area.
	Oromiya	West Wellega (Begi, Nejo, Gimbi, Guten, Didessa Valley, Kelem) North of Nekemte/Hinde.
	Amhara North	Gonder (Metema, Metema/Dansha/ Humera, Chilga, Wegera)
	Tigray	Shire.

Note: The list is not exhaustive.



**Figure-2:** The roles of bamboo forest in Ethiopia<sup>29</sup>.

## The Role of Bamboo in Food Consumption

Bamboo buds possess a huge likely hood to be used as an essential natural food since they are rich in proteins, amino acids, cellulose, and various important minerals and vitamins, and very low in fat<sup>30</sup>. Bamboo shoot is one of the common food items in many countries and their acceptance is rising from time to time, as the main or extra food. Being one of the speedy-growing vegetation, young branches of bamboo can be exploited for nursing the constantly-growing inhabitants of the region without depleting forest resource<sup>31</sup>. Bamboo shoot is low in fat and calorie accumulation however, it has rich in general nutrient content and edible fibers. Consequently, bamboos is highly expected to be consumed by the humans in enhancing nutrients in the nourishment of elite people and has paid attention to the attention of scholars<sup>32</sup>. Also, fresh, taped, heated or cooked, soak, fermented, frozen, liquid, and medicinal is the many forms in which bamboo shoots are processed<sup>33</sup>.

Bamboo not only plays an important role worldwide it is due to its great versatility as wood, food and fuel<sup>34</sup>. Bamboo shoots have no suspicion from a main food source from the plant source. Several edible types are existent in diverse units of the world that are consumed in many methods along-with called by varied names by different communityies<sup>35</sup>. Bamboo is used such as a diet doesn't matter what can be used up raw, roused, or

taped. These young shoots exist not solely delightful even so are amusing in nutrient components, mostly proteins or biomolecules, starches and minerals, besides roughage, and are low in fat and sugars<sup>36</sup>. The anti-nutrients which were found in the shoots were mostly lower than those found in most common vegetables and so the bamboo shoots could deliver nutrients of higher quality to the body<sup>37</sup>.

The bamboo buds displayed that the vegetation consists of a significant quantity of proteins, crude fiber, lipids, carbohydrates, and minerals<sup>38</sup>. Bamboo has huge potential in recognizing the food security tool of the country<sup>39</sup>. It also serves as fuel wood, animal fodder, and food for human<sup>11</sup>.

Because of that, the impact of bamboo in Ethiopia is known as mad from three parts: the culm, shoot, and foliage or leaves. But, there is a perfect awareness gap on the level of usage in the shoots as well as foliage. The consumption of bamboo shoots by human beings rests at the very smallest level as pera lack of awareness of the nutritional value in the country. Very a small number of recent studies remark on the human consumption of bamboo shoots. Comparatively, wild animals eat bamboo shoots more than human beings in the country. There is a certain study with the usage of bamboo foliage as well as leaves as fodder for livestock animals<sup>29</sup>.



Figure-3: Edible shoots of bamboo<sup>34</sup>.

### The Roles of Bamboo for Ecological/Ecosystem services

Bamboo provides significant ecosystem services. Its used for ecological purposes for instance soil stabilization, erosion avoidance on mountain slopes as well as carbon sink<sup>40</sup>. Forever a long period, Bamboos' rapid growth capacity and existence tend to make it sole potential and primacy types for carbon sink as well as carbon sequestration<sup>41</sup>. When it moves toward fixing degraded land, bamboo is very influential. Bamboo is also durable and its root can reduce soil erosion by up to 75 percent<sup>42</sup>. Wherever bamboo grows, it protects and restores the nearby environment by keeping soil and water as well as improving the quality of the land. The plant grows rapidly reducing degradation and restoring injured ecosystems. It is most fit for reforestation, a forestation, agro forestry, as well as watershed defense<sup>43</sup>. Bamboo can lessen gorges and keep soil fertility. In almost all applications, bamboo can replace wood, thus helping to reduce the pressure on the world's forests. Bamboo also grows on steep slopes and adapts to degraded lands, but does not oppose agriculture<sup>44</sup>. Bamboo is a key resource with significant economic, and conservational aids,

like upgrading country side lively hoods, reducing forest depletion, plus alleviating ecological problems<sup>45</sup>.

### The Roles of Bamboo for Climate change Adaptation and Mitigation

Bamboos have wide potential solutions to address the troubles that arise due to climate change (Figure-4). Bamboo can be used as adaptation and mitigation strategies for micro and macro-climate change such as a forestation/reforestation because it is the very rapidly growing plant on the earth with a growth rate of up to 250cm per day<sup>4</sup>. United Nations Framework Convention on Climate Change (UNFCCC) can identify bamboo's present and potential role in mitigating climate change/variability and sinks carbon that will considerably be lessening the bad effects of greenhouse gases in the atmosphere. As an energy source, bamboo biomass can prevent deforestation and reduce the use of fossil fuels by millions of households. Its fast-growing and sustainable features allow dense vegetation to be quickly generated on a large scale. Landscape measures to combat climate change work to the amount that carbon, the largest greenhouse gas, is sequestered<sup>46</sup>. Bamboo plays the chief contribution to reducing pressure on forestry resources.

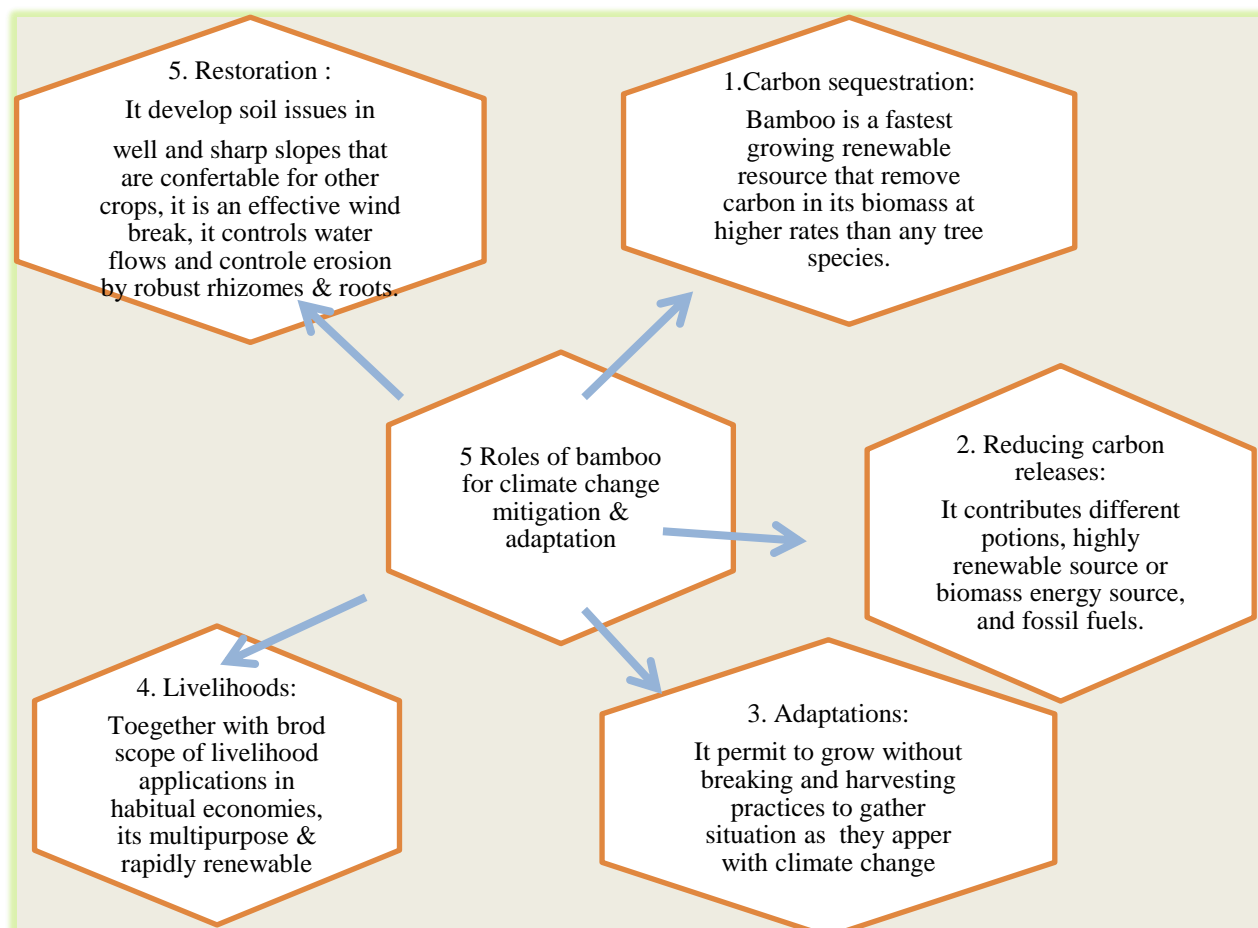


Figure-4: Five main roles of bamboo forest to alleviate the effects of climate change<sup>47</sup>.

In addition, bamboo plays for carbon sink above and below the surface of the ground (Figure-5). This versatile plant provides alternatives to fossil fuels for charcoal and gas, fast-growing and amazingly renewable dense vegetation stands, and harvested materials with a range of uses dating from the dawn of civilization and are now multiplying and improving in line with the accelerating advance of science<sup>46</sup>.

### The Role of Bamboo for Socio-Cultural Value

Bamboo plants have many traditional uses in Ethiopia as well as the whole world. Some of the cultural uses are furniture, musical instrument, basketry and traditional sticks (for elderly people), and provides very good raw material for cultural house constructions<sup>23</sup>. Bamboo is also planted as a decorative type due to its beauty, smart foliage/greenery, as well as easy-to-shape clump<sup>2</sup>. A Bamboo is an exceptional option for good and cheap housing<sup>48</sup>. Bamboo has many advantages for rural livelihoods, such as local furniture, fodder for livestock and fuel-wood, construction material, and also for soil conservation, and cash incomes used for household upkeep<sup>7</sup>. There are many traditional bamboo handi work returns which consist of chairs, tables, benches, shelves, grain granaries, baskets, cane, kitchen, rope, scaffold, food or indoor utensils, mats, beehives, umbrellas and are used for cultural activities<sup>49,19</sup>. The weaving industry for bamboo products has mostly small-scale and labor-intensive for

both men and women. Its role in employment generation has been significant and particularly beneficial to the social-economic development of the rural sector. Bamboo weaving work, like other bamboo handicraft work, provides supplementary income for many villagers<sup>50</sup>.

### The Economic Role of Bamboo

Bamboo is the largest non-timber forest product in the world and plays a crucial role in the livelihoods of millions of people and communities in the tropics and subtropics. Bamboo now is used as bamboo fuel and bamboo shoots for food purposes, bamboo furniture, and has a great perspective for future financial gain, which can drive countryside development<sup>13</sup>. People think bamboo is their next most vital for enhancing revenue, following agriculture<sup>51</sup>. Highland bamboo and its products also have a great contribution as a source of household income. It has been sold in the form of raw bamboo, basket, mat, and other household goods<sup>16</sup>. Bamboo has a significant socioeconomic impact. It is important for making earnings, for constructing, fuel wood, animal fodder, fences and equipment, human food, soil conservation or upgrading, and substantial carbon annihilation. The production of bamboo possessions helps financially poor societies, however, at the same time maintain vertical slopes and inclined slopes to watersheds<sup>11</sup>.

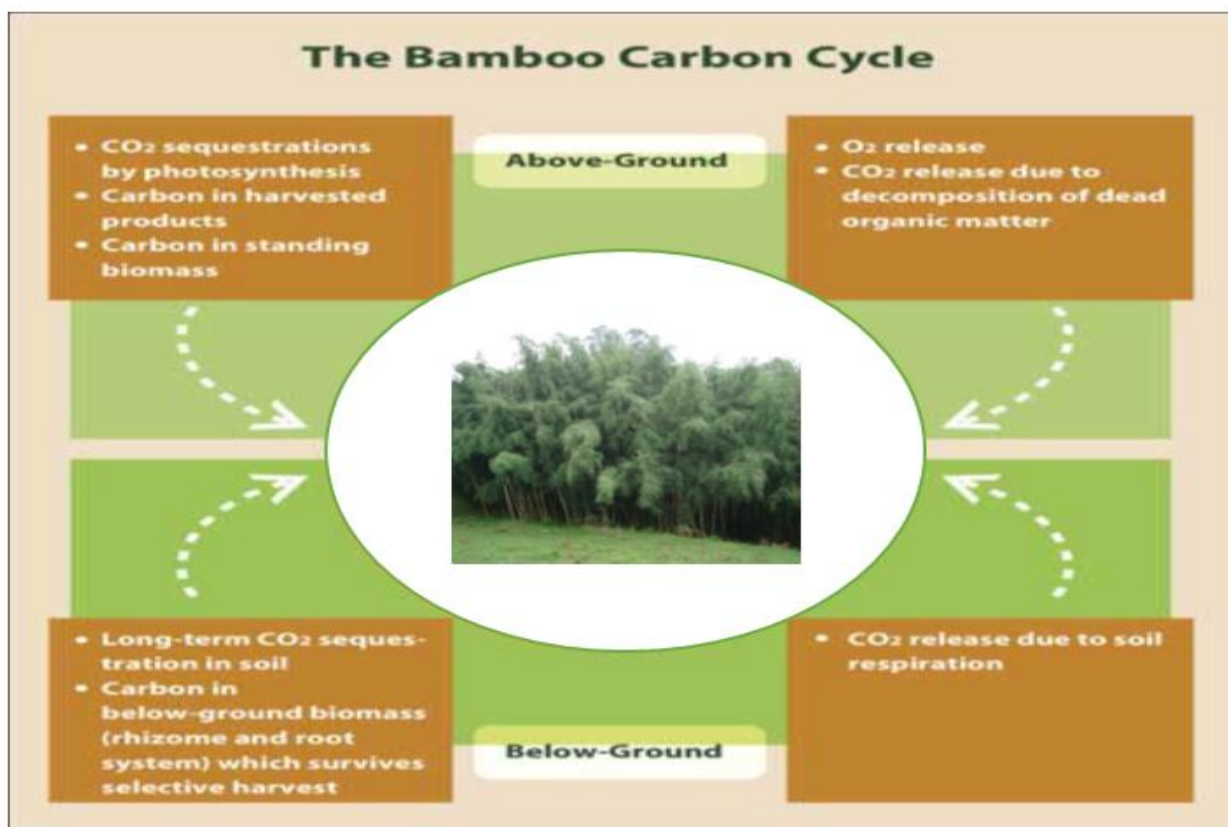


Figure-5: The roles of the bamboo forest for carbon sink above and below ground<sup>46</sup>.

Even if low-income household collected less bamboo and got less revenue, overall revenues made from bamboo harvesting was more important to livelihoods<sup>22</sup>. There are more than 20 diverse usages of bamboo in countryside parts of Ethiopia, even though these three product types are the greatest. These item types are buildings, traditional mats (*Satara*), and other several kinds of equipments<sup>19</sup>.

### The Role of Bamboo for Aesthetic Value

Bamboo garden centers/nurseries offer new bamboo growth that is used for city greening as well as beatification<sup>55</sup>. Bamboo is also evergreen and attractive to the environment. Various bamboo products are suitable on the other hand others serve decorative purposes. The study showed that bamboo keeps diverse aesthetic features. Bamboo has a variety of purposes in house beautification. Building inside decoration should entirely effect the natural features of bamboo materials<sup>24</sup>. The bamboo tool surface is smooth, lightweight, and versatile, with a simple and beautiful texture of natural and gentle color. Besides, bamboo wood can typically be seen in areas in an open field to protect the natural atmosphere<sup>3</sup>.

Bamboo plantations in terrains yield a good scene. The bamboo forest also grows fairly happily in almost all terrains and adjusts both macro/microclimates in tropical and subtropical areas. Some bamboo species originate from the mountainous areas<sup>56</sup>. The natural structure of a material of bamboo has been used in modern structures and designs, not because of its structural benefits such as durability and weightlessness, but because of its esthetic role. This natural beauty can be seen in two ways: first, the direct use of the bamboo plant as a dynamic, gorgeous plant in architecture. In Ethiopia, natural bamboo canes have been increasingly used in construction and interior design for a decorative purpose<sup>57</sup>.

Bamboo has been used for musical instruments in Ethiopia as aesthetic value. For instance, bamboo has high economic, eco-friendly, and aesthetic values in the Dawuro zone of southwestern Ethiopia. Among the aesthetic value; the longest woodwind musical instrument in the world locally called "Dinka" (4 to 5 meters long, four in number) is made from bamboo and other materials<sup>13</sup>.

### The Constrains of Bamboo Resources in Ethiopia

In Ethiopia, the bamboo reserves are under great stress that is directed toward the decline, and smaller attention was still obtained. This is because there is a very small local demand for manually handled bamboo crafts and there are only a few specialist companies that manufacture and sell bamboo furniture at a high price<sup>18</sup>. Also, bamboo production maybe an earnings-making which is generally small and it is mainly coined focused on handiwork plus additional households collecting, mostly in the rural areas<sup>51</sup>. For more sophisticated bamboo items, there is neither ample demand nor a market for local users. The impacts of value-adding training are therefore marginal and training involves the use of massive and costly equipment that smallholders either do not own or have access to. If processors have the abilities, but no means to use the information provided, then there is no use and value to the training given. There are still no known ways to sell bamboo<sup>58</sup>.

Accordingly, there are major challenges for bamboo product expansion was low awareness in the community. Ethiopia is not getting equivalent economic gain from the bamboo resource, compared to other growing countries<sup>16</sup>. The absence of farmers with enough knowledge and abilities to exploit bamboo is also among the causes of the decline of these forests. In addition to these, the obstacles for sustainable bamboo usage and trade are the lack of infrastructure that is difficult to transport to the market in some areas producing bamboo<sup>14</sup>.



Figure-6: (a) Bamboo musical instrument of Dawuro people and (b) bamboo decorative houses of Sidama people<sup>13</sup>.

Ethiopia is endowed with large bamboo resources but is under serious depilation through agricultural expansions and grazing land due to the lack of research as well as conservation interventions. At the same time, there is a lack of awareness about the appropriate cultivation management and harvesting of the highland bamboo at both the farm and market level<sup>29</sup>. Also, inadequate technologies and their transfer: lack of database on types, traditional methods of harvesting, processing, storage, market information, and feasible production options, information on seasons of harvesting, optimum harvesting rates, locations of high potential, and technologies for efficient utilization are not practically applied by the people where the resources exist. Moreover, the introduction and utilization of modern processing technologies are at their infant stage, tools for large-scale propagation and management of bamboo, and pre-extension services for the produced technologies and diffusion of information to the intended users are absent<sup>3</sup>. Furthermore, lack of product diversification in concentrated areas, bamboo products are seen as inferior, with seasonal variabilities and minimal demand for products with high-value addition<sup>20</sup>.

The bamboo market in the worth chain in Ethiopia is too small to allow environmental connectivity. There is slight relation between the existence and design of request, the position of marketplaces and goods, and their physical appearance to direct Ethiopia's bamboo agroindustry<sup>13</sup>. Similarly, Ethiopia's bamboo value chain is also not aimed at the export market (Figure-7).

Except for certain latest attempts to produce some goods by innovative machinery, nearly entire bamboo products exist habitually as well as manually made and are more used for the local market<sup>12</sup>.

### The Management Strategies of Bamboo Forests in Ethiopia

East African Bamboo Project (EABP) is working on the upgrading of bamboo forests in Eastern Africa, particularly, in Ethiopia and Kenya. The key objectives of this project are to improve the planting and exploitation of bamboo resources in these two countries in East Africa<sup>59</sup>. The understanding of the role of the forest by the communities was described as indirect advantages such as having a high potential to add rain spray, preserving soil richness, keeping extreme sunshine, and keeping soil from erosion, and direct advantages such as receiving non-wood forest products (NTFP) and timber and other forest-related products. However, these two well-contributed forests are known that the community's knowledge of an indirect advantage is greater than the forest's direct advantages. The forest publics remain further linked with the forest and they have different preservation approaches in their region due to their local awareness. This original knowledge of public-connected in the direction of the exercise of management was for traditional acceptance, medicinal value, for the withdrawal of honey and coffee shade, and others<sup>60</sup>.

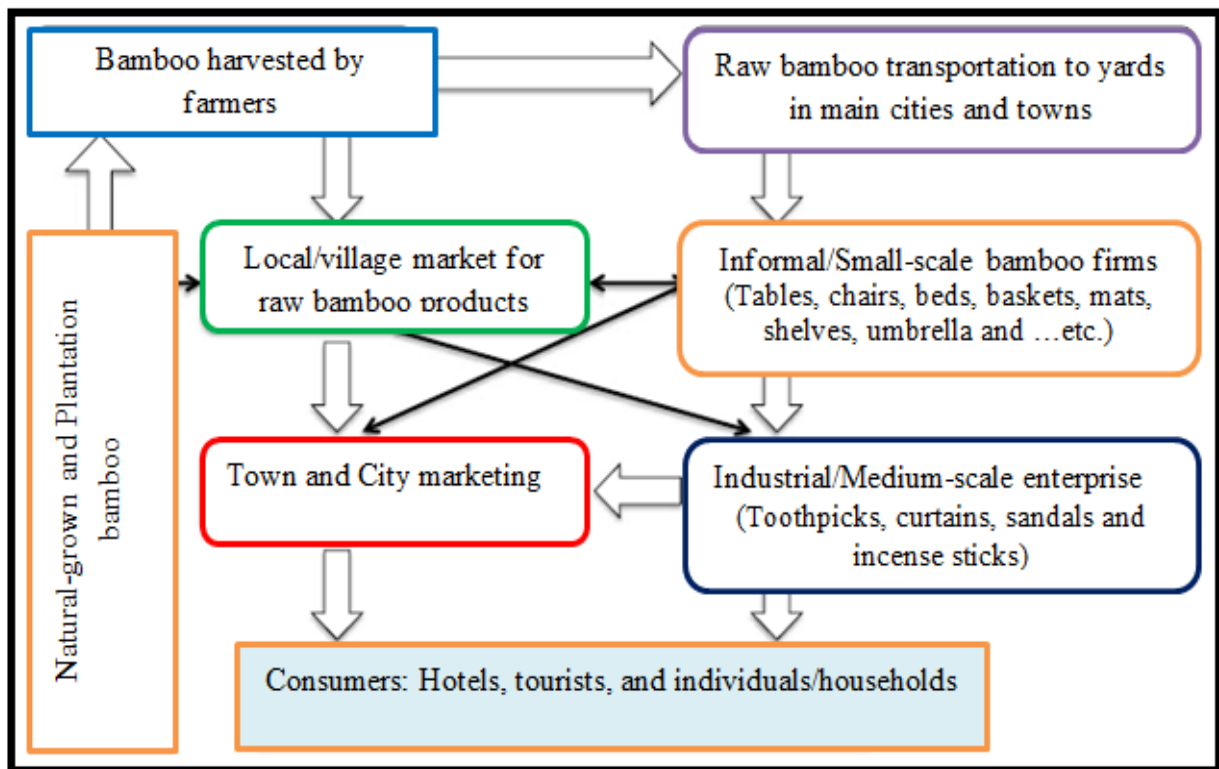


Figure-7: Bambo value chain in the domestic market in Ethiopia<sup>12,13</sup>.



Seedling beginning, succeeding for continued existence plus expansion stay vigorous for normal for estyrye-establishment by seeds<sup>61</sup>. The Government of Ethiopia has planned policies and strategies to boost the sustainable management of forests with bamboo as a renewable resource. This allows bamboo plantation for increased forest cover and improvement of livelihoods of the community while restoring biodiversity, carbon sequestration, and ecological role over water and soil conservation<sup>62</sup>. Sustainable plantation management currently means that bamboo forests can be used to encourage living's defective effects on the natural environment<sup>63</sup>.

Establishing more bamboo plantations for raw material supply for industries, watershed management, and income generation should be an important step in the future. The introduction of suitable species from other parts of the world should also be seriously considered to diversify the resource base<sup>64</sup>.

According to Boissiere *et. al.*<sup>65</sup> six there are diverse categories of bamboo forest management that are known (Figure 8).

**Upholding the exploitation of bamboo assets and other forests for manufacturing:** This would remain in abundant zones of the bamboo plantation, regions closer to infrastructure and the market, and where bamboos are ready to be harvested and have already reached maturity.

**Preservation of bamboo for biological diversity:** This activity must mark protection- significant spaces in sparsely populated areas, inaccessible areas, close to secure regions and agriculturally unsuitable soil agriculture. In conserved areas, to ensure the health of the bamboo forest, some bamboo culms should be removed annually.

**Cooperative Forest Management (PFM) for protection plus ecological usage:** Participatory forest management refers to the active participation of bamboo management NGOs and governmental organizations in Ethiopia. PFM should mark regions where bamboo forests are significantly existing and

mature, not far from transportation and market, highly populated areas, and close to agricultural investment plans are in place to rationalize the need for the conservation and usage of bamboo forests sustainably.

**The Regions discloser to bamboo reestablishment:** aside to encourage the restoration of bamboo forests is to end any action in some exceeding lyreduced parts in are as bamboo usually grows. This should be done where bamboo is scattered or has vanished, or where the presence of roads, nearby agricultural investment plans, and high population density can put pressure on the remaining resource of bamboo. The exclusion of bamboo areas in deteriorated places with steep slopes, inappropriate for agriculture, should be expected. These are some of the conservation possibilities for forest site, that refers to bamboo plantations. Some bamboo culm harvests can take place even in areas excluded before bamboo reach its maturity.

**Farming for bamboo repairing and manufacture:** This is an operation that complements the exclusion of areas. In zones inside exclusion (improvement replacing, accessibilities with densely populated areas, establishing bamboo farm can being to be a good economic choice than agricultural activities), plantings can be made.

**Garden center:** is mostly connected with farms: were a place where farmsteads are being existent, seeds and seedlings are needed. Garden centers can generate sprouts from spores, established shoots, or slight seedlings transplanted from the forest. Seeds are only available after bamboo flowering, which happens approximately every 35 to 40 years. Nurseries can also be used to acclimate exotic bamboo species that might be developed later into plantations. Nurseries need to be developed near roads because of transportation needs, and near a permanent stream or river, for irrigating the young seedlings. The slope should be gentle (<5%) for water runoff during the rainy season, to avoid further erosion and water accumulation in puddles.

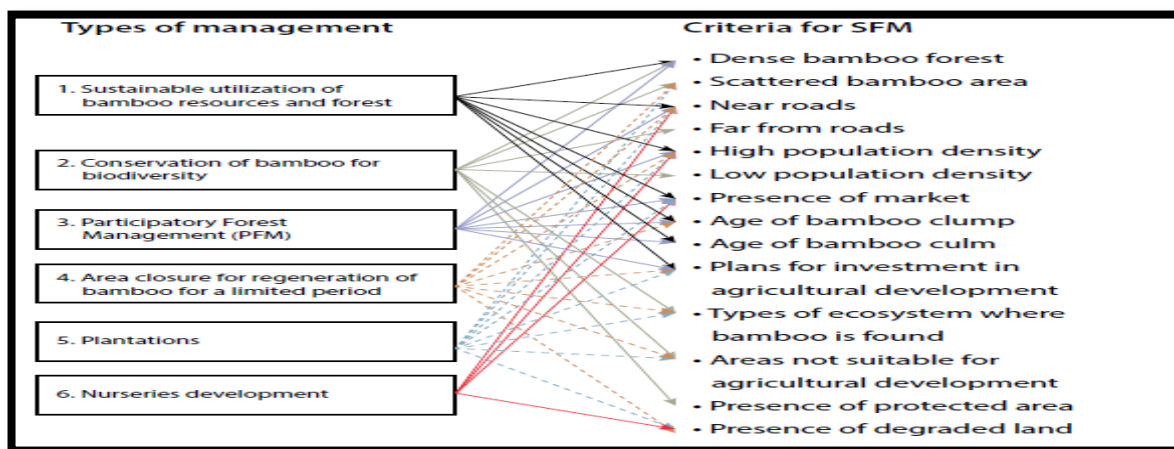


Figure-8: Integration of types of bamboo management and criteria of SFM or sustainable forest management<sup>65</sup>.

## Conclusion

Bamboo is the most basic woody grass widely distributed in the world including tropical, subtropical, and temperate regions. Ethiopia has Africa's largest natural bamboo forest, covering 67 percent of the total. There are two inherent bamboo types in Ethiopia, that are mountainous bamboo (*Yushania Alpina*) and drought-resistant bamboo (*Oxytenanthera abyssinica*) is found together in high ground and lowlands in the country. The roles of the bamboo forest are very wide and have multipurpose as well as it has also shown a great part in socio-economic, consumption, the environmental and cultural and aesthetic value in areas where it grows naturally and in farm centers of the country. Bamboo shoots are used as an important health food when processed They serve as medicinal usages, the shoot has lesser anti-nutrient content than in other vegetables, are fuel for food preparation, and animal fodder, and also used for feeding huge population without depletion of the forest resources. However, the consumption of bamboo shoots by humans remains at a very minimal level because of a lack of awareness of its edibility and nutritional value in the country. Bamboo serves as soil, water maintenance, and erosion prevention to improve the quality of the land, and carbon sequestration and it reduces the negative effects of greenhouse gases due to fast-growing features. Bamboo has also multiple socio-economic and aesthetic values like furniture, musical instrument, basket, beautification, traditional sticks, housing, and a source of livelihood and provides a very good raw material for cultural house constructions. However, bamboo resource in Ethiopia is under high pressure because of depletion and less attention from management, less value-adding training, no established means of bamboo selling, absence of awareness, weak technology efforts and its transfer, nearly the majority of bamboo harvests are made by the traditional way and by hand as well as used for the indigenous markets. Therefore, to maintain the multipurpose potential of the bamboo resource and derive benefits for present and future generations greater efforts are highly required from all stakeholders through applying the conservation of bamboo for biodiversity, nurseries, and sustainable utilization of bamboo resources in Ethiopia.

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