ADDIS ABABA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

The Contribution of Bamboo forest in enhancing livelihood and ecological resilience: The case of Bambasi Woreda, Beneshangul Gumuz Region, Ethiopia.

BY: MENGISTU TEREFE

ADVISOR: ASNAKE MEKURIAW (PhD)

SEPTEMBER.2024

ADDIS ABABA, ETHIOPA

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

.

The Contribution of Bamboo forest in enhancing livelihood and ecological resilience: The case of Bambasi Woreda, Beneshangul Gumuz Region, Ethiopia

College of Social Sciences Department of Geography and Environmental Studies.

Submitted by: **Mengistu Terefe** _____ _____

Name of Student Signature Date

Approved by the BoardExaminers Signature Date

1. Dr. Asnake Mekuriaw _____ _____

Advisor

2. Dr. _____ _____ _____

Internal Examiner

3. Dr. _____ _____ _____

External Examiner

4._____ _____ _____

Chairman

September 2024

Addis Ababa

AUTHER'S DECLARATION

The researcher declares that the Thesis on the title: "The Contribution of Bamboo forest in enhancing livelihood and ecological resilience", is my original work and the all sources that have been referred to and quoted have been dully indicated and acknowledged with complete references.

Name –Mengistu Terefe

Signature_____

Date_____

This thesis has been submitted for examination for approval as university advisor:

Advisor: Asnake Mekuriaw (PhD)

Signature-_____

Date-_____

College- Social Sciences

Department- Geography and Environmental Studies, Postgraduate program

September 2024

Addis Ababa

ACKNOWLEDGEMENTS

First and foremost, I thank God for all His grace, mercy, charity, forgiveness, help, and kindness that made me still alive, achieve this success, and go through all the difficult times. There are several challenges along the way and I believe I am privileged for. Secondly, the author goes to major advisor Dr. Asnake Mekuriaw, who took from his busy time for his intellectual stimulation, professional guidance, and encouragement in undertaking this study.

Many thanks to the Ministry of Education for the MA scholarship award, which facilitated my postgraduate studies at Addis Ababa University. My deepest gratitude also to Addis Ababa University for support me the necessary materials and paving the way to teaching learning processes. I would also like to thank the farmers of Bambasi rural and urban residents who took their precious time to complete my questionnaires and to the Bambasi Woreda Authority for granting me permission and facilitating a healthy environment to conduct the survey. There also I am grateful for my whole my staff teachers especially Fekade Kebede and Wakshuma Kelbesa for their technical support and by borrowing his computer. Finally I am grateful for my family , my wife Bachu Abera for supporting me throughout this thesis.

Table of Content

Contents

List of Table Page

List of Figure **Page**

ACRONOMYS

BGRBOA Beneshangul Gumuz Regional Bureau of Agriculture.

BOFED Bureau of Finance and Economic Development

BIPPCSA Bureau of Information and Public Participation Co-ordination and Social Affairs.

BWARDO BambasiWoreda Agricultural and Rural Development Office.

CF Community Forest

CFUG Community Forest User Group

DOF Department of Forestry

EABP Eastern Africa Bamboo Project.

EMA Ethiopian Map Authority

FAO Food and Agricultural Organization.

FAOWBR Food and Agricultural Organization World Bamboo Resource

FGQ Focused Group Question

INBAR International Network for Bamboo and Rattan.

LAI Lease Area Index

NTFP Non-timber Forest Product

Abstract

*The thesis explores the multifaceted role of bamboo forests in improving local livelihoods and promoting ecological resilience. Bamboo, a fast-growing and versatile plant, offers economic benefits through sustainable harvesting and various uses in construction, crafts, and food products. This study employs qualitative and quantitative methods to assess the socioeconomic impacts of bamboo forests on communities and their contributions to biodiversity conservation and climate change mitigation. Findings indicate that bamboo forests significantly enhance community resilience by providing employment opportunities, improving food security, and fostering sustainable land management practices***.** *Its over-exploitation affects the environment, wildlife habitat, native vegetation, and even the bamboo ecosystem. Regarding the economy of peoples, the study estimated the Contribution of Bamboo forest in enhancing livelihood and ecological resilience: with the general objective of assessing the role of bamboo forests in the regeneration of indigenous vegetation in Bambasi Woreda, Beneshangul Gumuz Regional State. Thet arget-specific aim of the study includes: analyzing the economic use of bamboo trees, examining the role of bamboo trees in the regeneration of indigenous vegetation, analyze the challenges of opportunities for bamboo trees in the study area. A sample of 124 respondents was randomly selected from three villages surrounding the known bamboo tree area (Anbesa Chaka) to analyze the significance of regeneration for Indigenous trees. The data were collected through structured questionnaires field observations, interviews, and focused group discussion. The study concluded that consideration of regenerative benefits to indigenous vegetation and economic characteristics living around the bamboo tree is essential in bamboo forestry conservation and rehabilitation. Therefore, the government associated with the community should emphasize on awareness of keeping and conserving the resources in Beneshangul Gumuz Regional State in general and enhance the rehabilitation program in Bambasi Woreda in particular. Besides this resource consumption trends should be improved to reduce wastage.*

Keywords: ***Contribution, Bamboo enhancing, ecological Benishangul Gumuz, Bambasi***

CHAPTER-ONE

INTRODUCTION

1.1 Back ground of the study

Bamboo is a natural regenerative plant, which naturally grows mostly in tropical and sub-tropical ecology (Akinlabi, 2017). It is natural plants which also grow in moist regions. Its species ranging from 1439-1500 with 115 genera's across the world. As many as 1500 bamboo species exits in the worldwide, most of which grows in Southeast Asia (Girma Belihu.2021).

Bamboo forests play a crucial role in terrestrial ecosystems, especially in tropical and subtropical regions. Bamboo, a fast-growing grass, significantly alters forest dynamics through its life cycle. Its growth patterns, die-back events, and subsequent regeneration cycles impact the structure and composition of forest ecosystems. Native bamboo species can affect tree regeneration diversity in subtropical Atlantic forests, influencing forest composition and biodiversity (Capellesso et al., 2022). Similarly, bamboo's dominance can lead to shifts in species composition, often favoring bamboo over other plant species (Campanello et al., 2007). Bamboo can suppress tree regeneration through several mechanisms, including competition for resources, alteration of microclimates, and physical barriers. Bamboo forest that found in south-eastern Peru can control forest succession, significantly affecting the growth of other tree species (Griscom et al., 2003).

Bamboo's influence extends to biomass accumulation and carbon sequestration. (Padgurschi et, 2021) indicates that native bamboo species can impact the biomass and carbon stocks of neo tropical forests, affecting overall forest health and carbon dynamics.

This has implications for forest management practices aimed at enhancing carbon sequestration and mitigating climate change (Guaratini et al., 2024) noted that bamboo dominance and subsequent die-off events significantly influence seedling dynamics in tropical secondary forests, often leading to changes in species composition and forest structure. These changes can delay or alter the natural succession processes, impacting long-term forest regeneration and biodiversity. Understanding their impact on indigenous vegetation is vital for sustainable forest management and conservation efforts. The spread of bamboo poses significant challenges for forest management (Buziquia et al. 2019) reviewed the impacts of bamboo spreading, emphasizing the need for effective management strategies to control its dominance and mitigate adverse effects on indigenous vegetation. Successful management requires a comprehensive understanding of

bamboo's ecological impacts and the implementation of targeted interventions. Bamboo forests significantly impact the regeneration of indigenous vegetation through their influence on forest structure, species composition, biomass accumulation, and nutrient cycling. Studies across various regions highlight the need for targeted management strategies to balance bamboo control with the promotion of biodiversity and forest health. This research aims to contribute to the understanding of bamboo's ecological effects and support sustainable forest management practices.

A total of 1.4 million hectares of which is distributed over the Eastern Africa. The pure natural bamboo forest in Ethiopia was the largest in Africa, over about 1 million ha, and 85% of this area is covered by Oxytenanthera abysinica, which is an indigenous bamboo to Ethiopia and endemic to tropical Africa. Bamboo tree is one of the fastest growing highest productivities, most versatile, short harvesting cycle, and annually renewable and harvestable plant if it is managed in intelligent way. Bamboo is a natural resource highly utilized in many parts of the world. Bamboo has received an increasing attention for its multiple uses and its advancing new applications over the past twenty years on the globe (Dwivedi, 2019).

About 2.5 billion people depend on bamboo with an estimate value of US$7 billion per year (Phimmachanh, 2015). Bamboo trees offer potentially huge ecological and socio-economic benefits in countries like Southeast Asia, Africa, and Latin America (Basumatary, 2015). It is wood forest product and wood substitute bamboo is of increasing interest to ecologist owning to its rapid growth and correspondingly high potential for mitigating climate change (Sheikh, 2014). It is the source for most popular materials for cutting boards, medicinal benefits, popular health care foods in the world (Maroma,. 2015). It has high economic and environmental values that convert solar radiation into useful goods and services better than most tree species (Embaye, 2003). In countries like India and China, it is used as paper pulp resource, scaffolding, agriculture implements, weaving material, play wood and particle board basketry, furniture, medicines and the likes. In general, bamboo has about a multipurpose and over 600 million people around the world generate income from it (Desalegn, 2014). In relation to its durability, a 4500-year-old bamboo house has been found in Ecuador (Yiping, 2010). However, in Africa bamboo has very limited uses (Bystriakova, 2004.).

Ethiopia is known for its diverse fauna and flora. In Beneshangul-GumuzRegion, the benefit from bamboo tree is mainly for subsistence uses such as housing, fencing, kitchen utensils,

baskets, mats, and agricultural implements and fuels for food (Boissière, 2019). Bamboo is an integral part of forestry and one of the major products in Bambasi woreda. The traditional use of bamboo has become part of Bambasi Woreda culture. Bamboo can also be called the backbone, especially, in Mao, Komo and Berta society (zelalem, 2019). Bamboo has many small, but important uses such as flutes, fishing traps, handicrafts, walking sticks, packing cases for fruits, and pipes for water supply and irrigation (Demissew et al., 2011). In Bambasi Woreda, bamboo is extensively found on non-farmlands. The natural stands are found mixed with deciduous sub-tropical vegetation. These natural stands, however, are suffering from lack of management, lack of developmental schemes and lack of conservation as well as unsustainable harvesting and out-dated cultural technologies.

1.2 Statement of the Problem

Despite the recognized benefits of bamboo forests, there is a lack of comprehensive understanding regarding their specific contributions to local livelihoods and ecological health. Many communities remain unaware of the potential economic advantages and ecological services provided by bamboo. Additionally, there is insufficient data on how bamboo cultivation can be integrated into broader sustainability initiatives. This research addresses these gaps by analyzing the impacts of bamboo forests on community well-being and ecological resilience.

The impacts of bamboo on seedling dynamics are particularly concerning bamboo dominance and die-off events significantly influence seedling dynamics in tropical secondary forests, often leading to decreased seedling survival and altered species composition (Guaratini, Gomes, & Alves, 2024). This can have long-term impacts on forest regeneration and biodiversity, as the establishment of new seedlings is crucial for forest renewal. Bamboo affects nutrient cycling and litter decomposition, which are vital processes for forest health. Austin and Marchesini (2011) noted that gregarious flowering and death of bamboo in Patagonian forests slow litter decomposition and nitrogen turnover, affecting nutrient availability for other plant species. This can lead to nutrient imbalances, further disadvantaging indigenous vegetation and promoting bamboo dominance.

Bamboo trees are important for indigenous vegetation that regenerates soil fertility, home of wildlife, carbon sink and in regulating climate. The over exploitation of bamboo forest resources for fuel wood, construction, income, as food and medicinal plant, wildlife habitat and the ecosystem of the bamboo tree. According to (BWARDO, 2019), the department of forest

protection and development office is committed as a part of the community forest initiatives for transferring of forest and management and use through local communities, However, there is still a number of policy and practical issues that need to address the potential of lowland bamboo as the source of economy of the people, growth and biodiversity conservation. In Beneshangul Gumuz Regional State study specifically, the lowland bamboo species are over exploited and degraded under the community forest management (Desta,). Lack of knowledge and local control over resources, rural poverty, increasing external market demand and social cultural practices are considered as the causes of lowland Bamboo degradation (Mosissa, 2019). Natural bamboo tree in Bambasi woreda have considerably reduced during the last four decades

Nature has given gift us a valuable resource, but our skills were very limited, so far, we are not able to utilize them in proper way. They have not thought about rural livelihood economy in large scale but only in the particular area excluding community cultivation. The trading of the bamboo trees seems to be profitable and easy to work and earn money. But no detailed studies have yet been conducted on the regeneration of bamboo forest on indigenous vegetation in Bambasi Woreda. Because of in adequate field survey, ecology and uses of bamboo is little known in this woreda's. Department of Forestry (DOF) in Bambasi Woreda conducted very limited research in this sector of which many rural communities in different parts of the Woreda are cultivating and managing bamboo successfully and depend on bamboo for their survival. Therefore, this study tries to fill the existing research gap by focusing on the overall contribution of bamboo tree in the study area. If not studied the sustainability of the bamboo resource may be in question.

Research Objectives

1.3.1General Objectives

The general objective of the study is to assessthe Contribution of Bamboo forest in enhancing livelihood and ecological resilience: The case of Bambasi Woreda, Beneshangul Gumuz Region, Ethiopia.

1.3.2 Specific Objectives

The specific objectives of this study are as follows:

1. To analyze the economic use of bamboo tree in the study area.
2. To examine the role of bamboo tree on the regeneration of indigenous vegetation

3. To analyze the challenges and opportunities to bamboo tree in the study area.

1.3.3 Research Questions.

The research particularly focused on trends of skills and knowledge bamboo tree management and its contribution in the regeneration of indigenous vegetation. Thus the study needs to answer the following questions:

1. What is the contribution of the bamboo tree on the economy of local people surrounding study area?
2. What are the prier trends and skills of people on bamboo tree utilization, management and conservations?
3. What are the major treble and future opportunities faced by bamboo tree utilization and restoration system?

1.4. Significance of the Study

The information generated from this research could be how the role of Bamboo forest to regenerate indigenous vegetation naturally. Furthermore, detailed study about the significance of bamboo forest for indigenous vegetation gradually, in consumption system in Bambasi Woreda were assisted the decision makers to identify the challenges and opportunities in sector and the basis for possible development interventions to boast the bamboo tree conservation.

Identification of factor that influences farmer for long term conservation practice and estimation of the amount of income household gets can help both policy makers to design conservation method and rehabilitation strategy programs. For that factors determined knowledge for local community dependency also help in revising and implementing methods and plans which have been designed to save the resource additionally. The result of this research will serve as a benchmark and a source of information to the governmental organizations and NGOs to carry out the conservation of bamboo sustainably and researchers which were conducted in the region on bamboo resource and related topics. Limited systematic documentation of the challenges and opportunities of bamboo forest in Bambasi Woreda make it difficult for sustainable use of bamboo forest. In the quest to conserve indigenous bamboo species for its ecological potential, the local community will also have the opportunity to acquire conservation skills which can be applied to monitor and safeguard other biological species, enhancing sustainable environmental management practices. The findings gained from this study imperative for successful planning and decision maker and can be used strengthen the aims sated on National Environmental

Information Management System which can assist Ethiopia work on progress towards achieving the targets associated with the United Nation Sustainable Development Goals (UNSDG) as Ethiopia efforts to achieve Vision by 2030.

1.5 Scope and Limitations of the Study

The study was made in Bambasi Woreda of Beneshangul Gumuz Regional State. The woreda is found along the main road goes from Addis Ababa to Asossa. It is found from the regional administrative city Assosa 45 km and 623km from Addis Ababa. The study area was 17km from the woreda and 28km from capital city of the region. Even though the study is needed in all forest areas, the study will be restricted only to *‚Anbessa Chaka,* and did not include other Woreda's forest that contribute to the conservation and rehabilitation activities as they are also beneficiaries of the resource. The chosen behind this forest is, from its name during the last 50s years before, known as the home wild animals especially lions and named from lion forestry. Nowadays, the forest of which bamboo tree become diminished and eradicated is because of most people migrated from north of Ethiopia during 1977 and 1982 E.C and settled surrounding the forest area.

1.7 Organization of the Thesis

This paper has been organized in well five chapters. From thus, the first chapter dealt on back ground of the study, statement of the problem, objectives, significance, scope and limitation of the study. Following second chapter associated with review of different literature which is related to bamboo tree characteristics and other relevant to the title. Then chapter three dealt with methodology of the data collection, techniques and definition of variables whereas chapter four deal with details of data analysis and interpretation. The last chapter generally presents summery, conclusions and the policy implication of the study.

CHAPTER-TWO

REVEW OF THE RELATED LITERATURE

2.1 Meaning of the Bamboo forest

Bamboo is a type of grass that belongs to the subfamily Bambusoideae that known for its rapid growth and versatility. Bamboo is incredibly strong for its weight, making it a popular material in construction, furniture, and crafts. It grows quickly and can be harvested without killing the plant, making it an eco-friendly resource. In many cultures, bamboo symbolizes strength, resilience, and flexibility. Beyond construction, bamboo is used in food (like bamboo shoots), textiles, and even musical instruments.Bamboo is admired for its practicality, beauty, and environmental benefits.

Its unique biological characteristics and ecological roles have significant implications for forest dynamics and biodiversity. Understanding the meaning of bamboo in the context of forest ecosystems is essential for assessing its impact on the contribution of indigenous vegetation. Bamboo is known for its rapid growth rate and ability to thrive in diverse environmental conditions. This growth trait allows bamboo to quickly colonize areas, often forming dense thickets that can out compete other plant species for light, water, and nutrients (Capellesso, Artusi, & Marques, 2022). The clonal nature of bamboo, where new shoots arise from a common root system, further enhances its ability to dominate large areas. Bamboo has received an increasing attention for its multiple uses and its advancing new applications over the past twenty years on the globe (Dwivedi, 2019). It provides considerable economic, social, and environmental values for local communities (Zelalem, 2019).Among others, fuel wood, timber and non-timber products, construction materials, medicinal uses, and cultural values (Tugume, 2019). Over 600 million people around the world generate income from bamboo and millions live in bamboo houses (Boissière, 2019).

2.2. Characteristics of Bamboo forest

Bamboo forests have unique growth characteristics with significant ecological implications, for the forest ecosystems.

Bamboo is renowned for its rapid growth rate, one of the fastest among plant species. Certain bamboo species can grow up to 91 centi-meters (35 inches) per day under optimal conditions. This extraordinary growth rate allows bamboo to quickly colonize areas, forming dense stands that can out compete other vegetation (Fadrique et al., 2021). The ability to expand rapidly is facilitated by its rhizomatous root system, which enables new shoots to sprout from a network of underground stems. This clonal growth mechanism allows bamboo to cover large areas swiftly, often leading to the formation of mono dominant bamboo forests.As most bamboo forests have morphology that attains tree size at the maturity they have been named as tree grasses. The rhizome is the structural foundation of the plant of which the Culm depends on mechanical anchorage; spacing and vigour (Embaye, 2000).The fibrous and thin root which spring from the rhizome nodes are responsible for the absorption of water and nutrient. So rhizomes are structured as aectomorph (monopodia), giving rise to a single-stemmed culms from each part of pachymorph (sympodial), developed to group of clustered culm(Embaye,2000). In most fully developed forests of Ethiopian lowland bamboo is a pachymorph where the highland bamboo is mostly a leptomorph. In each year, the bamboo population increase by 5-10 shoots per clump (Sosal, 2005). Bamboo is a perennial plant (Kigomo, 2020). Once the rhizomes root system is well established, new bamboo shoots attain full height (6-8m) and diameter 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 (Kaur, 2019). They are matured, strong and ready to be utilized after 2-3 year. The bamboo culm and rhizomes growth are affected by internodes expansion, which before developing are telescoped in to 2 to 3 cm in the bud (Bajera, G. B, 2010).bamboo flowers reward the end of its lifetime (14-50 year in some species) and then dies soon after. For this reason, bamboo flowering is considered as a “disease” Ethiopian who live in the bamboo growing areas (Mosissa, 2019). The average annual stem increment of unmanaged or wise use of natural bamboo tree of Ethiopia is 8.5-10 tons of over-dry matter per hectare.

Bamboo primarily reproduces through vegetative means, although sexual reproduction through seeds also occurs. The clonal nature of bamboo, where new shoots arise from a shared rhizome,

ensures the rapid expansion and persistence of bamboo stands. This reproductive strategy contributes to its resilience and ability to dominate landscapes, often at the expense of other plant species (Greig, Robertson, & Lacerda, 2018).Bamboo species exhibit unique phenological cycles, including mass flowering events followed by dieback. Many bamboo species flower gregariously, meaning all individuals in a population flower simultaneously at long intervals, often spanning several decades. After flowering, most bamboo plants die, a phenomenon that has profound ecological effects (Austin & Marchesini, 2011). This dieback can lead to significant changes in forest structure and nutrient cycling.

Africa has about 43 species of bamboo covering about 1.5 million hectares (Kigomo, 1988). Forty of these species are mainly distributed in Madagascar while the remaining three species are found in mainland Africa. Ethiopia is one of the countries in Eastern Africa that possess considerable bamboo resources. There are two indigenous species of bamboo in Ethiopia i.e. the highland or African alpine bamboo and a monotypic genus, lowland bamboo. These species are found in some other African countries, but nowhere else outside the African continent. The highland bamboo is distributed in Cameroon (Mt. Cameroon), Zaire (Kivu), Rwanda, Burundi, the Sudan and the mountains of Uganda, Kenya, Tanzania and Malawi (Nyika Plateau), while the lowland bamboo is wide-spread, occurring westwards to Senegal and southwards to Zimbabwe (Phillips, 1995). They are indigenous to Ethiopia and endemic to Africa, confined to the sub Saharan region. Ethiopia has over one million hectares of highland and lowland bamboo resources (Kindu, Y.M.M., 2010). The coverage of lowland bamboo is estimated to be 1,000,000 hectares (Phimmachanh, S., Ying, Z. and Beckline, M., 2015), while the highland bamboo is estimated to be 300,000 hectares (LUSO CONSULT, 1997). This means that 86% of the African bamboo resource is found in Ethiopia. Lowland bamboo in Ethiopia grows only in the western part along major river valleys and in the lowlands bordering Sudan. It occurs between 1100-1700 m.a.s.l. The species grows in woodland, mainly in river valleys and often forming extensive stands (Clark, 2015). The lowland bamboo has enormous importance for the rural society. Because of the shortage of proper woody plants for construction in the lowlands, the lowland bamboo is commonly used as an alternative for timber in house construction, fences and also as fodder for cattle, human food and as energy supply. Of the total estimated lowland bamboo coverage about 480,510 hectares have been mapped (Kibwage, 2011).

The dominance of bamboo in forest ecosystems often results in reduced tree density and basal area, as evidenced by studies in Andean forests (Fadrique et al., 2021). This reduction is attributed to bamboo's ability to outcompete tree seedlings for resources, thereby limiting the regeneration of tree species and altering forest composition. Similar observed patterns in subtropical forests of South America, where bamboo dieback led to changes in tree regeneration responses, further influencing forest dynamics (Budke et al., 2010). The competitive exclusion by bamboo can lead to a decrease in plant diversity, with bamboo-dominated areas supporting fewer species compared to mixed-species forests. Bamboo's influence on forest succession is significant, as it can both facilitate and hinder the process. In some cases, bamboo provides a protective canopy that shelters young tree seedlings from harsh environmental conditions, aiding their establishment. However, the dense bamboo canopy can also restrict light and nutrient availability, slowing down the succession process and delaying the transition to more diverse forest types (Greig, Robertson, & Lacerda, 2018). This dual role underscores the complexity of bamboo's impact on forest ecosystems, necessitating detailed studies to unravel its effects on forest succession and biodiversity.

This is the higher production rate than report from bamboo forest in tropical Asia and elsewhere. It is possible to harvest about 3 million tons of oven-dry biomass on a sustainable basis from the 1 million 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, furniture, construction, and energy supply of the country.

2.3 Types of Bamboo species

As far as prier information about coverage and distribution of bamboo tree in Ethiopia is very limited relatively uses for most people. From all of these, the total coverage of mapped high land bamboo (*Yushaniaalphina)* in Ethiopia is 129,000 ha and the total area of mapped lowland bamboo on other hand amounts to 480510ha (Dereso, 2019).Bamboo is a diverse group of plants, and there are over 1,400 species categorized into several genera. Here are some notable types of bamboo species.

Giant Bamboo (Dendrocalamus giganteus): One of the tallest bamboo species, reaching up to 30 meters (98 feet) and uses for Construction, furniture, and crafts.Moso Bamboo (Phyllostachys edulis): A large species native to China, known for its edible shoots uses timber, food, and paper production.Black Bamboo (Phyllostachys nigra): Notable for its striking black stems, which

develop color with age and uses Ornamental gardening and crafts.Golden Bamboo (Phyllostachys aurea): Features bright yellow canes and can grow up to 3-4 meters (10-13 feet)and used for Landscaping and privacy screens.Clumping Bamboo (Bambusa spp.): Forms tight clusters and is generally less invasive than running bamboo used as Ornamental gardens and erosion control.Timor Black Bamboo (Bambusa tulda): A tropical species with dark green to black culms and uses for Crafts and furniture. Bamboo Palm (Chamaedorea spp.): Although not a true bamboo, it has similar aesthetic qualities and is often used in indoor settings used for houseplants and landscaping. Sweet Shoot Bamboo (Phyllostachys dulcis): Known for its sweet edible shoots, popular in culinary applications used for food and ornamental purposes.Himalayan Bamboo (Dendrocalamus Hamilton):Adapted to high altitudes, growing well in cooler climates and Construction and traditional crafts in local communities Sinha, A. K., & Singh, P. (2018).

2.3.1 High land Bamboo

Highland bamboo, primarily found in the mountainous regions, plays a significant role in shaping the forest ecosystem. This study aims to assess the effect of bamboo forests on the regeneration of indigenous vegetation, focusing on the dynamics between bamboo species and native plant communities. Bamboo species, known for their rapid growth and extensive root systems, often dominate forest understories. This dominance can have both positive and negative impacts on the regeneration of indigenous vegetation. Understanding these impacts is crucial for forest management and conservation efforts. Bamboo influences forest dynamics through direct and indirect mechanisms. Directly, bamboo competes with tree seedlings for resources such as light, water, and nutrients. Indirectly, bamboo can alter the microclimate and soil properties, which in turn affect the growth and survival of tree species (Caccia et al., 2009).

In mixed temperate forests, the presence of bamboo can shape tree regeneration niches by creating dense thickets that limit light availability. This competition can hinder the establishment of shade into levant tree species, thereby influencing the composition of the forest (Caccia, Chaneton, & Kitzberger, 2009). The microclimate within bamboo-dominated areas differs significantly from that of non-bamboo areas. Studies on Atlantic Forest show that, bamboo-dominated understories can create cooler and more humid microclimates, which can be favorable for certain tree species while inhibiting others (Campanello et al., 2007). The altered microclimate conditions can influence seedling survival rates and the overall diversity of tree regeneration. The presence of bamboo can have a profound impact on the diversity of tree

regeneration. In subtropical Atlantic Forests, native bamboo species have been observed to reduce the diversity of tree regeneration. The dense bamboo understory can out compete tree seedlings, leading to a decrease in arboreal diversity (Capellesso et al., 2022). This reduction in diversity can have long-term implications for forest structure and function

Initially, bamboo growth stands developed from seedling and offset method greatly varies in high land bamboo. In related with the rare seed production of highland bamboo, establishing stands using seedlings is not the same. However, it is observed that productivity of out planted seedling under field condition takes longer time to produce larger size culms. Both the number and size plants in the newly established stand exponentially increase during the next 3-4 years in good sits, since the maximum stature of the stand is reached.

The high land bamboo area gives a good indication since these areas have been mapped quite perfectly from aerial photographs. Because of most high land bamboo areas are found in remote and inaccessible areas with comparatively low population pressure, it seems that the whole high land bamboo area has not decreased significantly (Embaye, 2005).In most surveyed literature agree that bamboo is a native forest resource in Ethiopia has over 650,000ha of native lowland bamboo and 350,000 ha of high land bamboo the later represents 86% Africa's forest resource high land bamboo resources.

2.3.2. Lowland Bamboo

Lowland bamboo, prevalent in tropical and subtropical regions, plays a significant role in shaping the ecosystem dynamics of these forests. This study aims to assess the effect of bamboo forests on the regeneration of indigenous vegetation, focusing on the interactions between bamboo species and native plant communities in lowland regions. Bamboo, with its rapid growth and dense clumping nature, often becomes the dominant understory vegetation. This dominance can influence the regeneration of indigenous vegetation through various direct and indirect mechanisms. Understanding these impacts is essential for effective forest management and conservation strategies. Bamboo impacts tree regeneration through both direct competition and indirect environmental modifications. Directly, bamboo competes with tree seedlings for essential resources such as light, water, and nutrients, often outcompeting slower-growing tree species (Caccia, Chaneton, & Kitzberger, 2009). Indirectly, bamboo can alter the microclimate and soil properties, which significantly affect the growth and survival of indigenous vegetation. In mixed temperate forests, bamboo creates dense under stories that limit light availability,

which is critical for the germination and growth of many tree species. This shading effect can inhibit the establishment of light-demanding species, thereby shaping the forest composition over time (Caccia et al., 2009)

Bamboo-dominated forests exhibit distinct microclimatic conditions compared to non-bamboo areas. For example, studies in the Atlantic Forest indicate that bamboo thickets create a cooler and more humid microclimate, which can be beneficial for some tree species but detrimental for others (Campanello et al., 2007). These microclimatic changes influence seedling survival rates and the overall diversity of regenerating vegetation. The altered microclimate within bamboo thickets can also affect soil moisture and temperature regimes, further influencing the regenerative success of indigenous plants. These environmental modifications play a crucial role in determining which species can thrive under bamboo-dominated conditions.

The lowland bamboo is vigorously growing species that produces a huge biomass in a short period of time. The maximum height of lowland bamboo Culm at Shorkole area of Homosha district of the regions and the number was recorded to be more than 5m and the number of culms per clump more than 12. At Jimma observation site, planted seedling produced 15culms/clump with an average height of 4m and the diameter of 3.5 cm at the age of two years. Both plant and clump size dramatically, has increased in the third rainy season. Surprisingly, at the age of three years, a culm produces an average of more than 36 culms with maximum height of 8 m and diameter 4.5 cm. reach harvesting in shorter time than from seedling origin. Thus, under good conservation conditions, stands established using offset methods are expected to get it to production starting from the fourth year.

2.4The Distribution of Bamboo forest in Ethiopia

The African continent has about 43 species type of bamboo which covering about 1.5 million hectors (Kigomo, 1980). Of which around 40 species are mainly distributed in Madagascar while the remaining species (3) are found in mainland of Africa. Ethiopia is one of the most eastern Africa's countries that possess a considerable bamboo resource. There are about two indigenous bamboo species in Ethiopia i.e. the highland or African alphinebamboo (ArundinariaAlphina) and the monotypic genus, lowland bamboo (Oxytenantheraabyssinica). Such types of species are found in some other African countries but nowhere else outside Africa. The high land bamboo is distributed in Cameroon (Mt. Cameroon), Zaire (Kivu), Rwanda, Burundi, Sudan and mountains of Uganda, Kenya, Tanzania and Malawi (Nyika plateau). While the lowland bamboo is

widespread westward to Senegal and south ward to Zimbabwe (Phillips, 1995). These bamboo species are indigenous to Ethiopia and endemic to Africa, confined to the sub-Sahara regions. Ethiopia has covered over one million hectares of highland and lowland bamboo resources (Kindu.Y.M.M, 2010). The coverage of the lowland bamboo is estimated to be 1,000,000hectores (Phimmachanh,S., Ying, Z. and Beckline,M., 2015). In other the highland bamboo is estimated to be 300,000 hectares (LUSOCONSULT, 1997). Which means 86%of the African bamboo resource is found in Ethiopia. The lowland part of Ethiopian bamboos grows only along river valleys in lowland bordering of Sudan. It is occurring with an altitude between 1100-1700 metre a.s.l and enormous importance for the rural society. As a result of shortage proper woody plants for construction in the lowlands, it is commonly used as an alternative for timber in house construction, fences, human food and as energy supply. Of the total estimated lowland bamboo coverage about 480,510 hectors have been mapped (Kibwage, 2011).

2.5 Bamboo Resource, Sustainable Forests Management and Rural Livelihood

Bamboo, a versatile and rapidly growing plant, plays a critical role in sustainable forest management and rural economy. This study aims to assess the effect of bamboo forests on the regeneration of indigenous vegetation, focusing on how bamboo resource management can be integrated into sustainable forestry practices to support rural communities. Bamboo is a valuable resource due to its fast growth, high biomass production, and wide range of uses. It is used for construction, furniture, paper, and even as a food source. The economic value of bamboo can drive sustainable harvesting practices that support rural livelihoods (Griscom & Ashton, 2003). In areas where bamboo dominates the forest understory, such as in south eastern Peru, bamboo can control forest succession and influence the structure and dynamics of the forest ecosystem (Griscom & Ashton, 2003).

Bamboo's rapid growth and dense clumping habit can have significant impacts on forest dynamics and the regeneration of indigenous vegetation. For instance, the dominance of bamboo in certain forest areas can alter seed rain patterns and consequently affect the composition and diversity of regenerating vegetation (Grombone-Guaratini et al., 2014). The dense bamboo understory can create a competitive environment for light, nutrients, and space, potentially hindering the growth of tree seedlings and other plant species (Lima et al., 2012). Incorporating bamboo into sustainable forest management practices involves balancing its ecological impacts

with its economic benefits. Bamboo dieback events, which often occur after massive flowering, can create opportunities for tree regeneration. These dieback events temporarily reduce competition, allowing for the establishment and growth of indigenous vegetation (González et al., 2002). Sustainable management practices can leverage these natural cycles to enhance forest regeneration and biodiversity.

For example, in the subalpine Nothofagus forests of the southern Andes, bamboo die-off has been shown to facilitate tree regeneration by creating gaps in the understory, thereby promoting light penetration and reducing competition for young trees (Holz & Veblen, 2006). By understanding and managing these dynamics, forest managers can improve the resilience and diversity of forest ecosystems. Bamboo plays a crucial role in supporting rural livelihoods, particularly in developing countries. Its fast growth and versatility make it an ideal resource for small-scale farmers and rural communities. The sustainable harvesting and processing of bamboo can provide income and employment opportunities, thereby enhancing the socio-economic well-being of these communities (Griscom & Ashton, 2006).

Moreover, bamboo-based agro forestry systems can improve soil fertility, reduce erosion, and provide a sustainable source of raw materials. This integration of bamboo into agricultural and forestry practices can help mitigate the impacts of deforestation and land degradation, promoting environmental sustainability and rural development. The long-term ecological effects of bamboo dominance in forests can be complex. For instance, in the Araucaria forests of southern Brazil, prolonged bamboo dominance has been found to impact the structure and diversity of adult tree populations. Comparative analyses between different successional stages have shown that bamboo-dominated areas have lower tree diversity and altered forest structure compared to non-bamboo areas (Lacerda & Kellermann, 2019). Understanding these long-term effects is crucial for developing management strategies that promote forest resilience and biodiversity.

2.5Global Trends of Bamboo Resources

Bamboo, a critical resource in many forest ecosystems, is characterized by its rapid growth, high biomass production, and significant ecological and economic roles. The global distribution and management of bamboo resources have far-reaching implications for forest dynamics, biodiversity, and rural livelihoods. This section examines the global trends in bamboo resources, focusing on their ecological impacts and management strategies. Bamboo species are widely distributed across tropical, subtropical, and temperate regions, with significant populations in

Asia, Latin America, and Africa. These species often dominate the forest understory, influencing forest structure and succession. In south eastern Peru, for example, bamboo (Guadua sarcocarpa) plays a crucial role in controlling forest succession, impacting the growth and composition of other vegetation (Griscom & Ashton, 2003).

The ecological impact of bamboo is multifaceted. In the Atlantic Forest of Brazil, bamboo dominance affects seed rain patterns, altering the regeneration dynamics of tree species (Grombone-Guaratini et al., 2014). Similarly, in the temperate forests of Patagonia, massive flowering events of bamboo (Chusquea culeou) lead to large-scale dieback, creating opportunities for tree regeneration but also posing challenges such as increased wildfire risk and changes in nutrient cycling (Marchesini, Sala, & Austin, 2009). Bamboo dieback events, often associated with synchronized flowering cycles, are significant drivers of forest regeneration. In southern Chile, bamboo dieback in lowland Nothofagus forests facilitates tree regeneration by reducing competition for light and nutrients (González et al., 2002). Similarly, in the southern Andes, bamboo die-off in subalpine Nothofagus forests promotes the establishment of tree seedlings, contributing to forest succession (Holz & Veblen, 2006).

However, the long-term effects of bamboo dominance can be complex. In the Araucaria forests of southern Brazil, prolonged bamboo presence impacts the diversity and structure of adult tree populations, indicating that bamboo can both facilitate and hinder forest regeneration depending on the context and duration of its dominance (Lacerda & Kellermann, 2019). Effective management of bamboo resources requires balancing their ecological impacts with their economic benefits. Bamboo's rapid growth and versatility make it an ideal candidate for sustainable forestry practices that support rural livelihoods. Sustainable harvesting and processing of bamboo can provide income and employment opportunities for rural communities, enhancing socio-economic development while maintaining ecological balance (Griscom & Ashton, 2006). In the Atlantic Forest hotspot, managing bamboo overabundance is crucial for maintaining forest structure and biodiversity. Strategies such as selective thinning and controlled harvesting can mitigate the negative impacts of bamboo dominance and promote the regeneration of indigenous vegetation (Lima et al., 2012). Understanding global trends in bamboo resources is essential for developing sustainable forest management practices. This research aims to assess the effect of bamboo forests on the regeneration of indigenous vegetation, providing insights into how bamboo management can be integrated into broader conservation and rural development

strategies. The findings will inform policies and practices that balance ecological sustainability with the socio-economic needs of rural communities.

2.6. Ecological importance of bamboo

Bamboo holds significant ecological importance in various forest ecosystems worldwide, influencing biodiversity, nutrient cycling, and habitat structure. This section explores the ecological roles of bamboo based on recent research findings, highlighting its impact on forest dynamics and biodiversity conservation. Bamboo's dense growth forms extensive stands that provide critical habitat for numerous species, from insects to mammals. In the Atlantic Forest of Brazil, areas dominated by bamboo exhibit altered forest structure, impacting light availability and microclimate, which in turn affect the composition and diversity of plant and animal communities (Lima et al., 2012). Such changes can create unique ecological niches and support a variety of specialized species adapted to bamboo habitats.

Bamboo contributes to nutrient cycling through its rapid growth and decomposition processes. Fallen bamboo leaves and culms enrich the forest floor with organic matter, enhancing soil fertility and supporting the growth of understory vegetation (Griscom & Ashton, 2003). In montane forests of the southern Andes, bamboo die-offs lead to nutrient pulses, stimulating tree regeneration and influencing long-term forest dynamics (Holz & Veblen, 2006). Bamboo's life cycle, including periodic mass flowering events and subsequent diebacks, plays a crucial role in forest disturbance regimes and succession patterns. In Patagonia, Argentina, massive bamboo flowering events trigger widespread die-offs, temporarily altering forest structure and creating opportunities for the establishment of tree seedlings (Marchesini, Sala, & Austin, 2009). Such disturbances are integral to maintaining biodiversity by resetting successional trajectories and promoting species turnover.

The extensive root systems and rapid growth of bamboo contribute significantly to carbon sequestration and climate regulation. Bamboo stands store substantial amounts of carbon in both aboveground biomass and soil, mitigating greenhouse gas concentrations and helping to stabilize local climates (Grombone-Guaratini et al., 2014). Sustainable management of bamboo resources can enhance these carbon storage capacities while supporting local livelihoods through carbon credits and sustainable product development. Understanding the ecological importance of bamboo is crucial for conservation and sustainable forest management strategies. Efforts to protect bamboo habitats and manage their dynamics can preserve biodiversity, enhance

ecosystem resilience, and support local communities dependent on bamboo resources (González et al., 2002). Integrating bamboo management into broader conservation frameworks can optimize its ecological benefits while addressing socio-economic needs, ensuring the long-term sustainability of forest ecosystems.

2.7The Economic Contribution of Bamboo Forest

Bamboo trees are versatile and until faceted non timber pant with a considerable potential of economic development in environmental protection (Zelalem,2019).It has numerous benefits in day to day uses for the local community where the species is growing. Because of their simple workability, strength, straightness, combined with extra ordinary hardness range of size, short period they attain maturity. They are sustainable and used for for several purpose. As a result, there are more than 1500multi uses ranging from medicine to nutrition and toys to air craft. Over the worldwide; 2.5billion people some livelihood on bamboo trees. Thus it plays important role which is social friendly (Kassahun, 2003).Especially the poor people are able to increase their income by production of crafts and subsistence use product made from bamboo resources (EABP.2007).Recently bamboo tree based small and medium businesses are growing in Ethiopia. In most areas particularly highland bamboo in Awi zone of Amhara national region is used as construction material for houses fences furniture and beehives in the village. More importantly, a market for bamboo tree was established and many product s it has been from developed for some time how may landless individual buy bamboo from farmers and engage in income generating project like producing mats, fence and furniture that design produce and sell along the road side. For this, highland bamboo is the major source of income (Haile, 2008). Ethiopia has the greatest bamboo resource in Africa representing a signification proportion of Africa's total bamboo resources (Bessie, 2014). The use of this abundant resource is restricted to the local where some people consider bamboo as valueless paint. The product diversification and value adding are very limited in the local knowledge on the potential of the various possible product is still poor.

2.8 The Bamboo Housing

Bamboo has garnered attention not only for its ecological benefits in natural ecosystems but also for its potential as a sustainable building material, offering innovative solutions to contemporary construction challenges. This section delves into the diverse applications and advantages of

bamboo in housing, drawing from recent studies and findings. Bamboo possesses exceptional strength-to-weight ratio properties, making it an ideal material for structural applications in housing. Research indicates that bamboo can withstand considerable loads comparable to traditional construction materials like steel and concrete (Griscom & Ashton, 2003). This inherent strength, coupled with its flexibility and ease of processing, allows for diverse architectural designs and applications in both rural and urban contexts (Lima et al., 2012).

Unlike conventional building materials that contribute significantly to carbon emissions, bamboo absorbs carbon dioxide during growth and continues to sequester carbon throughout its lifecycle. Moreover, bamboo forests mature rapidly compared to hardwood trees, enabling sustainable harvesting practices without depleting natural resources (Grombone-Guaratini et al., 2014). This sustainability aspect makes bamboo an attractive alternative for reducing the ecological footprint of construction activities. Bamboo exhibits excellent thermal insulation properties, providing natural regulation of indoor temperatures and reducing energy consumption for heating and cooling (Marchesini, Sala, & Austin, 2009). Its fibrous structure also absorbs sound waves, enhancing acoustic comfort within buildings and mitigating noise pollution from external sources (González et al., 2002). These attributes contribute to creating healthier and more comfortable living environments. In addition to its environmental benefits, bamboo offers economic advantages by providing income opportunities for local communities engaged in its cultivation and processing. Its rapid growth cycle and low maintenance requirements translate into cost-effective building solutions, particularly in regions where conventional materials are scarce or expensive (Holz & Veblen, 2006). Furthermore, bamboo holds cultural significance in many societies, preserving traditional building techniques and promoting cultural heritage through modern applications (Griscom & Ashton, 2006).In any construction programs bamboo tree emphasize use of many local materials that more suitable for health and environmental labour intensive technologies that more people employ bamboo tree can be meet most of these criteria. The bamboo tree can need only 800mt/m3 per n/mn2 when compare to concrete and timber that require 500 and 800mk/m3 per n/mn2. The study shows that production of bamboo requires only 1/8 of the energy that concrete building materials for the same capacity in comparison to steel. Bamboo is one the oldest and cultural material used for construction of houses and other related as an excellent material inputs. Comparatively it is very cheap, available and easy to work within most countries where the bamboo trees grow (Goh, 2019).The bamboo

tree has a very long history for its use for various purposes especially in the study area via, food, shelter, fence, and furniture etc. These resources has been serving humanity from cradle to grave in many countries since the ages in many different and in indigenous ways (Paudel, 2003).The global shortage of housing material especially in developing and in most refuges settlement it needs a serious consideration. To keep pace with population growth and to replace old houses, 75 million units held to be constructed each year in Asia continent alone. The supply of timber and other convectional construction accompanied making rise cost impressive to increasingly use of bamboo tree for housing purpose.

2.9Challenge and Future Opportunity of Bamboo Forest

Unsustainable harvesting practices can lead to the depletion of bamboo resources, threatening biodiversity and ecosystem services (Nambiar, K. K., & Kannan, M. (2018). Many communities are unaware of the ecological and economic benefits of bamboo, leading to underutilization and insufficient conservation efforts Kumar, A., & Singh, K. (2021). Limited market access for bamboo products can hinder the economic potential of bamboo cultivation, affecting livelihoods Van der Laan, H. (2019). Bamboo can be susceptible to pests and diseases, which can affect growth and sustainability (Wang, Y., et al. (2020). Implementing sustainable harvesting and management techniques to ensure the long-term health of bamboo resources Zhou, J., & Zhang, X. (2021). Investing in research to improve bamboo varieties for better growth rates, pest resistance, and adaptability to climate change Mao, H., & Liu, J. (2018). Increasing awareness and education about the benefits of bamboo to encourage sustainablepractices and community involvement Bhatia, S., et al. (2020). Promoting the integration of bamboo into agroforestry systems to enhance biodiversity and improve land productivity. Ghosh, P., & Chakrabarti, S. (2019). These challenges and future directions highlight the need for sustainable approaches to harness the full potential of bamboo for ecological and economic benefits.

2.10 Bamboo species as source of foliage forlivestock

Bamboo species have garnered attention not only for their ecological roles but also for their potential as a valuable fodder source for livestock, contributing to sustainable agricultural practices and biodiversity conservation. This section explores recent studies on the utilization of bamboo foliage for livestock, drawing from various research findings. Bamboo foliage is rich in nutrients essential for livestock, including protein, carbohydrates, and minerals (Campanello et

al., 2007). Different bamboo species exhibit varying nutritional profiles, influencing their suitability as feed supplements. Studies highlight the palatability and digestibility of bamboo foliage, crucial factors in determining its effectiveness as a feed source (Griscom et al., 2003). Integrating bamboo foliage into livestock diets can improve nutrient intake and promote animal health. Research suggests that incorporating bamboo into feeding regimens enhances digestive efficiency and supports growth rates in cattle and other ruminants (Capellesso et al., 2022). Moreover, bamboo's natural resilience to pests and diseases reduces the need for chemical inputs, aligning with sustainable agriculture principles (Padgurschi et al., 2021). The cultivation of bamboo for livestock fodder offers environmental and economic advantages. Bamboo's rapid growth and ability to thrive in diverse climates make it a reliable year-round fodder source, potentially reducing pressure on natural pastures and forests (Guaratini et al., 2024). This practice also contributes to income generation for rural communities engaged in bamboo cultivation, promoting economic resilience and local livelihoods (Buziquia et al., 2019).

While bamboo can provide substantial benefits as livestock fodder, careful management is essential to ensure sustainability. Monitoring bamboo stands to prevent overharvesting and promoting regenerative practices are critical for maintaining biodiversity and ecosystem integrity (Austin & Marchesini, 2011). Integrating bamboo into agroforestry systems can further enhance landscape diversity and resilience, supporting both agricultural productivity and conservation goals (Budke et al., 2010).Now the increasing human population made higher demand for food in Ethiopia that enforcing farmers of highland and mid altitude areas to cultivate more pasture land at the expense of natural grazing area. Consequently, most the livestock feed on resource availability in a country become crop residues, which are nutritionally considered as a high proportion of cell wall and being deficient in energy, protein and micro-nutrients. In Ethiopia, introducing and utilization of exotic multi- purpose fodder trees such as sesbans, leucadendron, and callicarpa palmate through integration of food crop cultivation with mixed crop cultivation started in Ethiopia in 1970s to supplement the roughage food resource. However, the degree of fodder planting and utilization undertaken by small holder farmers in the country even in country side have shown success rate and did not meet the required goals (Lukuyu, 2019).Thus there is a need to look for the asset of resource which less compete with human food production and can provide the essential nutrient taking in the main dry season feeds, one such potential feed resources are the bamboo trees.

2.11 Conceptual framework

This framework Overview of bamboo species, growth patterns, and ecological roles outlines the interconnections between bamboo forests, ecological resilience, and sustainability while addressing both ecological and socio-economic dimensions. It also discusses the significance of bamboo forests in various ecosystems and explains ecological resilience importance for sustain ecosystem. Bamboo contributes to the resilience of ecosystems through soil stabilization, water retention, and biodiversity support to explore sustainable harvesting and management practices related to bamboo. Bamboo forest helps in ecological benefits to traditional timber forestry, ability to capture carbon and mitigate climate change, and in providing habitat for various species. Bamboo forest benefits of roots in preventing erosion and improving soil quality and used as a resource and its economic benefits.

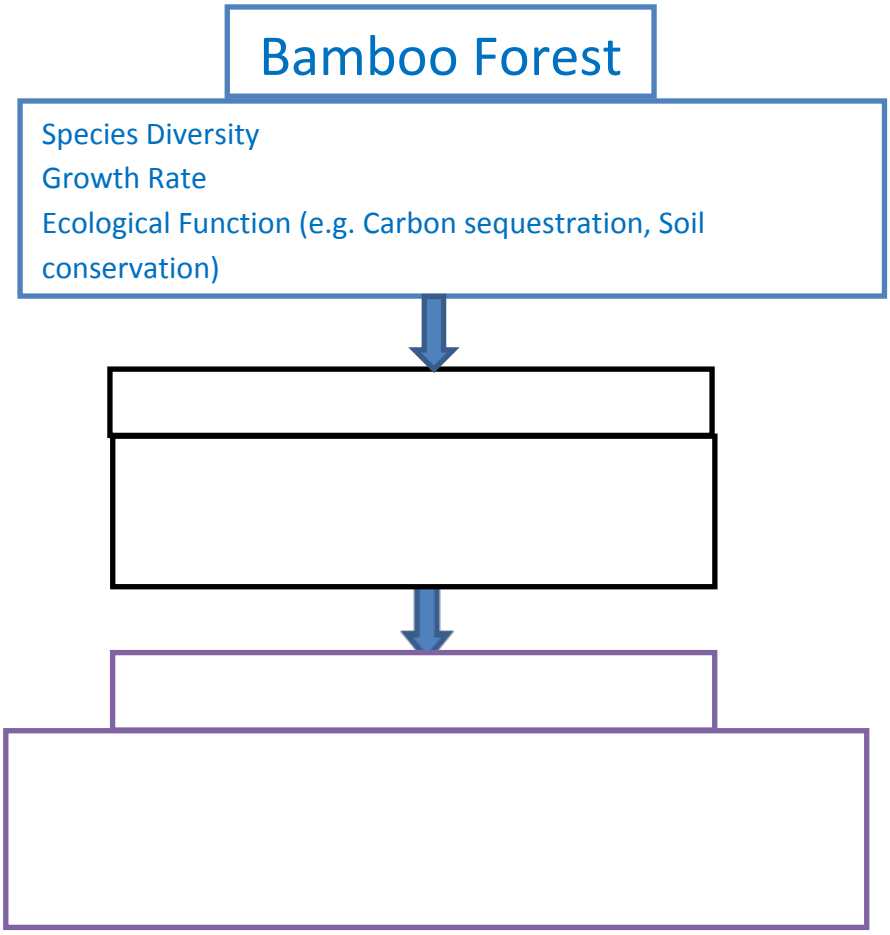


Chart of conceptual framework

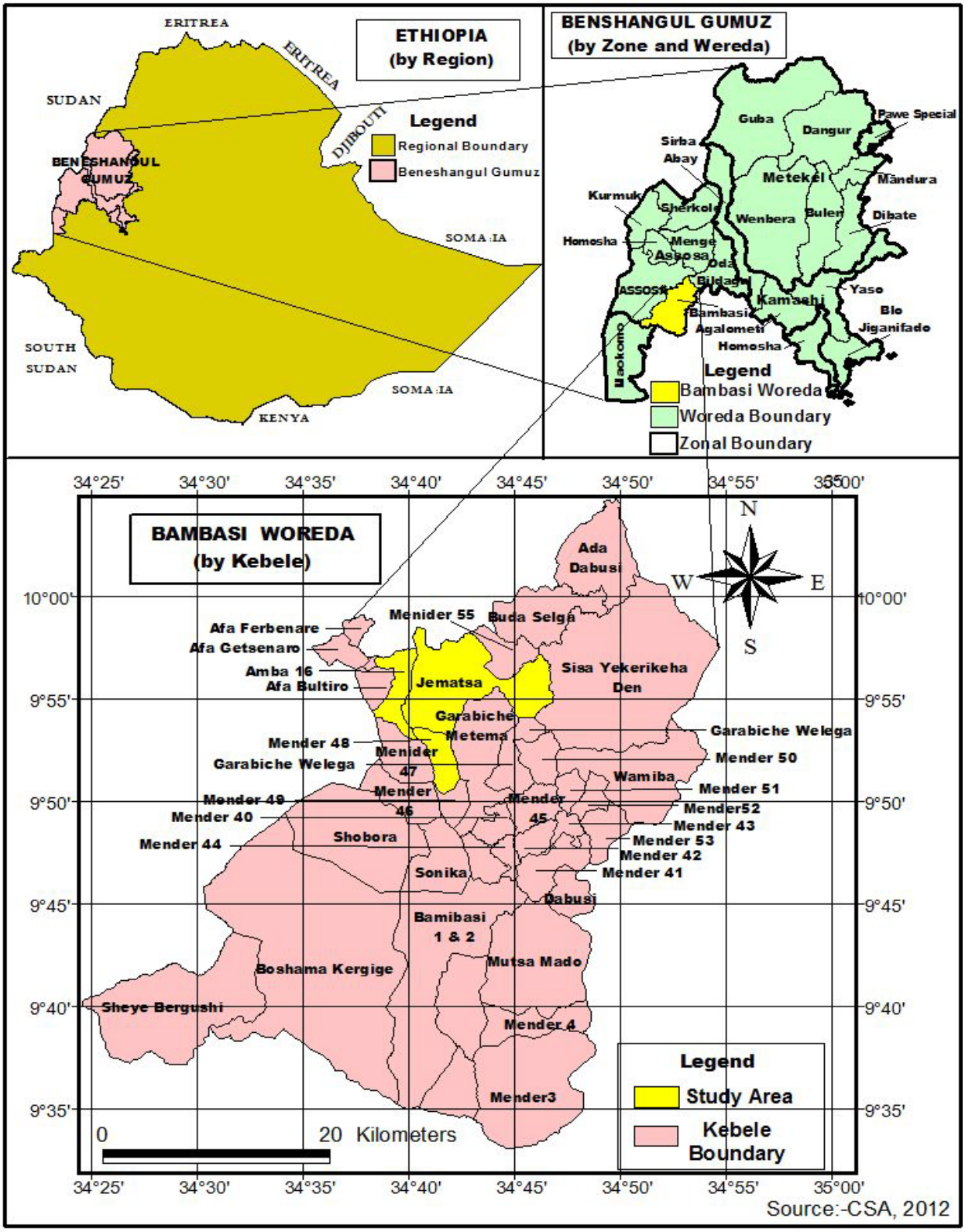
CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location

Beneshangul Gmuz regional state stretches along the Sudanese border between 9^0 17'and 12^0 06' North, and 34^0 10' and 37^0 04'East. It is divided by the Blue Nile (Abay) in two parts. Thus, the northern part is Metekal Zone comprises an area of 26,560km^{2}and the southern parts are Assosa and Kemashi zone with Mao Komo special woreda that occupy 23,820km$^{2.}$ These three administrative zones have 19 woreda and one special woreda. The altitude ranges from 580 to 2731m a.m.l, where about 75% of the relief is lowland below 1500m a,m,l and 25% is high altitude ranges from 1500-2500m a.m.l. where the remains 1% is covered by highland above 2500m.a.m.l (BGRS BoFED, 2011). Bambasi woreda is one of the seven woreda of Assosa administrative zones. The woreda is in the north-east of administrative town (Assosa) between $9^0$45' and 10^0 00'North and 34^0 45' east. It is bordered by Mao-Komo woreda on the Southwest, Assosa woreda in the Northwest, Oda Buldigilu in the Northeast and Oromia region in the Southeast. The topography of the Woreda is mainly plain (more than 99%). The total area of the Woreda is about 2210.16 Km^2 out of which about 22,464.5 ha (10.2%) was cultivated in 2012/2013 cropping season and about 112,127 ha is covered with forest out of which bamboo takes the lion share. The remaining areas are grazing land and mountains. The average cultivated land holding is about 1.5ha (BWOA, 2019). Now the Bambasi woreda is divided in to 38 kebeles out of which 20 kebeles are occupied by settlers and 14 kebeles are occupied by natives' people and the remains 4 kebeles both settlers and native's people live together.



Location map of the study area, Bambasi woreda in Beneshangul Gumuz,Ethiopia.

3.1.2 Climate

Bambasi woreda is found in kola and low woinadega climate of Ethiopia of which 85% lowland and 15% mid land where the altitude of the woreda's reaches up to 2300 mm. This allows variety of crops to be cultivated. It has one rainy season during March to October and distinct dry season extending from November to February. The rainfall of the woreda ranges between 1350-1400mm per year being received between May and September with highest in July and August (BWARDO, 2019). The temperate of the woreda ranges from 12-18c^0 and 25^0 –35 c^0 respectively. The hottest month period extends from January to May where the peak is March and the coolest period occur from June to November, the lowest being August (ASARC, 2019).

3.1.3 Soil and topography

The majority of the study area has diversified topography such as deep gorges like Bushma and Sheberguish with very steep slopes, very steep mountain ranges of Aba Moti and valley that flat to almost flat lowland plains (BIPPCSA, 2000). The soil of the study area is characterized by deep reddish, brown sandy, clay and loam with pH 5.5. The organic matter of the soil is about 3.18% (BOFED, 2017). The major soil types includes; nitosols, vertisols, pluvisols, and associated with loam soils. The region has well fertile soil that suitable for agriculture if it keeps and conserve well, can hold many production crops which not intensified like than other region.

3.1.4 Vegetation

According to Bambasi woreda agricultural office there about 51% of the woreda covered by natural forest including the dense and open bamboo forests. The areal coverage mostly covered by medium tree that never regenerated itself as once eradicated. Thus, the bamboo trees expand its coverage if it keeps from encroachment of people in forested area. Bamboo tree is highly important to the people's economy in the woreda. The other predominate vegetation type include *Syzygiumguineense, Terminaliabrownii, Sycamore Ficus Vast(□□□) Cordia Africana(□□□), Washgtoniafilifera(□□□□),Crotonmacrostachayus(□□□),Ficussycomorus(□□),Podocarbusfalactus(birbirsaa),Ficussur(□□)* and acacia species in association with *Ficussurand Cordia* Africana tree species (MELKAMU, 2019).

3.1.5 Population

The total population of the woreda is estimated to be 58,143 of which 29537 are male and 28606 female. From that about 81% are rural and the remaining's 19% are urban (BWHO,

2019). The total number of households is estimated at 12539 of which 10198 are rural and 2341 are town also 11917 households are male headed and 622 are female headed (BWARDO, 2019).

3.1.6 Economic Activities

The main economic activities of the people are engaged on primarily on agriculture of which cash crops such as maize, sesame, pepper, millet and most of the native peoples rent their land for other people those have not cultivate land. The majority of jamatse kebele's residents are search in especially younger adults on gold mining. A few people engaged on agricultural output of cash crops trade collect from farmers and depositing until the price rise. Based on data gathered from agricultural office of Bambasi woreda, out of 71327 ha of land is cultivable, only 22464 ha (31.49%) was cultivated in 2018/19 production year with different crops. Crops such as sorghum, maize and millet are the major cereals grown in the area and they occupy the largest proportion of the cultivated land. The oil crops furthermore, red papers, vegetables and perennial like mango are grown and used as cash crops in the woreda.

3.2 Research Methods

It is difficult to analyze the contribution of bamboo forest enhancing livelihood and ecological resilience. To determine the contribution of bamboo forest in the study area; field observation, questionnaires, key informant interview, focused group discussion has been employed in the selected study area. Thus the survey method is used to collect data of particular point in time with the intention of describing the nature of existing conditions or determining the relationship that exists between specific events. Thus the study conducted through predominated by quantitative and qualitative approach.

3.3 Sample size

In this paper, a multi-stage sampling technique was used to select 124 sample households. At the first stage, from 38 kebeles of Bambasi woreda, six kebeles bordering the study area of bamboo tree (Anbessa chaka) were purposively selected Then in the second stage six kebeles were stratified in to three groups; on the basis of the origin of the house hold, three sample kebele were finally selected Mender 48 and Amba16 from the settler group which covering large border of the study area and Jamatsa from the natives. Finally, there are 124 respondents were randamely selected based on the probability proportional the size of the households. Thus from the given total population three kebele's 896, of the sample size was computed using the below

Formula:

$$n= [(N) (p) (1-p)]/ [(N-1) (B/C)^2 + (p) (1-p)]$$

Where

N is the size of the population,

p is the percentage of the population expected to make a choice, and

n is the computed sample size required to achieve the required degree of accuracy;

B is acceptable amount of sampling error, or precision; and finally

C is Z statistic associated with the confidence level which is 1.96 that corresponds to the 95% level. B can be set at 0.1, 0.05, or 0.03, which are ± 10, 5, or 3% of the true population value, respectively. The acceptable amount of sampling error or precision is set at 0.05 or 5%. Confidence level of 1.96 corresponds to the 95% level. Using 0.05 will lead to a greater sample size than using 0.03; yet it consistently offers a sufficient sample size for a population that is smaller or larger (Biemer & Lyberg, 2003).

Where N = 896, p = 0.5, B = 0.05, C = 1.96

n = $[(896) (0.5) (1-0.5)] / [(2400-1) (0.05/1.96)^2 + (0.5) (1-0.5)]$

n= $[(896) (0.5) (0.5)]/ [(896) (0.0255)^2 + (0.5) (0.5)]$

n= (224)/ (1.56+ 0.25)

n= 224/ 1.81

n= 123.75=124

Table 1: Number of households taken from sampled kebeles

Selected kebele	Total household size	Sample size
Amba 16	390	54
Mender 48	275	38
Jamatsa	231	32
Total	896	124

3.4Method of data collection

Both primary and secondary data analysis were collected based on the nature and availability of information given. The primary data were collected from sample of farmers in the study area through structured questionnaire using face to face interview. Besides, data were collected through Focused Group Discussion (FGD) that constitute five male and three female respondents to gather qualitative information. The data generated through FGD are also used to refine the

questionnaire. Field observation and Key Informant Interviewers (KII) were conducted to validate with data gathered from the respondents. To get adequate and reliable information data from primary sources, different collection of techniques tools such as survey questionnaire, field observation and FGD of which (male=5 and female=3 household respondent) were applied. From those questionnaires, the key informant interview was assumed the most important gathering data tools in this proposed study focus. Moreover, the study will employ to field observation and focused group discussion in order to triangulate and support the data collected though questionnaire and key informant interviews

3.5. Source of Data

In order to achieve the subsequent objective of the study, both secondary and primary data source were used for the study. The primary data were gathered directly from selected households and key informants through questionnaire, interviews and field observation during survey and is the most important point that needs patience good approaches to the respondents. Whereas secondary data collection is gathered from officially published and unpublished documents, maps, article journal, magazines. Official reports, books, standard documents and other related materials.

3.5.1 Survey Questionnaires

Questionnaires are the first and the major instrument used to collect large amount of information about the intended purpose. Based on this, the questionnaires for the study were prepared in both open ended and close ended form to the selected households to enrich the study with valuable information. The questionnaires data comprised pertaining of the socio-economic characteristics of the respondents and the bamboo tree utilization management, marketing and conservation. The data were collected by data collectors (researcher) during data collection process, the continuous supervision were strictly undertaken by the researcher in order to maintain the similarity index and quality of data.

3.5.2 Key informant interviews

The key informant interview identifying different member of the community especially knowledgeable people especially from agricultural experts about bamboo tree and asking them question about their experience working within the community. In this study of key informant

interview four male and three female respondents were undertaken from social worker, local leader and the bamboo entrepreneurs since they have good knowledge of their locality and give more explanation about bamboo tree. Thus the information gain about bamboo tree and their existing condition, that regenerating vegetation, keeping and increasing soil fertility, management practice and government initiatives in bamboo sector were discussed information were for triangulation of households' surveyed data.

3.5.3 Field observation

In this study, frequent field observations were used for this because of participant main purpose of the observations was to achieve personnel perspective on the topic being studied within outsider perspectives. Field observation was made to get data on the trend users such as cultivation of bamboo tree, its management practice as well as status of bamboo on private. Field observations were made to obtain data on the activities in community forest was observed directly in the field by transit walk. It is conducted during the key informant interview in *Amba* 16 and *Mender* 48 kebeles since bisected by main road gone from Addis Ababa to Asossa near Anbesa Chaka. The discussion was conducted at harvesting area, homestead, teashops and meeting to strengthen the data generated from other data collection techniques that were planned and discussed so far it concerned.

Table 2 Number of households taken from sampled kebeles

Selected kebele	Total household size	Sample size
Amba 16	390	54
Mender 48	275	38
Jamatsa	231	32
Total	896	124

3.6 Method of Data Analysis

All the data from the semi-structured interview, key informants and field observation were organized and analysed by using the descriptive and inferential statistics. Of which the descriptive statistics such as arithmetic mean percentage and frequency distributions, maximum and minimum were computed to explain different socio-economic characteristics of the sample households. Whereas inferential statistics were also used to reach conclusions, and to infer from the sample data about what the population looks. The SPSS version 26 was used to put data in percentage and frequency. In other check the degree of relationship among the explanatory variable that was employed.

CHAPTER FOUR

DATA ANALYSISANDINTERPRETATION

This chapter as the whole presents the result and discussion of the study in general. From this descriptive statistic were used to analyze the data to have a clear understanding of the contribution of bamboo forest on regeneration of indigenous vegetation, challenges and opportunities of bamboo tree, socio economic, institutional and other characteristics of the respondent followed by the model.

4.1. The general characteristics of the households

The household characteristics includes age, sex, family size, origin and level of education of the households were briefly explained. The range of family size of the total sample households were from 2 to 10 persons with an average family size of 6 concerning sexes of the respondents 61% and 39% were male and female respondents respectively.The mean educational level of the households was 6, 27 and 66 university education (degree), secondary and elementary school respectively. Educational level plays an immense role in ensuring household access to basic needs such as food, shelter and clothing. The skill and education amplify the working efficiency of resulting in to more income food and security. In further more educating an individual has great opportunity to engage in other economic activity than depending on the bamboo tree for their economy of the livelihood.

4.1.1Age Distribution

The majority of household heads fall within the 35-44 age group (36%), indicating a strong representation of middle-aged individuals who are likely to be in their prime working years. The 25-34 age group constitutes 27%, suggesting a significant proportion of younger household heads, potentially indicating new families or emerging economic contributors. The 45-54 age group accounts for 29%, showing that nearly a third are approaching their later working years, which could affect economic stability and planning for retirement. Only a small fraction falls into the older age brackets, with 6.4% in the 55-64 range and 1.6% over 65, suggesting that very few elderly individuals are heading households, which may imply a younger demographic overall.

4.1.2 Family Size

The majority of households (58%) have a family size of 4-6 members, indicating a trend towards medium-sized families, which is common in many communities.Households with 1-3 members make up 25%, likely representing single-person or nuclear family units.A smaller percentage of households (14.6%) have 7-9 members, indicating that while larger families exist, they are not the norm in this sample.Only 2.4% of households have more than 10 members, suggesting that very large families are relatively rare.

Table 2: The age and Family size characteristics of the household

Item	**Categories**	**Frequency**	Per cent
Age of Household Heads	25-34	34	27
	35-44	45	36
	45-54	36	29
	55-64	7	6.4
	>65	2	1.6
	Total	124	100
Family size	1-3	31	25
	4-6	72	58
	7-9	18	14.6
	>10	3	2.4
	Total	124	100

Educational Level of Household Heads shows that, significant portion of household heads lacks basic literacy skills, which may hinder their access to information, employment opportunities, and participation in community activities basic level of education, suggesting that while these individuals can manage day-to-day tasks, they may still struggle with more complex educational or professional requirements. A moderate percentage has completed secondary education, which is crucial for many job opportunities and further education.This indicates a smaller number of household heads have pursued vocational training or post-secondary education, which could enhance their employability. A very small segment holds a higher education degree, suggesting limited access to advanced education, which could affect community development and economic

progression.The majority of household heads are settlers, indicating a community with a high influx of migrants. This could reflect economic opportunities in the area but may also suggest challenges related to integration and resource management. Smaller portion of household heads are natives, which may signal a potential division in cultural identity and access to resources or support systems.

4.1.3 Sex of Household Heads

Males predominantly lead households, reflecting traditional gender roles. This may impact decision-making processes and resource allocation within families and the community. A notable percentage of female-headed households exist, indicating a shift towards more equitable gender representation in household leadership, though they still represent a minority.

4.1.4 Education

The low levels of literacy and higher education may limit economic development and community engagement. Programs aimed at adult education and vocational training could be beneficial.

4.1.5 Origin

The high percentage of settlers suggests potential needs for integration programs and support for community cohesion, especially in resource sharing and cultural adaptation.

4.1.6 Gender Roles

The predominance of male-headed households highlights traditional gender norms, but the presence of female heads indicates emerging opportunities for gender equity. Policies that support women’s empowerment and leadership could strengthen community resilience.

Table3. Educational level, origin and Sex of the Household Heads

Item	**Categories**	**Frequency**	Per cent
Educational level of HH head	Not read and write	28	
	Read and write only	42	33.9
	High school	34	24.7
	Diploma	12	9.7
	Degree and above	8	6.5
	Total	124	100
Origin of the HH head	Settler	92	74
	Native	32	26
	Total	124	100
Sex of the Household Head	Male	78	61
	Female	46	39
	Total	124	100

4.2 The contribution of bamboo product to annual income for the people.

Bamboo tree plays a significant role in generating income for rural communities worldwide through various products derived from its versatile properties. This section explores the economic benefit of bamboo products on local economies, drawing insights from recent studies and research findings. Bamboo contributes to local economies by providing a diverse range of products, including construction materials, furniture, handicrafts, and even innovative applications like bamboo textiles and bioenergy (Griscom & Ashton, 2003). The cultivation and processing of bamboo into these products create employment opportunities across different stages of production, from harvesting and processing to marketing and sales (Lima et al., 2012)

Table 4: The annual income from bamboo forest product

Annual income from bamboo product	Frequency	Per cent
Selling bamboo tree	28	23
Furniture	42	34
Fire wood	24	19
Tie (□□)	18	15
Ballast	12	10
Total	124	100

The finding shows that the Jamatsa of the native people more economic benefit of bamboo forest product since culturally linked with resource than the two kebele *Mender* 48 and *Amba*16. Despite its economic potential, challenges such as market access, technological limitations, and policy support persist. Addressing these challenges through capacity-building initiatives, and investment in bamboo processing technologies can unlock greater economic opportunities (Campanello et al., 2007). Moreover, integrating bamboo into sustainable development strategies can foster inclusive growth and resilience against economic shocks. Bamboo products contribute significantly to the annual income of local communities, providing livelihoods, promoting sustainable resource management, and enhancing economic resilience. Continued research, policy support, and community engagement are essential to harnessing bamboo's full economic potential while ensuring environmental sustainability and social equity.

4.3 Contribution of bamboo forest for indigenous trees

Bamboo tree has strongcapacity for regenerating indigenous trees by sequestering number of other plant's qualities including its rapid growth. It also extensive root systems that sequester carbon below ground and holds on to carbon long after it is cut due to silica structure.Bambootree gives dense protective canopies for wildlife, stabilize soil from erosion and provide fine roots that add a considerable amount of carbon nutrient to the soil. One of the bamboo's natures is that grow in poor soil and harsh climate areas receiving full sun and high winds while its shallow and robust root system, often comprises of rhizomes, act as a net that binds soil and prevent water runoff.From the farmer's perspectives, they have no more awareness about the role of bamboo tree for native trees rather the economic importance for them. They have already familiarity with the existing degradation of bamboo tree by encroachment, wildfire and mass flowering, are willing to participate and willing to conservation and rehabilitation of the resource regardless of various problem and their poor economic situation. Farmers assumed that for the existing degradation of bamboo tree for contribution, conservation and rehabilitation of the resources because they well understood of bamboo for their economy.

Thus, the participation of the community should be ensured in every decision making and formulation of policies and strategies which are related to the conservation of bamboo tree. As well conserving and rehabilitating of bamboo indirectly regenerate the indigenous vegetation. This initiates the commitment of the community helps them to develop a sense of ownership

which has its own contribution for the sustainability and effectiveness conservation and rehabilitation of the forest.

This implies that bamboo tree gives them multipurpose for all activities and products. Because the bamboo tree highly consumed by farmers in countryside, others lead to minimizing bamboo tree by expanding cultivated land in searching of fertile soil near the bamboo forest. All of the above activities of bamboo tree led to directly or indirectly benefit other native trees for survival and keeps from being extinct.

As the information gained from both KII and FGD of agricultural expert states that, bamboo's contribution for other indigenous trees is very important in such that: by keeping soil fertility and decomposition, aeration, water purified, climate stability and food for cattle. The bamboo tree more available in an area become decrease the burden of indigenous trees from over consumption then regenerate, survives, make soil fertile, stable climate condition, adequate rainfall and pure water are available. Especially, trees like (Cordia Africana) that formerly used for timber production mostly replaced by bamboo tree utensils products in the households.

4.4 Bamboo as a replacement for everyday product.

Bamboo, known for its versatility and sustainability, serves a myriad of purposes in everyday life, contributing significantly to various aspects of human activities and industry. This section explores the diverse applications of bamboo and its products, highlighting its economic, ecological, and cultural importance. The information obtained from the Key informant Interviews (KII) in the study area is that bamboo trees have multipurpose uses. Bamboo forests offer a wide range of uses due to the unique properties of bamboo. Here are some of the main applications

4.4.1 For construction and building materials

Bamboo is used in the construction of houses, bridges, and scaffolding due to its strength and flexibility. It is crafted into various types of furniture, including chairs, tables, and cabinets thus, it can be a replacement of every building material like house, utensils doors, windows, tables' chairs in various size and activities functionalized in home. Bamboo can replace virgin wood from old growth forests which is used in toilet paper which serve as an alternative variety of plastic associated with bamboo product. The production of processed bamboo can also invade

harmful chemicals through consumers can learn to identify bamboo products made with these substances. Its rapid growth and renewability make bamboo a sustainable alternative to hardwoods, reducing pressure on natural forests. Bamboo's high strength-to-weight ratio makes it an excellent substitute for timber in scaffolding, flooring, roofing, and wall panels (Griscom & Ashton, 2003).

4.4.2Crafts and Art

Bamboo is popular for making handicrafts, including baskets, mats, and decorative items and Artists use bamboo for sculptures and installations. Bamboo's flexibility and ease of manipulation make it ideal for crafting a wide range of artisanal products. From furniture, baskets, and utensils to musical instruments and decorative items, bamboo artisans worldwide capitalize on its aesthetic appeal and durability (Lima et al., 2012). These products not only cater to local markets but also hold global appeal, contributing to cultural heritage and sustainable livelihoods. Bamboo fibers, derived from the plant's pulp, are increasingly used in textile production. Bamboo fabric is known for its softness, breathability, and moisture-wicking properties, making it popular in clothing, bedding, and home textiles (Holz & Veblen, 2006). The eco-friendly nature of bamboo fiber, which requires fewer chemicals and water during processing compared to conventional cotton, aligns with growing consumer preferences for sustainable fashion.

In many cultures, bamboo plays a crucial role in culinary traditions and household products. Bamboo shoots, a nutritious and versatile food source, are harvested for consumption in various cuisines worldwide (Grombone-Guaratini et al., 2014). Additionally, bamboo's antibacterial properties make it suitable for cutting boards, kitchen utensils, and personal care items such as toothbrushes and soap dishes. Bamboo biomass is increasingly recognized as a source of renewable energy.

4.4.3 Bioenergy

Bamboo can be processed into biomass for energy production, offering a renewable energy source. It is used for generating biofuels, charcoal, and biogas, contributing to sustainable energy solutions and reducing dependence on fossil fuels (Lacerda & Kellermann, 2019). Moreover, bamboo's ability to sequester carbon dioxide and mitigate soil erosion enhances its role in

environmental conservation and climate change mitigation efforts. The multifaceted uses of bamboo underscore its significance in modern society, from sustainable construction and artisanal craftsmanship to textile innovation and renewable energy. As global awareness of environmental sustainability grows bamboo's eco-friendly attributes and versatility position. It is used as a valuable resource for promoting sustainable development and preserving natural ecosystems. Young bamboo shoots are a delicacy in many cuisines and are rich in nutrients and bamboo leaves and shoots can be used to make herbal teas. It is extensively root system helps prevent soil erosion. Bamboo forests absorb significant amounts of carbon dioxide, contributing to climate change mitigation. Various parts of the bamboo plant are used in traditional medicine for their health benefits. It can be used for natural fencing and garden structures. These diverse applications highlight bamboo's versatility and its importance in sustainable development, ecology, and local economies.

Table 5 :Bamboo tree used in building material

The bamboo tree used in building	Item used	Frequency	per cent
	For house	124	100
	Bothy market	98	79
	Fence	80	65
	construction	68	55
	Total	124	100

The findings show that, as the information gained from most respondents, the bamboo tree used in building material is essential for people economically and availabilities to their surroundings. In addition to that, as information given from the Focused Group discussion, the bamboo tree contribution keeps and saves other indigenous trees to survive more in the study area. Bamboo has emerged as a competitive building material, offering numerous advantages that make it increasingly attractive for construction in various regions across the globe. This section explores the unique properties of bamboo that contribute to its competitiveness in the construction industry. One of the most significant advantages of bamboo in construction is its remarkable strength-to-weight ratio. Certain bamboo species exhibit tensile strength comparable to steel, making them ideal for structural elements such as beams, columns, and trusses (Griscom et al., 2003). Bamboo is renowned for its rapid growth, with some species capable of reaching maturity within three to five years. This fast growth rate allows for sustainable harvesting practices,

reducing pressure on natural forests and promoting reforestation efforts (Padgurschi et al., 2021). Moreover, bamboo cultivation requires minimal water and no chemical inputs, further enhancing its eco-friendly credentials. The flexibility of bamboo stems enables it to be easily bent and shaped, facilitating innovative architectural designs. Bamboo's versatility extends beyond structural components to include wall panels, flooring, and roofing materials (Campanello et al., 2007). Its adaptability to various climates and environments makes it suitable for both traditional and contemporary building styles. Bamboo exhibits excellent thermal insulation properties, helping to regulate indoor temperatures and reduce energy consumption (Greig et al., 2018).

Additionally, its dense fibers contribute to effective sound absorption, enhancing acoustic comfort in buildings. These attributes make bamboo an ideal material for eco-friendly construction practices aimed at improving energy efficiency and occupant comfort. Beyond its technical merits, bamboo holds cultural significance in many societies, influencing architectural traditions and design aesthetics (González et al., 2002). The natural beauty of bamboo's grain patterns and textures adds a distinctive aesthetic appeal to interior and exterior spaces, appealing to environmentally conscious consumers and architects.

In conclusion, bamboo's inherent strength, rapid growth, sustainability, flexibility, thermal and acoustic properties, as well as its cultural appeal, collectively positions it as a competitive building material in the construction industry. As global awareness of environmental sustainability increases, bamboo continues to gain traction as a viable alternative to conventional building materials, offering solutions that balance ecological responsibility with architectural innovation. Bamboo tree has durable qualities which make it a competitive building material not only used as a replacement for hard wood flooring but as a substitute for steel and reinforcement in concrete production. In addition the role of bamboo also serves as skeleton of the house and fixer as nails.

4.4.5. The uses of bamboo forest for farmers

In the study area bamboo tree was used as a means of generating income for most of the respondents (**Table** 6). These respondents were asked to list the major use and benefits they are getting from bamboo. The major uses reported includes: for construction (97%), fencing (82.%), for firewood(100%), making furniture’s (66.%), as source of income(78.%),as source of food13%) and for housing(45%).

Table 6: Major use of bamboo forest

major uses of bamboo forest to the respondents	Frequency	per cent
Construction	120	97
Firewood	124	100
Making furniture	82	66
Source of income	97	78
As source of food	16	13
For housing	56	45
Total	124	

The respondents are familiar with the economic, ethical, and scientific importance of bamboo trees. They reported that bamboo trees have their economy, income, utensils, fuel, and house construction. Generally, bamboo trees have strong ties with people and their culture since, in all cases; they are linked and difficult to separate from people's livelihoods. For instance, native people mainly depend on bamboo trees for different purposes, including cultural, economic, and house construction, so there is no need for extra inputs from either industrial or any other indigenous vegetation for building and input for related household facilities.

Farmers harness bamboo for a myriad of economic purposes. Bamboo shoots, a nutritious and marketable food source, are harvested from young bamboo plants (Fadrique et al., 2021). Bamboo also serves as a raw material for handicrafts, furniture, and construction materials, providing additional income streams (Buziquia et al., 2019). The versatility of bamboo products meets local and global market demands, offering sustainable livelihood options for rural communities. Farmers often intercrop bamboo with other agricultural crops, leveraging bamboo's light canopy and non-invasive root system that allows for companion planting (Padgurschi et al., 2021).

The response from both KII and FGD, bamboo trees have played a major role in the livelihood of rural people and in rural industry, especially 75% of the households' dependents on bamboo; and its related industry for income, food and housing. Although, the rural communities have using bamboo forest have been viewed as an inferior substitute of timber. For instance, although over 75% of people in the study areas live in bamboo house, yet there has been little effort to build such houses commercially. Traditionally bamboo has been harvested in natural forest and its use has been limited to temporal construction and low quality utensils prone to rapid decay. Consumptions or utilization has therefore been direct and restrict to poorer people with low income and low purchasing power. The market linkage has a consequence been weak non-existent in most countries including Ethiopia particularly in the study areas. Now a day, the bamboo tree

noted has versatile uses as well as building material, plywood and particle board manufacture, basketry furniture, pickled or stewed bamboo shoots and medicines. But in Ethiopia and other particularly in the study area, there is a problem of resource management and technical improvement that can convert this fast growing grass in to a durable raw material for consumption purpose and wide range of semi-industrialized products. As indicated in Table 7, respondents further indicated that some of the major indirect benefits of bambooforestsprovide include. B uilding,controllingerosion(96%),cultural(93%),maintainingbiodiversity(90%),Reducingpollution(88%),Herbalmedicine(85%)regulatingclimate(78%),wildlife habitat (83%).

Table 7: Major indirect uses of bamboo forests

Major indirect uses of bamboo	**Frequency**	
	Number	**Percent %**
Maintaining biodiversity	112	90
Regulating climate	96	78
Controlling erosion	119	96
Reducing pollution	108	88
Wildlife habitat	102	83
Herbal medicine	105	85
Cultural	115	92

Bamboo forests provide diverse ecological and economic benefits to farmers, making them integral components of agricultural landscapes across various regions Bamboo forests enhance soil health and water retention, crucial for agricultural productivity (Griscom et al., 2003). Bamboo's extensive root system stabilizes soil, preventing erosion and landslides, which is particularly beneficial in hilly or sloped terrain common in many bamboo-growing regions (Campanello et al., 2007). Furthermore, bamboo's leaf litter enriches soil fertility through nutrient cycling, improving crop yields and reducing the need for chemical fertilizers (Guaratini et al., 2024). Beyond ecological and economic benefits, bamboo holds cultural significance in many societies. Traditional knowledge of bamboo cultivation, harvesting techniques, and craft man ship is passed down through generations, fostering community cohesion and preserving cultural heritage (Austin & Marchesini, 2011). Bamboo-based festivals and rituals celebrate its role in local traditions, reinforcing its socio-cultural importance among farmers and their communities. In conclusion, bamboo forests play a pivotal role in sustainable agriculture,

offering ecological resilience, economic opportunities, and cultural significance to farmers. By integrating bamboo into agricultural landscapes, farmers can enhance soil health, diversify income sources, and strengthen community ties. Embracing bamboo's multifaceted benefits contributes to resilient and sustainable agricultural practices, essential for addressing global environmental challenges.

4.5 Causes for degradation of bamboo forest

The degradation of bamboo forests can result from a variety of natural and anthropogenic factors. Here are some of the main causes. Unsustainable logging practices, legal and illegal, lead to the removal of bamboo and associated vegetation. Bamboo forests are often cleared for agriculture, urban development, or infrastructure projects. Excessive harvesting of bamboo shoots or timber without allowing for regeneration can deplete the resource. Temperature and Rainfall Shifts: Changes in climate can affect bamboo growth patterns and health, leading to reduced growth and increased vulnerability to pests. Invasive species and pests can damage bamboo plants, leading to reduced health and productivity. Bamboo can be susceptible to various diseases that weaken or kill the plants. Poor land management practices can lead to soil erosion, affecting bamboo root systems and overall health. Continuous agriculture or overgrazing can deplete soil nutrients, making it difficult for bamboo to thrive.Expanding urban areas can encroach on bamboo forests, fragmenting habitats and reducing their size. Changes in water availability due to climate change or mismanagement can adversely affect bamboo growth. Natural or human-induced fires can destroy bamboo forests, especially in dry seasons contaminated water sources can also impact the health of bamboo forests. Communities relying on bamboo for subsistence may exploit resources unsustainably, leading to degradation. Insufficient understanding of sustainable practices can result in harmful harvesting methods. Addressing these causes requires integrated management strategies that promote sustainable use, conservation, and restoration of bamboo forests.

Table 8: Household's response about the cause of bamboo forest degradation

Major cause of bamboo forest degradation	Frequency	Per cent
Natural Disaster	13	2
Agricultural Expansion	103	78
Mass Flowering	30	24
Wild Fire	62	26
Total	124	100
Wild Fire	62	26

Similar studies reported that the cyclical die-off of bamboo, often triggered by synchronized flowering events is one primary natural cause for bamboo tree degradation. This phenomenon, observed in species such as *Chusquea montana* and *Guadua sarcocarpa*, results in the mass death of bamboo stands, creating substantial ecological disturbances (Holz & Veblen, 2006; Griscom & Ashton, 2003). Additionally, environmental stressors such as drought, disease, and pest infestations can exacerbate bamboo mortality (González et al., 2002). Anthropogenic factors also significantly contribute to bamboo degradation. Land-use changes, including deforestation for agriculture, urban development, and logging, lead to habitat fragmentation and loss (Caccia et al., 2009). Overexploitation of bamboo for commercial purposes further diminishes bamboo populations, undermining their regeneration capacity (Capellesso et al., 2022). Furthermore, inadequate management practices and lack of sustainable harvesting protocols can accelerate the degradation process (Griscom & Ashton, 2006).

4.5.1 Consequences of bamboo degradation on the ecology.

The degradation of bamboo forests can lead to significant environmental, economic, and social consequences. Here are some of the main impacts. Degradation can lead to the loss of habitat for various species that depend on bamboo forests, resulting in decreased biodiversity. Species Extinction: Endangered species may face extinction if their habitats are destroyed or fragmented. Bamboo's extensive root system helps prevent soil erosion. Its loss can lead to increased soil erosion, affecting land fertility and water quality. Erosion can lead to sedimentation in rivers and streams, impacting aquatic ecosystems. Bamboo forests play a role in carbon sequestration. Degradation reduces their capacity to absorb CO2, contributing to climate change. The removal of bamboo can alter local microclimates, affecting temperature and humidity levels. Communities that rely on bamboo for income (e.g., harvesting, crafts, and construction) may suffer economically. Degradation can push communities into poverty due to the loss of resources and employment opportunities. Bamboo shoots are a valuable food source. Degradation can lead to reduced availability, affecting local diets and nutrition. Soil degradation and erosion can negatively impact nearby agricultural lands. Erosion and sedimentation can lead to poorer water quality in nearby rivers and streams, affecting both human and wildlife populations.Changes in vegetation can disrupt local hydrological cycles, affecting water availability.As bamboo forests decline, competition for remaining resources can lead to conflicts among communities. Many

cultures have traditional ties to bamboo forests. Degradation can erode cultural practices and knowledge. The loss of bamboo can increase vulnerability to flooding and landslides, particularly in hilly or mountainous regions. The overall resilience of ecosystems and communities to environmental changes and disasters may be reduced. Reduced Ecosystem Services: Bamboo forests provide various ecosystem services, such as air purification, water filtration, and habitat provision. Degradation diminishes these services. Addressing bamboo forest degradation is crucial for maintaining ecological balance, supporting local economies, and preserving cultural heritage. Sustainable management practices can help mitigate these consequences.

The respondent also asked different question regarding on the consequence of bamboo forest degradation on the environment. As explained in the tables 8 below 21% of the respondent reported that the degradation of bamboo forest directly result in reduction in purified water. However, indirectly reductions in purified water affect health status of the community which may result in declining the product and productivity through reducing the productive labour. About 31% of the respondent asserted that the degradation in bamboo forest results in change in climate condition. From the survey data most of the respondent knows as the consequence of bamboo forest degradation, change the climate condition of the area. This is the reason why bamboo forests the capability to absorbed carbon die-oxides from the atmosphere. About 21% and 27% of the respondent indicated that bamboo forest degradation leads to reduction in income and accelerate soil degradation respectively.

Table 9: Consequence of bamboo tree degradation on the ecology

Consequence of bamboo Degradation	Frequency	Per cent	per cent
Reduction in purified water	26	20.97	21
Changes in climate conditions	38	30.65	31
Reduction in soil conservation	34	27.42	27
Decrease in economic overturn	26	20.96	21

The degradation of bamboo forests has profound ecological, economic, and social consequences. Ecologically, the loss of bamboo disrupts forest dynamics and species composition. Bamboo

often plays a crucial role in shaping forest structure by influencing light availability and soil conditions, thereby affecting the regeneration of tree species (Caccia et al., 2009; Campanello et al., 2007). The die-off of bamboo can lead to a temporary increase in tree seedling establishment due to reduced competition, but this is typically followed by changes in species diversity and forest structure (Giordano et al., 2009). Bamboo degradation also impacts carbon sequestration and soil health. Bamboo forests are significant carbon sinks; their decline reduces the overall carbon storage capacity of forest ecosystems (Padgurschi et al., 2021). Additionally, bamboo roots help stabilize soil and prevent erosion. Their degradation can lead to soil erosion and loss of fertile topsoil, further impairing forest regeneration and agricultural productivity (González et al., 2002).

Economically, the decline of bamboo affects livelihoods of households dependent on bamboo resources. Communities relying on bamboo for construction materials, handicrafts, and food face reduced income opportunities (Griscom & Ashton, 2003). The loss of bamboo as a raw material can lead to increased reliance on alternative, often less sustainable resources, exacerbating environmental degradation (Buziquia et al., 2019). Socially, bamboo degradation undermines cultural practices and traditional knowledge systems. Many indigenous and local communities have culturally significant uses for bamboo, from rituals to everyday tools. The decline of bamboo populations threatens the preservation of these cultural practices (Austin & Marchesini, 2011). In conclusion, the degradation of bamboo forests, driven by both natural cycles and human activities, leads to significant ecological, economic, and social repercussions. Addressing these challenges requires integrated conservation and sustainable management strategies to ensure the resilience and sustainability of bamboo-dominated ecosystems.

4.5.2 Challenges and analysis of farmer opinions for better conservation of bamboo tree

The respondents were asked about the kind of action and intervention to be taken to better conserve and rehabilitate bamboo trees. About 65% of the respondents suggested that rules and regulations that govern the conservation and rehabilitation process in which the representative of the community actively participate should be designed and strong measure should be taken on these whom were deforesting it (Table 9).Out of selected households, about 66% suggested a clear demarcation on the flowered bamboo so as to control encroachment in to the forest search of additional land and 60% of the respondent expressed their view that government should be

active in coordinating and teaching of community to participate in the conservation and rehabilitation of bamboo and seedlings. About 42% of them suggested that the government should reduce investment and other program that cause deforestation of the bamboo trees and 54% of the respondent believed that the government should provide seeds.

Table 10: Respondent's opinion about conservation of bamboo forest

Respondents' suggestion	frequency	%
Setting rules and regulations	80	65
Demarcating the forest area	82	66
Coordinating and teaching community	74	60
Supplying seeds and seedlings of bamboo	67	54
Minimize its deforestation of bamboo	52	42

4.6 Opportunities for bamboo tree Utilization and Conservation

Even though it is too late there has been a growing awareness in recent years about the importance of bamboo being an important means of economic growth and of improving the socio-economic conditions of the rural poor. Bamboo as an industrial material can substitute wood to a great extent and that too at low cost. Bamboo has been traditionally harvested from forest lands and the homesteads which may have a few clumps of one of the many species of bamboo for household use but very little intervention in terms of purposive planting has been done in the past. Convincing and informing users and of bamboo's versatility may fit in with a strategy of poverty alleviation and reducing pressure on tropical forests.The newly organized bamboo enterprise in the study area was highly exploited the bamboo tree resources without giving adequate attention for its plantation and bamboo nursery expansion. Besides there is no law that assists the bamboo dependent of managing, conserving and wise use of bamboo tree based enterprise. Households were also asked during the survey whether they have observed gradually the agriculture is expanding in recent decades because of population growth. Agricultural expansion is also direct and indirect impact on the bamboo trees since majority of the Ethiopian people mostly engaged on primary economic activities.

Table 11: Respondent's opinion about the intervention in the conservation of bamboo forest

Respondents' suggestion	Frequency	%age
Setting rules and regulations	78	63
Demarcating the forest area	82	66
Coordinating and teaching community	72	58
Supplying seeds and seedlings of bamboo	70	56
Minimize its deforestation of bamboo	52	42

The people in the study area are mostly engaged on using and working on it. As a result, people have no option rather than utilizing of the bamboo tree especially since it is tied with people livelihood. In case of conserving the resource, the governmental policies rules and regulation is well structured within Non-Governmental Organization (NGO) like biodiversity. The reason behind is that, the settlement of peoples around the study areas. It is surrounded by four kebele's of the cultivated land is very nearer to the bamboo trees.

4.7 Challenges for bamboo forest management.

As shown below (**Table** 12), the respondents indicate challenges for the bamboo trees are the expansion of agriculture due to large number of people migrate and settled to the area comparatively since their soil is fertile than other areas. Beside to this there is encroachment of people around the resource surrounding and low income of people gets their day to day subsistence economy on the study area. About 19% the respondents indicated that the major challenges for the diminishing on bamboo trees in the study area was over use of the resources to support their day to day subsistence.

Table 12: The major challenges of bamboo tree management

Item	Category	Freq.	Percent
What are the major challenges on diminishing on bamboo forest in your area?	House hold	24	19
	Agricultural expansion	54	44
	Encroachment	41	33
	Low income	5	4
	Total	124	100

The diminishing bamboo resources pose several challenges that can affect ecological balance and forest dynamics. One of the primary challenges is the alteration of tree regeneration niches due to the scarcity of bamboo. The reduction in bamboo can lead to changes in these micro environmental conditions, potentially hindering the growth and establishment of tree seedlings that have adapted to the presence of bamboo.

These changes further hinder the regeneration and growth of native plant species. For such occasions, environment policy plays a crucial role in addressing the challenges of diminishing bamboo resources. Effective conservation strategies require coordinated efforts and supportive policies. However, inconsistencies in policy implementation, lack of technical support, and limited access to conservation funding can pose significant obstacles to sustainable bamboo forest management (González et al., 2002). The diminishing of bamboo forests present several challenges in conserving and regeneration of indigenous vegetation as well as to the households. These challenges include alterations in micro environmental conditions, disruption of natural regeneration cycles, changes in microclimate, economic pressures, interruption of disturbance cycles, reduced seed dispersal, soil degradation, and policy constraints. Addressing these challenges requires integrated conservation strategies that balance ecological, economic, and social factors.

CHAPTER -FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusions

The study concludes that bamboo forests play a crucial role in enhancing both livelihoods and ecological resilience. They not only provide direct economic benefits to communities but also contribute to environmental sustainability. The findings highlight the need for policies that support bamboo cultivation and management, emphasizing its potential as a tool for poverty alleviation and ecosystem restoration**.**

The findings show that most local people use bamboo tree products as a replacement for every building material like house utensils, doors, windows, tables, and chairs in various sizes for firewood, furniture, fences, and household activities functionalized in homes. From all listed different bamboo products, firewood is the most used, with a higher income share of forest with over 43%. It is also a source of income since its product is mostly, available in the study area, where people engage in bamboo tree plantations and use it as a trade exchange. Besides this, bamboo trees can be a replacement for other indigenous trees by reducing overconsumption and giving long survival by keeping them from being extinct.

Indirectly, bamboo trees are used to maintain biodiversity, regulate climate, control erosion, reduce pollution, wildlife, habitat, and use herbal medicine. The main causes of bamboo forest degradation also include natural disasters, cultivation near bamboo forests, mass flowering, wildfires, and agricultural expansion. For better conservation of bamboo trees, people are aware of keeping rules and regulations, demarcating the forest area is an alternative use of bamboo, especially other energy, to minimize its deforestation and teach the community. The main challenges arising from conserving bamboo trees in the study area concluded that agricultural expansion, encroachment, and low income of people.

5.2. Recommendations

The relationship between bamboo trees and indigenous vegetation is linked. For better conservation of bamboo trees, people are aware of keeping rules and regulations, and demarcating the forest area is an alternative use. Policymakers formulate a design for farmers linked with the resources, that incorporate the regional state with the federal government. Based on result on this study, the following recommendations were forwarded:

- Policy Support: Governments should implement policies that promote bamboo cultivation and integrate it into rural development strategies.
- Community Engagement: Enhance community awareness programs about the benefits of bamboo and encourage local participation in bamboo management.
- Research and Development: Invest in research to explore innovative uses of bamboo and improve cultivation techniques.
- Sustainable Practices: Encourage the adoption of sustainable harvesting practices to ensure the long-term viability of bamboo forests.
- Partnerships: Foster partnerships between local communities, NGOs, and government agencies to create a supportive framework for bamboo-based initiatives.

References

Akinlabi, E. T., anane-Fenin K. and akwada D.R., 2017. Regeneration, Cultivation and Sustainable of bamboo. In bamboo (pp. 39-86). Spring, Cham.

Assosa agriculture research centre report of 2019.

Atmadja, S., Eshete, A. and Boissire, M., 2019. Guideline on sustainable forest management in dry lands of Ethiopia.

Austin, A.T. & Marchesini, V.A. (2011) Gregarious flowering and death of understorey bamboo slow litter decomposition and nitrogen turnover in a southern temperate forest in Patagonia, Argentina. *Functional Ecology*, 26, 265–273. Available from: https://doi.org/10.1111/j.1365-2435.2011.01910.x

Bareja, G.B., 2010. Bamboo production and propagation method. Online research march, 5, p. 2013.

Basumatary, A., Middha, S.K., usha, t., brahma, B.K., 2015. Bamnoo as potential source of food security, economic prosperity and ecological security in North-East India: an overview of research on plant biology, 5(2).

Bessie, S., Beyene, F., Kotu, B.H., Goshu, G. and Mengesha, Y., 2014.Local Communities' Perceptions of Bamboo Deforestation in BenishangulGumuz Region, Ethiopia. *Journal of economic & Sustainable Development*, *5*(24), pp.148-162.

Biemer, P.P.L. & Lyberg, K. (2003). *Introduction to survey quality*. New York: John Wiley.

Boissier, M, Bayessa, M. And Atmadja, S, 2019. Huiding principle of sustainable bamboo forest management planning inBeneshangul Gumuz Regional State(BGRS)

Budke, J.C., Alberti, M.S., Zanardi, C., Baratto, C. & Zanin, E.M. (2010) Bamboo dieback and tree regeneration responses in a subtropical forest of South America. *Forest Ecology and Management*, 260, 1345–1349. Available from: https://doi.org/10.1016/j.foreco.2010.07.028

Buziquia, S.T., Lopes, P.V.F., Almeida, A.K. & de Almeida, I.K. (2019) Impacts of bamboo spreading: a review. *Biodiversity and Conservation*, 28, 3695–3711. Available from: https://doi.org/10.1007/s10531-019-01875-9

Bystriakova, N., Kapos, V. and Lysenko, I., 2004. Bamboo biodiversity: Africa, Madagascar and the Americas (No. 19). UNEP/Earthprint.

Central statistical authority report of 2007

Caccia, F.D., Chaneton, E.J. & Kitzberger, T. (2009) Direct and indirect effects of understorey bamboo shape tree regeneration niches in a mixed temperate forest. *Oecologia*, 161, 771– 780. Available from: https://doi.org/10.1007/s00442-009-1412-z

Campanello, P.I., Gatti, M.G., Ares, A., Montti, L. & Goldstein, G. (2007) Tree regeneration and microclimate in a liana and bamboo-dominated semideciduous Atlantic Forest. *Forest Ecology and Management*, 252, 108–117. Available from: https://doi.org/10.1016/j.foreco.2007.06.032

Capellesso, E.S., Artusi, Á.C., Marques, M.C.M., Dalastra, C.H., Haiduki, L., Bayer, C. et al. (2022) Effects of a native bamboo species on tree regeneration diversity of a subtropical Atlantic Forest. *Forest Ecology and Management*, 524, 120530. Available from: https://doi.org/10.1016/j.foreco.2022.120530

Cochran, W. G., (1993). *Sampling Techniques*. Second Edition. John Wiley & Sons, Inc. New York. Library of Congress Catalog Card Number: 63-7553

Deseso, Y., 2019Regeneration of lowland bamboo oxytenantheraabyssinica AR Muyrno in mandura district Northwest Ethiopia. Biodiversity international journal, 3(3)

Desta S.B., 2016 collective action, property right bamboo deforestation in Beneshangul Gumuz Region, Ethiopia. J.Resour. Dev.Manag, 16, pp.94-102

Desta, S.B., 2014. Deforestation and strategy for rehabilitation in Beles Sub basin, Ethiopia journal of Economic and Sustainable Development.

Dwivedi, A.K., Kumar, A., Baredar, P. and Prakash, O., 2019. Bamboo as a complementary crop to address climate change and livelihoods–Insights from India. Forest Policy and Economics, 102, pp.66-74

Empaye, K. 2003. Ecological aspects and resource management of bamboo forest in Ethiopia (Vol.273)

Fadrique, B., Santos-Andrade, P., Farfan-Rios, W. Salinas, N. Silman, M. Feeley, K. J. (2021). Reduced tree density and basal area in Andean forests are associated with bamboo dominance. Forest Ecology and Management, 480(), 118648– .doi:10.1016/j.foreco.2020.118648

Girma Belihu, 2021 The Dependency of Farmers On Bamboo Forest For Rural Livelihood, Debrebirhan university.

González, M.E., Veblen, T.T., Donoso, C. & Valeria, L. (2002) Tree regeneration responses in a lowland *Nothofagus*-dominated forest after bamboo dieback in south-Central Chile. *Plant Ecology*, 161, 59–73. Available from: https://doi.org/10.1023/A:1020378822847

Greig, C., Robertson, C., Lacerda, A. (2018). Spectral-temporal modelling of bamboo-dominated forest succession in the Atlantic Forest of Southern Brazil. Ecological Modelling, 384(), 316 332. doi:10.1016/j.ecolmodel.2018.06.028

Griscom, B. W., Mark, P., Ashton, S. (2003). Bamboo control of forest succession: Guadua sarcocarpa in Southeastern Peru, Forest Ecology and Management, Volume 175, Issues 1–3, Pages 445-454, https://doi.org/10.1016/S0378-1127(02)00214-1.

Griscom, B.W. & Ashton, P.M.S. (2006) A self-perpetuating bamboo disturbance cycle in a neotropical forest. *Journal of Tropical Ecology*, 22, 587–597. Available from: https://doi.org/10.1017/S0266467406003361

Grombone-Guaratini, M.T., Alves, L.F., Vinha, D. & Franco, G.A.D.C. (2014) Seed rain in areas with and without bamboo dominance within an urban fragment of the Atlantic Forest. *Acta Botânica Brasílica*, 28, 76–85. Available from: https://doi.org/10.1590/S0102-33062014000100008

Guaratini, M. T., Gomes, E. P., Alves, L. F. (2024). Impacts of bamboo dominance and die-off on seedling dynamics in a tropical secondary forest (Brazil). Volume 49, Issue1. https://doi.org/10.1111/aec.13479

Haile, B., 2008. Study on establishment of bamboo processing plants in Amhara Regional State (Doctrial dissertification, Addis Ababa University).

Holz, C.A. & Veblen, T.T. (2006) Tree regeneration responses to *Chusquea montana* bamboo die-off in a subalpine *Nothofagus* forest in the southern Andes. *Journal of Vegetation Science*, 17, 19–28. Available from: https://doi.org/10.1111/j.1654-1103.2006.tb02419.x

Kassahun, T. And Dawuro, T., 2014. Review of bamboo value chain in Ethiopia. International journal of Africa society Culture and Traditions, 2(3), pp.52-67.

Kigomo, B.N., 1988, November. Bamboo resource in east Africa region. In bamboos current research, proceeding of the international bamboo Workshop (pp22-28

Kindu, Y.M.M., 2010. Status of bamboo resource development, utilization and research in Ethiopia: A review. Ethiopian journal of natural resource, 1, pp.79-98.

Lima, R.A., Rother, D.C., Muler, A.E., Lepsch, I.F. & Rodrigues, R.R. (2012) Bamboo overabundance alters forest structure and dynamics in the Atlantic Forest hotspot. *Bioogical Conservation*, 147, 32–39. Available from: https://doi.org/10.1016/j.biocon.2012.01.015

Li, H., & Zhang, L. (2021). "Sustainable management of bamboo forests." Sustainability, 13(4), 1801.

Lin, j., Gupta,S., Loos, T.K. and Birner, R.,2019. Opportunities and Challenges in Ethiopia Bamboo Sector: A Market analysis of the Bamboo Based Value Web. Sustainability, 11(6), p.1644.

Liu, Y., & Zhang, Y. (2018). "Effects of climate change on bamboo growth patterns." Global Change Biology, 24(3), 1332-1344.

Marchesini, V.A., Sala, O.E. & Austin, A.T. (2009) Ecological consequences of a massive flowering event of bamboo (*Chusquea culeou*) in a temperate forest of Patagonia, Argentina. *Journal of Vegetation Science*, 20, 424–432. Available from: https://doi.org/10.1111/j.1654-1103.2009.05768.x

Maroma, D.P., 2015. Utilization of Bamboo Shoots (Bambusa vulgaris) in Chips production. Open Access Library Journal, 2(5), p.1.

Mekuriaw, Y., Urge, M, and Animut, G., 2011. Role of indigenous bamboo species (Yushaniaalpina and Oxytenantheraabyssinia) as ruminant feed in northwetern Ethiopia. Livestock research for rural development,23(9), p.9

Mosissa, D. And Woldegebriel, g., 2019. Evaluating the natural regeneration of lowland bamboo (Oxytenantheraabyssibica Ar Munro) forest after mass flowing and mass death in Homosha District of Beneshangul Gumuz Region North western Ethiopia. MOJ Eco Enviro sci, 4(1), pp. 19-32

Padgurschi, M., Reis, T. S., Alves, L. F., Vieira, S. A., Joly, C. A. (2021). Outcomes of a native bamboo on biomass and carbon stocks of a neotropical biodiversity hotspot. Acta Oecologica 111, doi:10.1016/j.actao.2021.10373

Sinha, A. K., & Singh, P. (2018). Bamboo: A Comprehensive Overview. Journal of Forestry Research, 29(3), 1-12.

Yiping, L., Yanxia, L., Buckingham, K., Henley, G. and Guomo, Z., 2010. Bamboo and Climate Change Mitigation: a comparative analysis of carbon sequestration. International Network Bamboo and Rattan

APPENDIXS

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES DEPARTMENT OF GEOGRAPHY AND ENVORONMENTAL STUDIES QUESTIONIRES FOR SUMPLE KEY INFORMANT INTERVIEW

Dear respondent, the main objective of this research is to collect information which will use for the study on the role of bamboo forest on regeneration of indigenous vegetation; the case of bambasi woreda. This study is going to be conducted for the partial fulfilment of MA degree in Geography and Environmental Studies at college of social sciences. Frankly speaking, the information obtained through the questioner survey will purely be used for academic purpose only. Moreover, I confirm you that the information you are going to offer would be kept confidential. Your full support and willingness respond to the question is very essential for the success of the study. Therefore, you are kindly requested to answer all the question and give clear appropriate and reliable information on the issues.

Accordingly, I will select some of the respondent related to the study to provide enough information based on my study topic, moreover, your willingness, care-full, honest response and impartial of your answer will be vital and determines the success of this study. Thus, the response you give for the conduct is only used for academic purpose, so please feel freely and be confidentially.

Therefore, dear sir/madam respondents, please provide your responses based on the instruction given below.

- ✓ No need of writing your name and phone number.
- ✓ Answer the question based on its contents.
- ✓ When you fill the answer please keep it secret.
- ✓ Encircles the letter of your choice.
- ✓ For the open-ended questions write your answer in the space provided.

APPENDIX I

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES OPEN-ENDED QUESTIONNAIRES FOR SURVEY QUESTIONS

I Socio-demographic information [encircle the letter of your choice]:

1. Gender: A. Male B. Female
2. Age of the respondent: A. 15-24 B. 25-34 C. 35-44 D. 45-54 E. 55-64 F. 65<
3. Educational status: A. Illiterate B. Read and write only C. Elementary D. High school E. Certificate F. Diploma G. Degree H. MA degree
4. Origin: A. Native B. Settler
5. Duration (experience): A. 5-10year B. 10-15year C.15-20year D.> 20year
6. Family size: A. 1-3 B. 4-6 C. 7-9 D. >10

II. Respondent's Awareness about Economical, ethical and scientific importance of bamboo

1. Are you satisfied with the availability of bamboo forest? A. Yes B. No
2. How do you rate the use of bamboo tree? A. purposeful B. multipurpose
3. Most households are uses what kind of trees? A. Bamboo tree B. other indigenous vegetation
4. What are the indirect uses of Bamboo resource to the local community? (Circle more than one answer)

A. Regenerating indigenous vegetation B. Regulating climate C. Controlling erosion D. Reducing pollution E. Wildlife habitat F. Maintaining biodiversity G. Cultural equipment H. all

5. What are the contributions of bamboo product to annual income for economy of the people? (Encircle more than one answer)

A. Selling bamboo tree B. Furniture C. Fire wood E. Tie (□□) E. Ballast F. all

6. Do you think bamboo forest ecosystem can expand or diminishing?

A. Expanding B. Diminishing

7. Do you require permission to collect /transport or sell bamboo resource? A. No B. Yes

If yes, who grants permission? A. Forest Dept. B. District Commissioner C. Divisional head D. Other, specify E. all

8. Choose more than one rate of the following list of bamboo forest on the basis of its uses?

A. Construction B. Firewood C. Fence D. Making furniture E. Source of income F. As source of food G. all

9. Choose the best from the following indirect uses of bamboo

A. Maintaining biodiversity B. Regulating climate C. Controlling erosion D. Reducing pollution E. Wild life habitat F. Cultural G. Herbal medicine H. All

10. Which of the following is the cause for bamboo forest degradation? A. Natural disaster

B. Cultivation of near bamboo forest C. Mass flowering D. Agricultural expansion E. Wild fire G. For housing H. all

11. Which of the following items is Consequence of bamboo degradation on the ecology?

A. Reduction of purified water B. Change in climate condition C. Reduction in soil conservation D. Decrease in economic turn over E. All

12. In your opinion, what should be done in the conservation of bamboo forest?

A. Setting rules and regulations B. Demarcating the forest area C. Coordinating and teaching community D. Supplying seeds and seedlings of bamboo E. Minimize its deforestation of bamboo F. All

13. What are the respondent opinions about the intervention in the conservation of bamboo forest?

A. Setting rules and regulations B. Demarcating the forest area C. Coordinating and teaching community D. Supplying seeds and seedlings of bamboo E. Minimize its deforestation of bamboo F. All

14. What are the major challenges on diminishing on bamboo resources in your area?

A. House hold B. Agricultural expansion C. Encroachment D. Low income

15. In which way Bamboo tree used in building material?

A. House B. Fences C. Bothy market D. Construction E. All

APPENDIXS II

ADDIS ABAB UNIVERSITY SCHOOL OF GRADUATE STUDIES, DEPRTMENT OF GEOGRAPHY AND ENVIRONMETAL STUDIES OPEN-ENDED QUESTIONAIRES FOR FOCUSED GROUP DICUSSION

Date: _____ Kebele_____

Focused Group Discussion (FGD) members: Male: ------- Female: -------- Age----------

Duration in the study area----------position----------

1.What are the opportunities, challenges and constraints you face in using bamboo tree? ----------

2. Does bamboo forest destruction is a serious problem in your area? (Yes or Not?) If your answer is yes, how?----------

3. Based on question number (2) in your view, what is (are) the main cause(s)of this problem?.....

4. What are the major multipurpose (uses) of bamboo in your locality? ----------

5. Is there any Bamboo based enterprise in your village? ----------

6. Is there any govt./ non-government organizational activities for organizing and Managing bamboo-based enterprises? Yes….. No…… If yes, what are they? ----------

7. What are your opinion/ suggestions to make these bamboo resources more available for use and conservation? ----------

8. Is there any policy related to bamboo management and conservation? Yes or No

9. What should be done to conserve and rehabilitate bamboo forests and what Sustainability of conservation and restoration in your area? ----------

10. What kind conservation strategies are practiced in the study area? ----------How much it is effective and efficient? ----------

11.What is/are the existing rules and regulation practiced on bamboo tree conservation and bamboo tree used in the study area?----------

12. As a bamboo forest user of this area, what can you do to improve the availability and accessibility of bamboo trees? ----------

BY: MengistuTerefe

ADVISOR: - AsnakeMekuriaw (PhD)

APPENDIXS III

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES, DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES QUESTION FOR KEY INFORMANT INTERVIEW.

Name of the organization: ----------Position: ----------

Name of interviewee: ----------Job experience: ----------

1. What are the opportunities, challenges and constraints you face in using bamboo tree?
---

2. Does bamboo forest destruction is a serious problem in your area? (Yes, or Not) why or why not--------
---

3. Based on question number 2 in your view, what is(are)the main cause(s) of this problem? ----------
---

4. What are the multipurpose uses of bamboo in your locality? List down? ----------
---

5. What are the likely consequences bamboo tree degradation in your area? ----------
---

6. In your view compare the use of bamboo tree with indigenous vegetation for local community? ---------
---

7.Do you think bamboo in private forest land needs cultural treatments?----------
---

8. Who is/are mostly engaged in the bamboo forest conservation of the study area? ----------
---

9. What is the prevailing management system of the bamboo tree in the area? ----------
---

10. What is/are the potential challenges in conserving and rehabilitating bamboo forest? ----------
---

11. What is/are the role of your office in managing and conserving bamboo trees? ----------
---

Based on question number 11 above, is there other formal or informal rules and regulations for managing or conserving bamboo trees in your area? ----------
---

12. Did the agricultural office teach and terrain rural households in relation to environmental conservation? (Yes or No) If yes, in what mechanisms? ----------
---

13. Is there any institutional support for the bamboo forest of the area to encourage the conservation and rehabilitation of bamboo forests? ----------
---

BY: MengistuTerefe

ADVISOR: - AsnakeMekuriaw (PhD)

Thank you for your cooperation