Ethiopian Economics Association (EEA)

Green Legacy Initiative for Sustainable Economic Development in Ethiopia

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ACRONYMS

ADB	African Development Bank
AEMW	African-Eurasian Migratory Water birds
CCC	Convention on Climate Change
CITES	Convention on International Trade in Endangered Species
CMS	Conservation of Migratory Species of Wild Animals
CRGE	Climate Resilient Green Economy Strategy
CSA	Central Statistical Agency
CVM	Contingent Valuation Method
EEA	Ethiopian Economics Association
EFCCC	Environment and Forest and Climate Change Commission
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
FGD	Focus Group Discussions
FDRE	Federal Democratic Republic of Ethiopia.
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLI	Green Legacy Initiative
GoE	Government of Ethiopia
INDC	Intended Nationally Determined Contributions
KII	Key Informants' Interviews
MEFCC	Ministry of Environment and Forest and Climate Change
NDC	Nationally Determined Contribution
NFSDP	National Forest Sector Development Program
NGOs	Non-Governmental Organizations
PAGWW	Pan-African Agency for the Great Green Wall
PFM	Participatory Forest Management
REDD+	Reduces Emissions from Deforestation and Forest degradation
SDG	Sustainable Development Goals
SNNP	Southern Nations, Nationalities and Peoples
WB	World Bank
WTP	Willingness to Pay
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification

UNCB	United Nations Convention on Biological Diversity
UNEP	United Nations Environment Programme
UNSDCF	Sustainable Development Cooperation Framework

EXECUTIVE SUMMARY

Introduction

Forests play a significant role in the livelihood of the people, serve as a buffer in maintaining livelihoods, provide environmental services such as carbon sequestration and provide social or cultural benefits to the local people in Ethiopia. However, the contribution of forests to the overall economy of the country is still very low. Though several direct and indirect drivers of deforestation and forest degradation have been identified, there has not been significant progress in reversing the situation. The mass tree planting program called the Green Legacy Initiative (GLI) was launched by the Prime Minister of Ethiopia in 2019 with the objective of restoring degraded lands, increase the forest cover and reduce the impact of climate change.

The purpose of this research was to investigate the effectiveness of the GLI in contributing to sustainable economic development of Ethiopia. More specifically, the study aimed at: i) Assessing the levels and successes rates of the GLI both at national and regional levels, ii) Exploring the roles of socioeconomic and livelihood conditions in implementing the GLI, iii) Evaluating willingness to participate and commitment levels of the local communities in the GLI, iv) Examining the role of GLI on green growth path of the country, and v) Identifying implementation challenges, remedial measures, and future opportunities in managing natural resources in the same.

Methodology

Both primary and secondary data sources were employed in this research work. Key informant interviews (KIIs) and focus groups discussions (FGDs) were held to collect crucial and communally share data. Experts view from federal, regional, and district levels government offices were collected to cross-check with the primary data. Both primary and secondary data were collected from four regional states, namely, Amhara, Oromia, Sidama and Southern Nations, Nationalities and Peoples (SNNP) Regions. Two woredas per region and two *kebeles* per woreda were selected purposely based on the activities related to the GLI in collect the data. The number of households chosen for face-to-face interview was selected using random sampling techniques. To achieve the stated objective, the study adopted a mix of qualitative and quantitative analysis techniques. The study also adopted the method developed by Winrock International's Carbon Monitoring Program to estimate the carbon sequestration potential of the GLI.

Findings

The results reported that the performance of the GLI over the last three planting periods was well beyond the target. For example, the survival rate of trees planted during the 2020 GLI period was 83.5% (official report by the government), which shows that the program is very successful. The assessment of the study showed that there are regional variations in terms of GLI implementation performance. It was fund that the regions with better performance were Oromia and Amhara followed by SNNPR. These regions have relatively better facility (resources and expertise) to raise and plant seedlings. In addition, the suitability of agro-climatic zone contributes to the success of the GLI in these regions. The political instability and the conflict that happened in the different parts of the country affected the performance of some of the regions in the country. This was true for the case in the northern part of the country (Tigrai and Amhara), Afar, western Wollega and Benishangul Gumuz regions. The situation in these regions made it difficult to mobilize the local people and facilitate the overall coordination of the tree planting programs.

The study found that the local communities are well aware of the socioeconomic and environmental roles of trees. It is also important to capitalize on these benefits of trees in promoting the tree planting campaign to mobilize large number of people for tree planting. Failure to involve the local communities in the GLI might result in failure in the implementation of the GLI.

The econometric estimation results showed that the number of trees owned by farm households is a function of socioeconomic characteristics such as education of head, family size, land size, number of livestock owned, access to infrastructure including distance to market and roads, social capital indicators such as membership in agricultural producer group, and tenure security. The success of GLI cannot be achieved if tree planting on farmer’s plot were not considered. There is a need to encourage farmers to plant and own more number of trees and bushes. Hence, there is a need to alleviate the barriers that negatively affect the tree planting behavior of farm households. Similarly, several factors that affect the number of trees/seedlings planted were identified using econometric regression. These factors include age and gender of the household head, family size, education, land size, access to infrastructure such as distance to nearest main road and markets, household membership in local organizations such as agricultural producer and credit group. All there are related to the total number of seedlings planted during the last two years.

This research work used the Contingent Valuation Method (CVM) to estimate the Willingness-To-Pay (WTP) of rural households to maintain the tree planting program for the next five years. The results from the double bounded model indicated that the mean annual WTP per household is ETB 255. The study suggests that rural households place a fair amount of money to keep the GLI program for the next five years, which recommend that local communities are committed to GLI. In this regard, it is good to consider those households in the community that are more likely to support the tree planting program. The specific socioeconomic and livelihood condition of the local community has to be considered during the initial stage of the tree planting period. The various groups of the society such as the youth and elderly, male and women, literate and illiterate, and others are all involved during the last three tree planting campaigns. On the contrary, the study found that the role of public infrastructures such as sport facilities, schools, public libraries, and other institutions and associations were limited. It is necessary to provide them with special responsibilities to plant, manage and maintain the trees. Such program has to be properly planned and implemented by the relevant government organization starting from the federal to the district level.

Successful implementation of the GLI significantly contributes to the fulfillments of the green growth target of the country. In Ethiopia, people largely depend on forests for food, fire wood, medicinal plants, wild coffee, honey, spices, etc. In addition, forests sequester and store carbon dioxide from the atmosphere, helping to reduce greenhouse gas emissions. This study attempted to estimate the carbon sequestration potential of the GLI both at the national and regional levels using the official data. Among the regions, Oromia region has the highest amount of carbon sequestered in the last three green legacy campaigns followed by Amhara (2019) and SNNP (2020 and 2021). The carbon sequestration estimation reported that if resources are available and all the necessary post-planting activities are conducted properly, then the contributions of the plantation in mitigating climate change will be significant. It is also important to recognize the potential of trees in urban areas in sequestering carbon from the atmosphere and mitigate the impacts of climate change. The country can get a significant amount of revenue from sale of carbon. In line with this, it is necessary to work on developing clear rules and guidelines for the benefit sharing mechanisms.

Finally, this research report identified several implementation challenges that need to be addressed to enhance the contribution of the GLI to the economic, social and environmental goals of the country. Various factors such as policy and institutional, technical or biophysical, socioeconomic, and project characteristics influence the success of the afforestation and reforestation projects both in the short and long-run. The policy and institutional factors include lack of land use policy and plan, tenure insecurity, lack of security and political stability in some of the regions, challenges related to forest implementation guidelines, and poor institutional arrangement. The socioeconomic drivers include lack of sufficient budget, poor provision of nursery equipment and materials, lack of adequate transport, lack of appropriate incentive mechanisms, and markets. The project characteristics are lack of clear purpose of planting, project implementers, inaccessibility of some of the planting sites, low involvement of relevant stakeholders, and lack of monitoring and follow up. Last but not least, the bio-physical factors such as inappropriate site selection for tree planting, poor soil depth, lack of enough moisture, unavailability of sufficient number of seedlings, poor quality of seedlings, inappropriate tree species types, and inappropriate planting time are also among the main implementation challenges. The country should be able to address the aforementioned implementation challenges related to the forest sector.

The current efforts of the government involves various governmental and non-governmental organizations, public institutions such as schools should be strengthen further endeavors. The participations of such institutions should not be limited to planting seasons only but also in post-planting activities. Public infrastructure such as the city/town sport offices, schools, public libraries, etc. can be provided special responsibilities to plant, manage and maintain the trees. Institutions such as sport fan associations, youth and women’s associations, development associations, alumni, trade unions, professional associations, producers’ and consumers’ associations, etc. can be involved in the tree planting program. This has to be properly planned and implemented by the relevant government organization starting from the federal to the district level. It is necessary to have clear guidelines, rules and regulations regarding the involvement of these actors in the GLI.

Recommendations

In sum, the study recommends the following activities for future related researches. First, a comprehensive survey covering each region would provide better picture about the GLI in the country. Second, further analysis on the tree planting behaviors of farm households using a nationally representative data would help to derive appropriate intervention mechanisms. Third, there is a need to establish detail data regarding the activities of the GLI such as number and type of trees planted in each site, type of trees/species, number of people participated, participation rate by socioeconomic groups, estimated contribution by the local community and others supported by satellite based information.

1. INTRODUCTION

1.1. Background of the Study

It is estimated that Africa's forests and woodlands covers 675 million hectares or 23% of the overall land area of the continent (African Development Bank, 2018). Several hundred millions of people in the continent depend on forests for food, energy, and income, and act as a safety net during hard times (FAO, 2018). Forests and forest resource plays a significant role in the livelihood of the people in the developing world including Ethiopia. In addition, studies indicate that forests and tree-based systems can serve as a buffer in maintaining livelihoods and represent natural insurance, provide environmental services such as carbon sequestration, water protection and preserving biodiversity. Moreover, forests provide social or cultural benefits to the local people.

However, deforestation and forest degradation are still rampant in many parts of Africa even though the net loss of forest area has decreased substantially since 1990. Africa had the highest net loss of forest area in 2010–2020, with a loss of 3.94 million hectares per year (FAO and UNEP, 2020). Similarly, Ethiopia's forest cover which has been around 40% of its total land area at the beginning of the century reached to 3% in the 1970's and 80's. The country was able to increase its forest coverage to 15.7% of the total land cover (MEFCC, 2018).[3] Evidences show that the net deforestation rate is, on average, around 72,000 ha per annum (MEFCC, 2018). This makes rehabilitation of degraded lands through afforestation/reforestation activities crucial to the country.

The main causes of deforestation and forest degradation in Ethiopia are conversion of land for agriculture because of rapid population growth, fuel wood and charcoal production; timber harvesting for construction, free grazing, and wild fire (MEFCC, 2016). In addition, frequent institutional restructuring, inadequacy of skilled man power and finance, poor linkage between research and extension are all considered to be the challenges of the forest sector in the country (UNIQUE, 2016).

[3] This, however, has been partly due to the change in the definition of forest by the Ethiopian government.

Recognizing the problem of the forest sector, Ethiopia has put tremendous efforts to reverse the situation and enhance the role of forests in the social, economic, and environmental objectives of the country. The country's forest sector policies and strategies such as Climate Resilient Green Economy (CRGE) and the National Forest Sector Development program (NFSDP) show that the various factors responsible for the degradation need to be addressed and reverse the ecological functions. In the CRGE the forest sector has been considered as one of the four pillars of the green economy that the country is planning to build by 2030.[4]

As part of these efforts, the Green Legacy Initiative (GLI) was launched by the prime Minister of Ethiopia in May 2019. It has the aim of tackling deforestation and climate change by planting trees. The Green Legacy Initiative claimed that a total of 4 billion, 5 billion, and 6 billion seedlings were planted in 2019, 2020, and 2021, respectively. The plan is to plant 20 billion seedlings by 2022. During the 2021 GLI period, the country distributed about 1 billion seedlings to the neighboring countries such as Djibouti and South Sudan as part of the regional effort to fight climate change that is the crucial challenge facing the continent.[5]

Generally, such kind of programs provide several opportunities such as mitigating the impacts on climate change and enhance ecosystem services, financial benefits from reforestation and afforestation programs, revenue from both timber and non-timber products, livelihood improvement, and enable the country to meet national and global restoration and reforestation commitments. The GLI, among others, could have a significant role in terms of fulfilling the climate related commitments of the country if it is implemented effectively. According to FAO (2021), in order to meet the Sustainable Development Goals (SDG), countries need to undertake large-scale forest restoration programs and prevent, halt and reverse the loss of biodiversity. For example, Ethiopia committed to restore 22 million hectares of degraded forests and lands by 2030 (EFCCC, 2018). However, this kind of programs need to be closely followed and monitored, identify the challenges and success factors that would help attain the objectives set by the initiative. Thus, the

[4] The other three are: Improving crop and livestock production practices for higher food security and farmer income while reducing emissions; Expanding electricity generation from renewable sources of energy for domestic and regional market; Leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings.
[5] Discussion on the Green Legacy Initiative is retrieved from https://greenlegacy.et/green-legacy/home

overall objective of this study is to investigate the effectiveness of the GLI in contributing to a sustainable economic development of Ethiopia.

1.2. Objectives and Research Questions

The purpose of the current study was to investigate effectiveness of the GLI in contributing to the sustainable economic development of Ethiopia. More specifically, the study attempted to:

1) Assessing the levels and successes rates of the GLI at national and regional levels;
2) Exploring the roles of socioeconomic and livelihood conditions in implementing the GLI;
3) Evaluating the willingness to participate and commitment levels of the local communities in the national initiative;
4) Examining the role of GLI in economic development (the path to green growth) of the country; and
5) Identifying implementation challenges, remedial measures, and future opportunities in managing and conserving forests, soil, and water resources.

With the same purpose but in different form of writing, the current study aimed at answering the following research questions.

i) To what extent is the GLI successful? Are there visible differences across regions in the levels and rates of success? What are the factors contributing to the differences, if any?
ii) What roles could the different socioeconomic and livelihood conditions play in implementing the GLI?
iii) Are local communities willing to participate in the GLI? What are the factors impeding participations, if any?
iv) What is the role of the GLI in the path to green growth objective of the country?
v) What are the major challenges in implementing the GLI?

1.3. Scope of the Study

To remind, this study aimed to investigate the effect of the GLI on the sustainable economic development of Ethiopia. To achieve this purpose, the study mainly focused on four regions: Amhara, Oromia, Sidama and SNNPR. Due to limitations of resources, the study could not cover large number of study sites, which can be representative at national level. Similarly, the number of sampled households is not so large for the same reason. However, the gaps have been minimized by considering data from key informant interviews and secondary sources, which focuses on both national and regional level issues. Empirically, the study adopted both qualitative and quantitative methods. In order to understand the contribution of the GLI to the green growth path of the country, the study adopted allometric equations using data collected from one of the successful GLI sample sites in Amhara region. For the regional and national level analysis, the study used the official data on the performance of GLI over the last three years. However, the official data may not be realistic for various reasons discussed in this document. It should have been supported by ground but working data, which requires a significant amount of resources. Moreover, most of the trees planted have not reached at their maturity stage yet, which makes it difficult to actually estimate and fully realize the carbon sequestration potential of the program. Hence, the study considered only three planting periods such as 2019, 2020 and 2021.

1.4. Organization of the Report

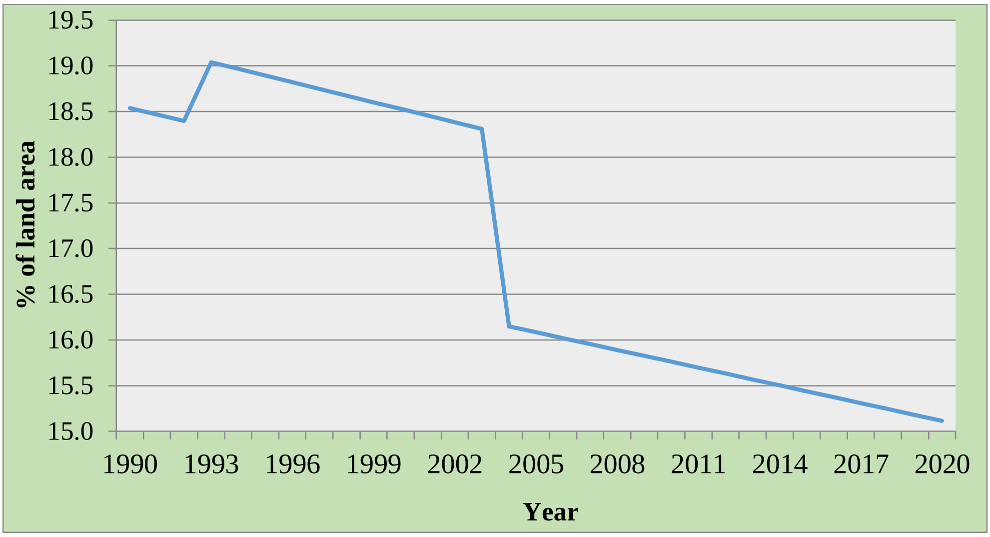
This report is divided in to eight chapters. The next chapter focuses on discussing the status of the forest sector in Ethiopia. Chapter three provides a brief review of the available literature on the afforestation/reforestation (A/R) and climate change, determinants of participation in the A/R program and implementation challenges of A/R programs or initiatives. The methodology employed in this research was discussed in Chapter four. The nature of data and the method of analysis are both briefly highlighted in this Chapter. In Chapter five, the study describes basic socioeconomic profile of surveyed households in the sample regions. Assessment of the status of the GLI and results of empirical (econometric) analysis on the socioeconomic determinants of people's participation in the GLI as well as their preferences (based on CVM) on the GLI are also discussed in this chapter. Chapter six discusses the role of the GLI in climate change mitigation and hence to green growth objective of the country. In this chapter, the study discussed the opportunities of GLI and quantitatively showed the carbon sequestration potential of the GLI. Chapter seven presents the implementation challenges of the GLI. The last chapter is the conclusion and recommendations.

2. THE STATE OF ETHIOPIAN FOREST SECTOR

2.1. Ethiopian Forest Coverage Trend

The forest[6] cover in Ethiopia was 18.5% around 2000 and has been in serious trouble for decades. Due to continuous efforts to rehabilitate the degraded areas, afforestation/reforestation efforts, and partly due to the change in the definition of forests, the recent estimate becomes 15.7% (FAO, 2020) with a total forest area of 17.22 million hectares. The majority of undisturbed remnant natural forests are located in the south west and south east part of the country. Figure 1 below shows the trends in forest cover of the country.

Figure 1: Forest cover trends



Source: WB data on forest inventory

As shown in Figure 1, the forest cover has been declining for the last two decades. On average the country losses 92,000 ha of forest per year between 2000

[6] A new forest definition was provided in 2015 as follows: forest is defined as land occupied with trees (including bamboo) attaining a height of more than 2 meters at maturity, canopy cover of more than 20 % and covering an area of more than 0.5 ha, with a minimum width of 20 meters.

and 2013. The gain in forest cover, through afforestation/reforestation activities, was on average 18,000 ha per annum, which makes the average annual net loss of 73,000 ha per year over the same period (FAO, 2020). The government of Ethiopia is committed to reverse this situation and enhance the contribution of the forest to the country's economy. The target is to increase the forest cover by 15% from its current level of 15.7% to 30% by 2025 (MEFCC, 2018). The country has also promised to the international community to reduce forest degradation and deforestation and increase the forest cover. Ethiopia's Nationally Determined Contribution (NDC) indicated that the forest sector is expected to reduce emissions by 255 $MtCO_2e$ by 2030 where 130 million tons of which are to come from the forestry sector (MEFCC, 2018).

2.2. The Role of Forest Sector in the Ethiopian Economy

Ethiopia has diverse forest resources that provide several benefits to the people which can ensure a green economic growth pathway. However, the contribution of forests to the overall economy of the country is very low. According to MEFCC (2018) forests contribute to the GDP was 2.3% in 2015 and planned to increase to 8.3% by 2020. However, this figure is believed to be underestimated as it did not consider several services of the forest into account. A more comprehensive assessment undertaken by UNEP in 2016 showed that the contribution of forests to the Ethiopian economy is about 13%. It is also argued that there is no proper account of the benefits of forests because they are either belonging to another sector or proper valuation methods have not been adopted (UNEP, 2016). In general, this shows that there is a big room for forests to contribute to the country's economy.

The low economic contribution of the sector is mainly due to the subsequent challenges that the sector encounter. Forest degradation and deforestation is the cause for low agricultural productivity, food insecurity, and rural poverty. The main challenges facing the forest sector in Ethiopia are discussed in detail in the next section.

Forest products play a significant role in the livelihood of rural communities in Ethiopia. Households use forest products such as firewood, fodder, honey, wild coffee, mushroom, spices, medicinal plants etc. Available evidences from developing countries show that, on average, household derive 10-60% of their income from forests (Wiebe et al., 2022; Ali et al., 2020; Beyene et al., 2019;

Kamanga et al., 2009; Heubach et al., 2011). In particular, the poor are more dependent on forests and hence derive a significant share of their income from forest resources.

2.3. Challenges of the Forest Sector in Ethiopia

Despite the social, economic and environmental benefits, Ethiopian forests are under threat due to farm land expansion as a result of growing population, increase in fuel wood demand, free grazing, weak enforcement of laws, tenure insecurity, etc. The following factors were identified based on a review of studies on deforestation and forest degradation in Ethiopia.

i) Farm land expansion

Available evidences show that agriculture together with logging is responsible for about 80% of global deforestation (Duker *et al*., 2019). In Ethiopia, clearing of land for additional cropland, which is driven by rapid population growth is a serious threat to the forest sector (Bekele et al., 2015). The extent of deforestation might depend on the type of crops to be grown. Available empirical studies show that smallholders are the main agents for deforestation (Solomon et al., 2018; MEFCC, 2017; EFCCC, 2017). In addition to small-scale farming, large-scale commercial farms are also considered to be one of the causes of deforestation in the country (EFCCC, 2017).

ii) Increasing demand for fuel wood

The demand for wood products is increasing in the country due to rapid population growth and urbanization (FSR, 2015). Fuel wood extraction for fire wood and charcoal production is also another significant driver of deforestation in the country. Moreover, these fuels are used in traditional and inefficient stove types. There is still a huge gap between demand and supply of fuel wood (MEFCC, 2018). The extractions of these sources of fuels are usually illegal and conducted by local people who are not familiar with the consequences of their action on the environment (EFCCC, 2017; MEFCC, 2016). Ethiopia’s wood and other forest products supply comes from domestic production and import. The country’s foreign reserves have been exploited for importing wood products, which could have been substituted by domestic production. For example, Ethiopia imported various industrial wood products worth of USD 182.53 million in 2015 (EFCCC, 2015), and the same report indicated that the trend of importation has more than doubled between 2007 and 2015.

At national level, there is huge gap between demand and domestic sustainably produced supply of wood products (FSR, 2015). This has triggered two economically unfavorable outcomes. First, it is driving unsustainable extraction of wood from the natural forests, and hence the degradation and loss of biodiversity. Second, this forces the country to depend heavily on imported wood products for its wood-based industries. Unless actions are taken swiftly, the situation will drive further degradation of the natural forests and affect the foreign exchange reserves.

iii) Overgrazing/free grazing

It is estimated that more than 80% of Ethiopia's population resides in rural areas, and highly dependent on agriculture including livestock production as main economic activity. Like other SSA countries, livestock production in Ethiopia is mainly based on free grazing. In Ethiopia, overstocking and overgrazing and poor livestock management, mainly based on the free grazing system, is one of the main causes of natural resource degradation (Melkie, 2020; Solomon et al., 2018; EFCCC, 2017). Another study by Legesse et al. (2019) also argued that overgrazing is one of the causes of deforestation in Ethiopia.

iv) Poorly planned infrastructural development

Infrastructural developments such as roads and hydro dams significantly aggravate the deforestation within the country (Melaku *et al*., 2015). The evidence, however, is mixed. For example, a recent study by Baehr et al. (2020) argued that local infrastructure development, roads in particular, does not have an impact on the less densely forested regions in Cambodia. Legesse et al. (2019) find that road construction is considered to be one of the major cause of deforestation in the South eastern part of Ethiopia.

As already indicated in (i) above, expansion of large-scale commercial agriculture also plays an important role in the forest cover change of the country. It has direct impact on the forest cover as expansion for more land usually takes place in the forested regions. In addition, large farms displace farmers and push them to the remaining forest areas in search of farm land, which could result in successive deforestation of the natural forest lands (Bekele *et al*., 2015). MEFCC (2016) also reported that large scale agricultural investments, which are often established in dense forest cover, is one of the most important drivers of deforestation in Ethiopia.

v) Forest fires

Forest fires damage large area of forests in various parts of the country. The causes might be the traditional practice of using fire as a means to clear forest in search of additional farm land or to get rid of wild animals' harboring sites; or making charcoal, etc. In addition, the rapid population growth intensifies the impact of forest fires. For example, fires are used as the major tool to clear forest land and convert it to agricultural use in the highlands of Ethiopia where there is rapid population growth. Smoking out wild bees in order to extract honey is also another cause of forest fires. Melkie (2020) indicated that both wild and human induced fires are becoming common challenges in some parts of the country (e.g. North Gondar, Bale, Benishangul Gumuz Regional State) and are causing serious damages on forest resources.

vi) Frequent institutional restructuring

The forestry sector suffers from frequent institutional restructuring that has resulted in limited capacity to engage in sustainable forest resource management and a poor forest information management system. This has been shown in the last four years where the forest sector has been downgraded from ministerial position to commission and recently restructured as Ethiopian Forest Development (EFD) under the MoA. In addition, the structure of the organization at the regional level is not homogenous and sometimes the link between the regional and the federal level offices is not clear.

vii) Tenure insecurity and weak enforcement

Tenure insecurity and weak enforcement are among the underlying causes of deforestation in Ethiopia (EFCCC, 2017). Tenure security is crucial for long-term investment decision. In Ethiopia, there is still limited capacity to enforce forest regulations and lack of tenure security as a result of absence of state-recognized community and individual rights to forests often discourages investment in the sector (McLain *et al.*, 2019). The national forest law established in 2018 states that communities and associations can have forest ownership rights. But to speed up the implementation of this law, the country needs to enact and implement corresponding forest regulations and guidelines (FDRE, 2018).

viii) Lack of human and institutional capacity development

This is crucial for forest sector development. Skilled human resource availability is important for the entire cycle of sustainable forest management, from the establishment and maintenance of forests and trees to proper harvesting, processing and marketing of products and services. The prerequisite to effective sector development, including attracting private sector investments, is the existence of technically capable and efficient human resources. The country lacks sufficient quantity of skilled man-power, which requires immediate solution if the country wants to materialize the desired development and industrialization of the sector. In general there are several other factors that affect the forest sector in Ethiopia. In order to derive the benefit from forests and forest resources there is a need to address the challenges that the sector faces. Unless these drivers are addressed, efforts to achieve effective emission reductions from reducing deforestation and degradation may be a challenge.

3. LITERATURE REVIEW

The current section of this research report aims at reviewing some of the available but related empirical studies on afforestation/reforestation associated issues. There is a plethora of studies on factors affecting tree growing, farmers' preferences towards tree planting, barriers and challenges to tree planting programs, etc. Also, there are literature on the role of trees on climate change adaptation and mitigation, its role to country's overall sustainable development, in satisfying household energy demand and other socioeconomic roles. Below are reviewed literature related to the core concepts of the current study.

3.1. Trees and Climate Change

Climate change is increasingly becoming a threat to the world in general and developing countries like Ethiopia in particular. The impact of climate change is more serious in countries like Ethiopia where the whole economic performance strongly depends on performance of the agricultural sector. Empirical studies on climate change and agriculture sector in Ethiopia, like other countries in sub Saharan Africa, show that land degradation due to deforestation reduce production and productivity of the sector. Several empirical studies show that farmers adopt various types of climate smart agricultural practices including tree planting to cope up with the impacts of climate change (Abegunde *et al*., 2019).

It is clear that due to human activities, the amount of carbon dioxide levels in the atmosphere continue to rise. Therefore, trees can help by reabsorbing from the atmosphere, or reducing emission of carbon dioxide and other greenhouse gases. However, the extent of carbon sequestration depends on several factors such as type of forests, management of forests, quality of forest, trees species, etc (Beyene *et al*., 2016). While trees help to mitigate the impact of climate change, it should also be known that climate change also affect trees. Climate change has the potential to increase both the frequency and the intensity of several natural disturbances such as wild fires, droughts, storms, snow and ice, insect infestation and disease outbreak, which would result into other land use types (Bracki, 2019).

A review by Pramova *et al*. (2012) show that trees and forests can support adaptation in five major ways (1) forests and trees providing goods to local communities facing climatic threats; (2) trees can regulate water, soil, and microclimate for more resilient production; (3) forested watersheds regulating water and protecting soils for reduced climate impacts; (4) protect coastal areas from climate-related threats; and (5) trees regulate temperature and water for resilient cities in urban areas. In general, several evidences show that trees can significantly contribute to the achievement of sustainable development goals (SDG) (Turner-Skoff and Cavender, 2019).

3.2. Determinants of Tree Planting

It is argued that forestry has tremendous potential to contribute to the green economy and increase household as well as state revenues in African countries in general and Ethiopia in particular (ADB, 2018). Given the role of trees in the livelihood of the people and its significant role in climate change mitigation as well as fulfilling SDGs, evidences show that there are still barriers to the decision to grow trees on private land as well as on people's participation on community level afforestation/reforestation programs. There are some empirical evidences (see for example, Lee *et al*., 2020; Gessese *et al*. 2016; Mekonnen and Damte, 2011) on what determines household's decision to plant trees. These studies indicate that various socioeconomic, political and environmental factors are considered to be the determinants of tree planting.

Household socioeconomic characteristics such as age and gender of the head, family size, land size etc are found to be important determinants of tree planting (Lee *et al*., 2020; Gessese *et al*. 2016; Kulindwa, 2016; Danquah, 2015; Mekonnen and Damte, 2011). However, the direction and magnitude may vary among studies. For example, Danquah (2015) find that large household size and increasing cultivated land area under crop production decrease the likelihood that a farmer will be involved in voluntary tree planting in the target communities in Ghana.

Tenure security is a significant factor in making long-term decision such as tree planting. For example, a recent study Boissiere *et al*. (2021) argue that securing long-term rights and making sure that the local communities' benefits from tree planting is one of the measures to have a successful tree planting. A study by Danquah (2015) in Ghana argues that secured land tenure rights significantly and positively influence farmers' decision to engage in voluntary tree planting. Similarly, Mekonnen and Damte (2011) identified several households, environmental and geographical factors that determine the number of trees planted by farm households in Ethiopia.

Several other factors are included in related studies. For example, in Tanzania, Kulindwa (2016) identified households' awareness of tree planting programs is positively and significantly related to the extent of trees planted. On the other hand, the right/freedom to harvest and transport tree products, households' attitudes towards tree planting, and family size do have e negative effect on households' tree planting behavior in Tanzania (Kulindwa, 2016). Physical factors such as the dynamics of soil erosion (Danquah, 2015), type of land, whether it is sloped or not and size of forest land (Gessese *et al*., 2016) are all considered to be linked with the tree planting behavior of households.

3.3. People's Participation in Afforestation and Reforestation Programs

There are studies that examined the willingness of households to participate in afforestation programs but most of these studies use a simple correlation analysis or regression analysis considering the dependent variable as binary or likert scale type. For example, Liu *et al*. (2019), using microeconomic data from Western China, explored the factors which influence rural households participation in afforestation programs. However, this study was conducted by simply categorizing the willingness of households into four categories: positive willingness, neutral willingness, unwillingness, and enforced willingness. The results show that households with more information channels, greater satisfaction with existing forest structures, more funds for forestry work, and lower degrees of farmland fragmentation in heavy rainfall regions have a positive willingness to participate in afforestation.

Another study in Bangladesh show that participating farmers with a higher level of education, higher income and positive attitudes toward Tree Farming Fund (TFF) tended to express more willingness-to-pay (Salam *et al*., 2006). Another study by Obiri *et al.* (2011) in Ghana argue that free supply of seedlings, provision of food aid and free inputs supply were the dominant motivating factors influencing participation in the planting program. In addition, poor extension services and lack of strong efficient organization were the major constraints affecting people's participation.

In sum, local people's willingness to participate in community works such as tree planting have been assessed using different approaches. However, environmental valuation techniques such as contingent valuation method have not been commonly employed to value the preferences of local communities' willingness to pay, for instance, for rehabilitation of degraded lands (Beyene *et al*., 2021). The empirical literature on valuation of forest sector in general is limited. Available empirical studies include Beyene *et al*., (2021), Vedel *et al*. (2015), and Broch *et al*. (2013).

There are some valuation studies related to forests and REDD+ in Ethiopia. In a valuation of community forestry in Ethiopia, Mekonnen (2000) found that household's socioeconomic characteristics such as household size, income, and distance of homestead to proposed place of plantation, number of trees owned and sex of household head are significant variables that explain willingness to pay for community forests. Gelo and Koch (2015) have conducted a similar study on valuation of Participatory Forest Management (PFM) in the south western part of Ethiopia. Another study by Dissanayake *et al*. (2015) analyses the preferences for REDD+ contract attributes in Ethiopia by using a choice experiment.

In line with the current government's objective to increase the forest cover and restore the degraded lands, it is necessary to fully mobilize and involve the local community in the tree planting program. Hence, it is crucial to study the local communities' willingness to pay to participate in the green legacy initiative.

3.4. Livelihood Impacts of Afforestation Programs

Trees provide multiple benefits such as environmental, societal and others to the planet. Hence countries design afforestation/reforestation is to derive such multiple benefits. It has an impact on the environment, livelihood of the people, water availability, etc. Trees are essential for healthy communities and people. In Ethiopia, the current tree planting program could provide our country the opportunity to meet 15 of the 17 internationally supported United Nations Sustainable Development Goals (Turner-Skoff and Cavender, 2019)

Several empirical studies show that forests and trees contribute to the livelihood of the people in many ways. For example, rural households in Ethiopia derive 20-40% of their income from forests and trees (Beyene *et al*., 2019; Tesfaye *et al*., 2010; Babulo *et al*., 2008; Mamo *et al*., 2007). Forests can lift the poor out of poverty. Scholars have shown the link between poverty alleviation and incomes from forest resources as well as the role of forest-based incomes as safety nets in time of shocks (Wunder *et al*., 2014; Shackleton *et al*., 2007). It has to be noted, however, that afforestation may not have positive effects all the time. It may lead to negative environmental impacts if there is no proper planning and management of the program. Afforestation may also result in food price hikes if there is competition for land suitable for agriculture (Kreidenweis *et al*., 2016).

3.5. Drivers of Successful Afforestation Program

In addition to the household level factors that play crucial role on the decision to plant or participate in afforestation/reforestation programs, there are external factors that determine implementation of these programs. External environments such as policies, legal issues, and institutional set ups are crucial challenges in implementing tree planting initiatives within the country. For example, Nunes *et al*. (2020) discussed that the main challenges of afforestation include environmental, socioeconomic, political and legal ones. Based on review of literature on drivers of reforestation success, Moges *et al*. (2021) argue that many reforestation projects in Ethiopia fail because there is lack of attention to the need for careful planning of technical and biophysical details, limited attention to the participation of local communities and the need for empowering and engaging grassroots institutions. Moreover, lack of adequate attention to the legal, institutional and funding support for such kind of long term projects also contribute to the failure of reforestation projects in the country (Moges *et al*., 2021). Lemenih and Kassa (2014) also argued that poor participation of local communities, lack of proper management plans, unclear benefit sharing mechanisms, and poorly defined rehabilitation objectives are the main challenges of re-greening practices in Ethiopia.

Institutional capacity building in support of extension services at the community level is a prerequisite for effective and sustainable plantation development program in Ghana (Obiri *et al*., 2011). A recent review by Hohl *et al*. (2020) indicated that the goals and needs of the local communities shall be considered in project planning and implementation. For the success of the afforestation/reforestation programs, a more active participation could be expected from non-state actors in re-greening initiatives; more attention to market signals; devolution of management responsibility; clear definition of responsibilities and benefit-sharing arrangements; and better tenure security, which are all major factors to success (Lemenih and Kassa, 2014). An assessment of the socioeconomic drivers of the recent tree planting program in Ethiopia by Boissiere *et al*. (2021) showed that local participation, marketing prospects and socio-economic incentives, and tree and land tenure determine the outcome of the tree planting campaign.

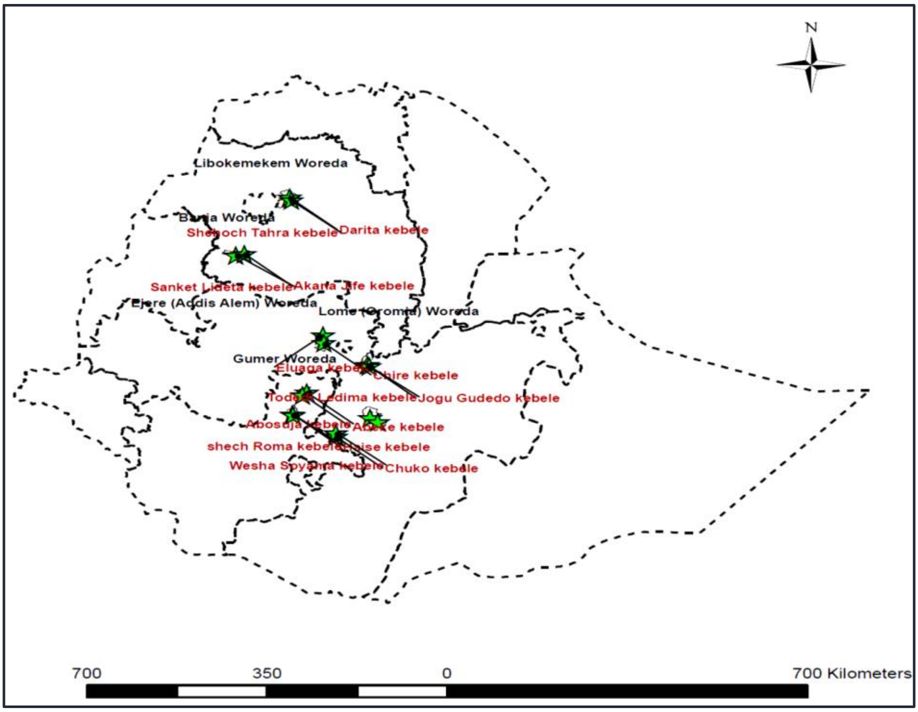
As shown above, there are evidences on the role of trees in climate change and human livelihoods by satisfying food, energy, livestock feed, and other environmental benefits. Given all these benefits, scholars try to understand the determinants of tree planting and identify the household, socioeconomic, environmental and political factors that hinder tree planting decision by households. Some studies also discuss the perception and preferences of local communities in rehabilitation efforts. However, we still need additional research to gain a better understanding of the perception of local communities towards restoration activities (Hohl *et al*., 2020). A continuous assessment of environmental initiatives is crucial to take timely measures that could address the barriers in the implementation of these initiatives and achieving its political, social, economic and environmental goals. In particular, assessment of the current GLI and identify the challenges and success of the initiative is necessary to enhance the contribution of the GLI to climate and people's livelihood. Therefore, this study will contribute to the literature by addressing several issues of the GLI.

4. METHODOLOGY OF THE STUDY

4.1. Description of the Study Areas

The study sites are located in four regional states: Amhara, Oromia, Southern Nations, Nationalities and Peoples (SNNP) and Sidama regional states. These regions together account about 93.5% of the total plantation resources in the country (EFCCC, 2017). Two *woredas* per region and two *kebeles* per *woreda* were selected purposely based on the activities related to the GLI. The study sites were selected in close collaboration with the relevant regional offices. Accordingly, Banja in Awi zone and Libokemkem *woredas* from South Gondar zone were selected from Amhara region. In Oromia, the study considered Ejere from West Shewa, Lume from East Shewa and Limuna Bilbilo from Arsi zones. In SNNP, the study sampled Lemo and Gumer districts from Hadiya and Guraghe zones, respectively. Finally, Wondo Genet from Hawassa Zuriya was considered from Sidama regional state. Figure 2 shows the location of the study sites.

Figure 2: Map of the study sites



4.2. Sampling Techniques

The sample sites (i.e. *kebeles*) for this study were chosen purposely. The study considered sites from each region where GLI implementation is relatively active so that the research could clearly find out the barriers and success factors in the implementation of the GLI. Two *woredas* from Amhara region, three *woredas* from Oromia region, one *woreda* from Sidama and 2 *woredas* from SNNP region were selected. Two *kebeles* per *woreda* were selected which made a total of 16 *kebeles*. Then, from a list of population in the *kebele*, the study sampled 20 households using a systematic random sampling technique.[7] The sample households were distributed among the four regions depending on the size of seedling planted in the last three GLI programs. Accordingly, 120, 80, 80, and 40 households were selected from Oromia, Amhara, SNNP, and Sidama regions, respectively. Finally, the study conducted a survey on 320 households sampled from the four regional states.[8]

Table 1: Study region, district and number of households

Region	Districts	Number of *Kebeles*	Number of households included in the sample	Number of households in the region
Oromia	Ejere	2	40	120
	Lume	2	40	
	Limuna Bilbilo	2	40	
Amhara	Libokemkem	2	40	80
	Banja	2	40	
SNNP	Lemo	2	40	80
	Gumer	2	40	
Sidama	Wondogenet	2	40	40

[7] Interval was determined by dividing the total number of households of the kebele by the sample size. And the first sample household will be taken between one and the interval number (N) randomly by using lottery method. Then the sample household to be included in the sample is chosen by taking every N[th] household from the total household in the kebele.

[8]The sample size was determined by EEA and we could not have more samples due to budget restriction.

4.3. Types and Methods of Data Collection

Both primary and secondary data sources were employed to address the predefined research questions. Primary data were collected from households through face to face interviews, Focus Group Discussions (FGD) and Key Informants' Interviews (KII). The FGD and KII were used to supplement the findings from the household level survey and to address research issues, which cannot be addressed using the household level survey. The study had a total of 14 FGD in the 14 *kebeles*, *i.e.* one FGD per *kebele*. The KII focused on gathering information regarding the green legacy initiative from experts at the federal, regional and district levels.

The structured household level survey questionnaire has several components such as i) household's socioeconomic characteristics, ii) questions on household's participation and perception about the GLI and their assessment., iii) Questions on the nature of the landscape where the GLI was conducted; questions on status of area, location, type/species of trees, nature of management, etc. iv) Question on people preferences towards the GLI. The latter is based on a contingent valuation method (CVM) scenario where households are asked to state their willingness to pay (WTP). Several household level data such as shocks, income sources, and forest product related questions were also gathered. A total of 12 enumerators were involved in the field work, mainly for managing the survey, which was conducted from November 20 to December 10, 2021.

Secondary data such as actual number of seedlings planted, survival rate, *etc* were collected from federal offices. However, information on the levels of implementation of the GLI overtime such as performance in terms of tree seedling preparation, participation in tree planting by gender, age, and location were predominantly incomplete.

4.4. Method of Data Analysis

The study adopted a mix of qualitative and quantitative approaches. Appropriate econometric techniques were employed to analyze the relationship between the explanatory variables and the dependent variables using discrete choice models such as Heckman model and count models. Specification of the models is discussed in the respective sections. In addition, information obtained from the FGD and KII are all used to supplement the findings from the quantitative analysis. In addition, the study adopted Winrock method of estimating the carbon sequestration potential of the GLI.

4.4.1. Definition of Variables

Table 2 below presents the definition of variables used in the empirical analysis on the determinants of participation in GLI as well as the determinants of trees planted on farmer's plot. The study included variables representing household characteristics such as age and gender of the head of the household, education level of the head (whether the head can read and write), whether the head is married or not and family size. Family size may represent the availability of labor in the family. This increases the probability of participation in GLI as well as the decision to plant trees on their private lands. Age of the households is positively correlated with the decision as well as the extent of trees planted. Male headed and married households are more likely to participate in the GLI. They are also expected to have more number of trees on their private tree lands. Educated households are better aware of the role of trees. Hence compared to illiterate households those who can at least read and write are more likely to participate in the GLI and are expected to plant more trees. Similarly, educated households are more likely to plant trees on their private lands.

Access to local level institution may facilitate information flow and hence enhance participation of local people in the GLI as well as in their decision to plant trees on their private lands. Accordingly, variables such as whether any member of the household is a member of credit/microfinance group, watershed management group, agricultural producer group and tree nursery group may determine the tree planting behaviour of households. The decision of households to participate in the GLI or to invest on their private lands may be affected by tenure security. The study expects that households who are concerned that somebody might dispute/claim his/her ownership or use rights to part or all of his/her land are negatively correlated with the tree planting behavior of households.

The study also included variables representing economic status of the household. For example, crop income which refers to revenues collected from annual crops, asset ownership indicators such as land size (in ha) and number of livestock owned measured in tropical livestock unit (TLU) are included in the analysis. The study expects that both land size and livestock are likely to have a positive effect on household's decision to plant trees as well as the number of trees. This is because they will benefit more than other households with less of these assets. Afforestation/reforestation activities help protect the land from erosion and provide more feed for the livestock. The effect of farmer's annual crop income is the same as other indicators of economic status. Those households participating in off-farm works may or may not be able to participate in GLI or tree plantings on their private plot.

Table 2: Definition of variables

Variable	Definition	Mean values
Age of household head	Age of the household head in years	45.89
Sex of household head	If the head of the household is male(=1), 0 otherwise	0.91
Marital status of head	If the head of the household is married (=1) 0 otherwise	0.90
Education of head	If the head can read and write (=1), 0 otherwise	0.83
Occupation of head	If main occupation of the head is agriculture (=1), 0 otherwise	0.91
Household size	Family size of the household	5.58
Distance to nearest forest	Distance from nearest main road(two ways in minutes)	43.91
Distance to nearest market	Distance from nearest main market (two ways in minutes)	114.18
Access to Microfinance	1 if there is any microfinance institution near to your village	0.85
Annual crop income	Total annual crop income per year in ETB	54310.58
Number of livestock (TLU)	Number of livestock in TLU	2.65
Member of Credit group	1 if the HH is a member of credit/microfinance group	0.58
Member of Agr produce group	1 if the HH is a member of agricultural producer cooperatives	0.37
Access to extension	1 if the HH has any contact with extension agents	0.94
Land area in Ha	Total land size of the household in hectare	1.08
Distance from the 2021 GLI site	Walking distance to GLI Tree planting site (two-way) in minutes (2021)	68.23
Tenure security	1 if the HH is concerned that somebody might dispute/claim his/her ownership/use rights to part or all of your land	0.19
Doromiya	1 if the HH resides in Oromia region	0.375
Damhara	1 if the HH resides in Amhara region	0.25
Dsnnp	1 if the HH resides in Oromia region	0.375

The report collected data on indicators of access to infrastructure. These are the two way distance of the nearest road and nearest market from the household residence measured in minutes. Moreover, we gathered information on the accessibility of the GLI sites in the 2021 tree planting program. This is negatively related to the participation decision of households.

5. DATA ANALYSIS AND DISCUSSION

5.1. Socio-demographic Characteristics of Respondents

Table 3 below presents the descriptive statistics for the variables used in the different empirical analysis in the consequent sub-topics. The descriptive statistics showed that sample surveyed household heads are 46 years old on average and 91% are male headed. Added to these, more than 83% are literate, which shows that they can at least read and write. The average household size of the sampled households in the study area was 5.58 which were higher than the national average of 4.9 for rural households (CSA and ICF, 2016).

Table 3: Descriptive statistics of variables used in the analysis (N=320)

Variables	Mean	Std. Dev.	Min	Max
Age of household head	45.89	12.43	21	89
Marital status	0.90	0.30	0	1
Household size	5.58	2.29	1	13
Distance to nearest market	114.18	83.12	4	360
Distance to nearest road	43.91	49.04	0	300
Distance to forest	51.33	40.21	0	240
Access to Microfinance	0.85	0.36	0	1
Livestock ownership in TLU	2.65	2.37	0	17.85
Member of Credit group	0.58	0.49	0	1
Member of Agr. Producer	0.37	0.48	0	1
Land area in ha.	1.08	1.04	0	7
Annual cop income	31842.41	52540.19	0	422300
Access to Extension	0.95	0.22	0	1
Distance from the 2021 GLI site	68.23	50.42	0	240
Tenure security (N=295)	0.19	0.39	0	1
DAmhara	0.25	0.43	0	1
DSNNP	0.375	0.485	0	1
DOromiya	0.375	0.485	0	1

Source: Survey data (2021)

The average cropland holding size of the households was 1.08 ha where some households were landless and the maximum holding is 7 ha. The average livestock size was 2.65 TLU with a minimum of 0 and maximum of 17.85. Households owned income from various sources such as selling annual crops or permanent trees, off-farm work, and gifts and remittances. However, in the analysis the study considered only total annual gross crop income. On average, sampled households earned ETB 31842.4, which ranges from 0 to ETB 422,300.

In terms of location, the two way distance of planting sites from household residence was 68 minutes. The average distance of the household from nearest market (two ways) is 114 minutes and that of the nearest road was 44 minutes. Similarly, the distance of the nearest forest from the household's residence was 51 minutes. More than 95% of the sampled households responded that they have access to extension services. In terms of access to services such as microfinance, it seems that the sampled households have relatively better access to these facilities. For example, 85% of them reported that they have access to microfinance institution, which is near to their village.

The descriptive statistics further showed the level of participation of sampled households in local institutions. For example, 52% of the sampled households were member of the watershed management group. More than 58% are member of credit groups and more than 37% of the sampled households were members of agricultural producer's cooperatives. Only 6% of the sampled households were members of tree nursery cooperatives. This tells us that there is a need to encourage more people to join the producers' cooperatives, which could strengthen their negotiation power in the market.

As already described earlier in this section, regional dummies are included to understand the effect of regional variation on tree planting behavior of households. In sum, the distribution of the research sample was as follows: 37.5% from Oromiya, 25% from Amhara, 25% from SNNP and 12.5% from Sidama. Sidama was part of the SNNP region during the first two GLI programs.

5.2. Performance of GLI at the National Level

The study used secondary data sources collected from various offices to compare the planned versus actual performance (tree planting) for the last three years both at the national and regional level. The study also presents the factors responsible for the differences between regions in terms of achieving their planned planting targets.

Several worldwide efforts in tackling the effect of environmental degradation have faced several challenges because the trees planted have not survived or destroyed due to various social and economic problems (Le *et al*., 2012). On the other hand, there are few successful examples of afforestation/reforestation programs such as China's Three-North Afforestation Program (TNAP) (Zhu *et al*., 2017). As shown below, the GLI can be considered as one of the successful afforestation/reforestation initiatives, which can be scaled up to other developing countries. Table 4 below presents the performance of the GLI at the national level.

Table 4: Performance indicator of GLI at National level

Activities	**Year**				
	2019	**2020**	**2021**	**2022 (target)**	**Total**
Targets (in billions)	4	5	6	6	20
Number of seedlings planted (in billions)*	4.7	5.6	6.7	6	22.6
Area covered in ha	1,400,000	1,200,000	2,104,901	X	xx
Survival rate (%)**	78.5	83.5	X	X	xx
Number of people participated (millions)	23	X	X	X	xx

Note: Data on the number of seedlings prepared and area covered by post planting care is unavailable

* One billion seedlings was distributed to neighboring countries in 2021

Source https://www.greenlegacy.et/green-legacy/home

** Obtained from EFCCC (2020, 2021) NDC Highlights, Vol 1(2). However, this figure varies depending on the source. For example, in 2019 the survival rate is 88.5% based on GLI website at the PMO

The country performed well in all the three planting periods since the actual seedlings planted is greater than the planned target. Different species of trees were planted. For example, of the total 6.7 billion trees planted during the 2021 GLI period, around 3.02 billion were trees, 3.3 billion were agro-forestry, and 371.9 million were fruits trees. The remaining 62.9 million were ornamental trees planted in urban areas (MoA, 2022).

Another indicator of performance was the survival rate of seedlings planted. As shown in Table 4, the survival rates for the year 2019 and 2020 GLI period were 78.5 and 83.5%, respectively. According to EFCCC (2020), this performance is due to the post planting care such as watering, weeding, and replacement of planting. This will have tremendous environment, social and economic benefits to the country. On the contrary, there are still issues related to the post planting activities and these benefits can only be realized if there is a continuous protection and maintenance of the planted seedlings till they grow and reach to maturity stage.

The initiative is participatory in that various groups of the society were involved especially during planting period. For example, the participation of women was significant in the last tree planting campaigns. Of the total 23 million people mobilized in the 2019 GLI, 30% were women and girls (EFCCC, 2020).

It has to be noted that these are not the only indicators showing the success of the GLI. For example, Moges *et al.*(2021) indicate that the most common indicators used to assess reforestation success includes forest growth indicators such as tree growth performance (measured by tree basal area, height, stem form), area remaining intact or maintained in the long term, and actual production of timber, fruit, fuel wood, etc. (measured in amount/ha). This requires some time to measure and fully understand the forest growth indicators. Other indicators include environmental indicators such as vegetation structure, species diversity and ecosystem functions. This study shows one of the main ecosystem functions of forests, carbon sequestration, and need to assess other ecosystem functions such as protection of soil from erosion, nutrient cycling and water conservation.

The GLI should be attractive to local communities by providing them with direct or indirect benefits. The most common indicators used for measuring socioeconomic success of reforestation are local income, local employment opportunities, other livelihood opportunities, provision of food, etc (Moges *et al.*, 2021: Le *et al.*, 2012). We argue that GLI provides direct benefits (e.g. employment opportunities) and indirect benefits (e.g, protect land from soil erosion). For example, the GLI has directly created around 767,000 green jobs in the past four years.[9] Moreover, these jobs are mostly for women and youth. A more complete picture of

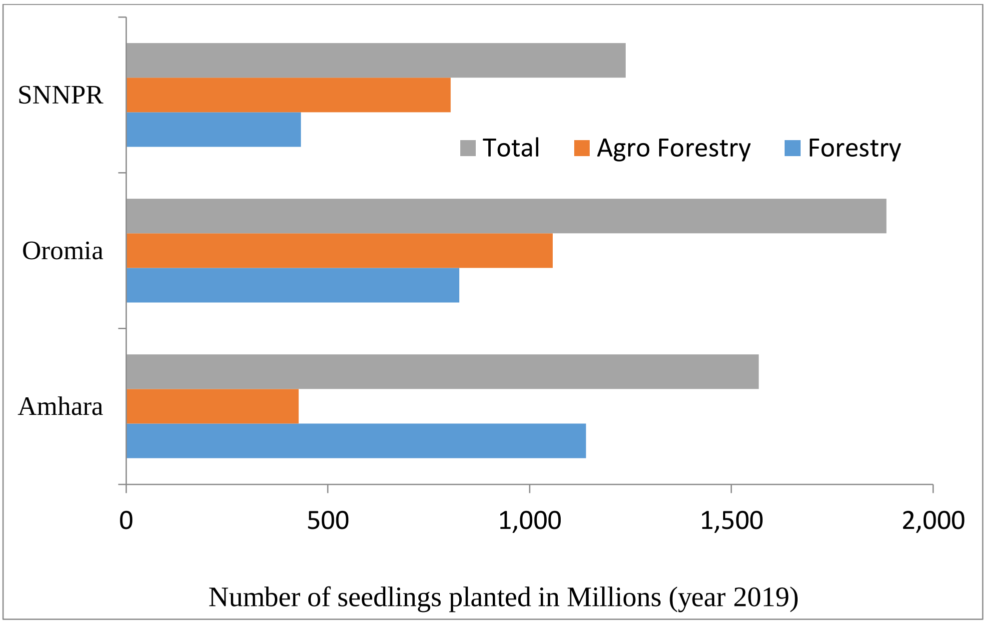
[9] Retrieved from https://www.worldagroforestry.org/blog/2022/09/15/beyond-green-legacy-initiative-ethiopia

the socioeconomic contribution of the GLI requires comprehensive survey including the direct and the indirect services provided by trees.

5.3. Performance of GLI at the Regional Level

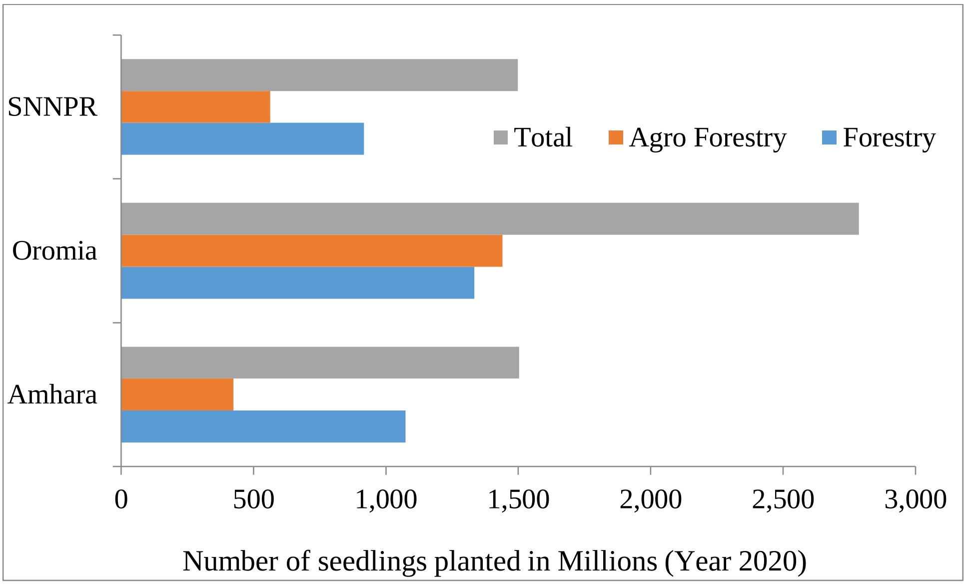
Regional governments play a greater role in implementing the GLI. As described above, the national level performance is successful as compared to the planned number of seedlings to be planted. In this section, the study attempted to assess the regional performances and explain why there are differences between regions. Figure 3 reports the performances of the three main regions for the last three tree planting campaigns.

Figure 3a: Number of seedlings planted for the year 2019 by regions (only for three main regions)

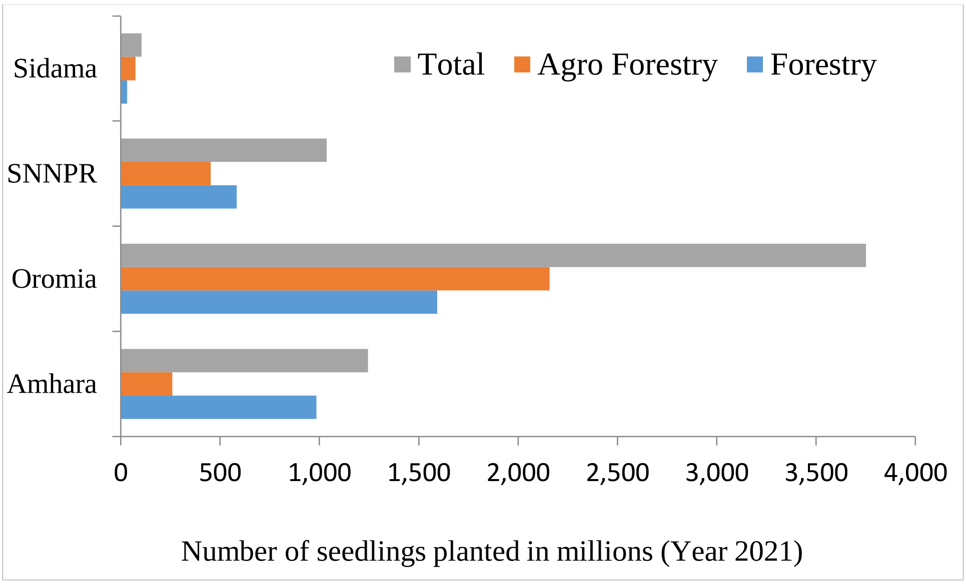


Note: SNNPR includes Sidama region.

(b). Number of seedlings planted for the year 2020 by regions.



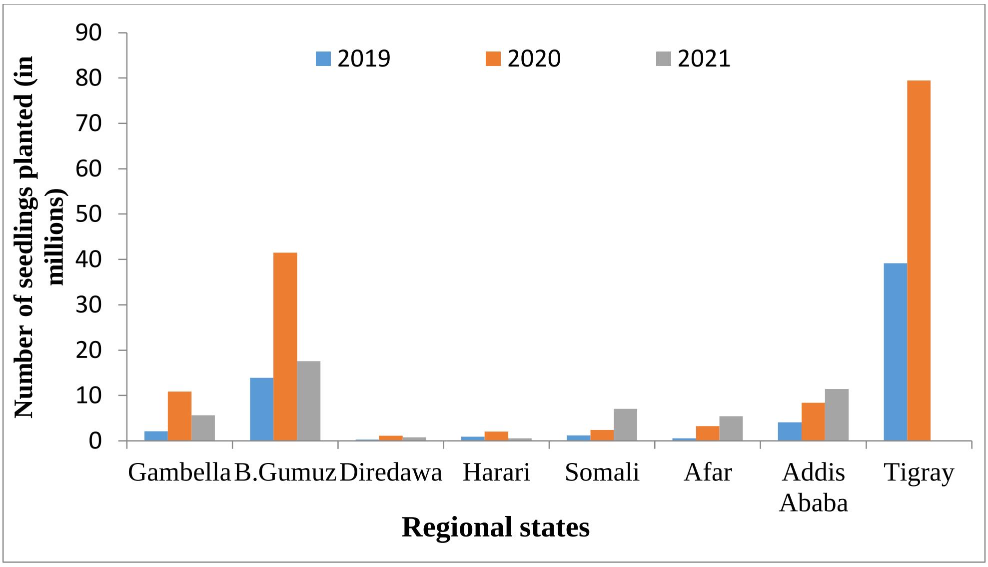
(c). Number of seedlings planted for the year 2021 by regions



There are regional variations in terms of GLI implementation. As shown in the figures above, the regions with better performance are Oromia and Amhara followed by SNNPR. This is mainly due to the relatively better facilities (resources and expertise) to raise and plant seedlings in these regions. In addition, the suitability of agro-climatic zone contributes to the success of the GLI in the three regional states. Based on the discussion we had with the key informants, we also learned that political and professional commitment of leaders is the main factor for the success of these three regions.

The political instability and the conflict that happened in the different parts of the country hindered the tree planting programs. For example, the conflict in the northern part of the country could not allow planting trees as it was difficult to transport the necessary materials mobilize local people and facilitate the overall coordination of the tree planting programs. There was no guarantee to protect even the already planted trees as well as the existing matured trees and forests. This has been the situation in Tigray, some parts of Amhara and Afar regions. There are also conflicts in other parts of the country in particular, Benishangul Gumuz and Western Oromia regions, which affects the performance of the GLI.

Figure 4: Number of seedlings planted in other regional states



While the data show that the GLI performed better over the last three years, experts' view obtained through key informant interview revealed that there were several challenges that would make it difficult to achieve what was claimed by the government. The divergence between these two views might be due to the nature of reporting and lack of serious monitoring during post planting periods. Those who argue that the success rate was low argue that sufficient tending operations were not carried out. To some extent weeding and watering have been done, though not at sufficient level. Beating up, mulching, protection from physical damages and other post planting activities need to be carried out. In general, post planting activities have not received as much attention as the planting phase.

5.4. Types of Tree Species Planted

Different types of tree species were planted in the last three tree planting campaigns. The most dominant species planted in most of the regions are gravelia robusta, Junipurus procera, cordia africana, grass species, flower plants, cupressuslusitanica, eucalyptus globulus, eucalyptus camaldulensis, acacia decurens, Olea africanea, acacia saligna, cassia siama, cupress, juniperuss, hygenia abysinica, schinus mole, bottel brush (Calestemon). Others such as enset, *wanza*, coffee, chat, *gesho,* and fruits such as avocado and banana are also common.

Environmental factors such as climatic conditions, soil, rainfall, temperature, etc need to be considered in selecting trees and shrubs for planting. For example, soil conditions such as the PH level and porosity affect the growth of trees and shrubs. Since Ethiopia is a country with diverse climatic and environmental condition, it is necessary to consider the right type of species suitable to the unique features of each region. However, this is found to be one of the main problems of the GLI. The detail is presented in Section 7.

5.5. People's Perception of the Benefits of the GLI

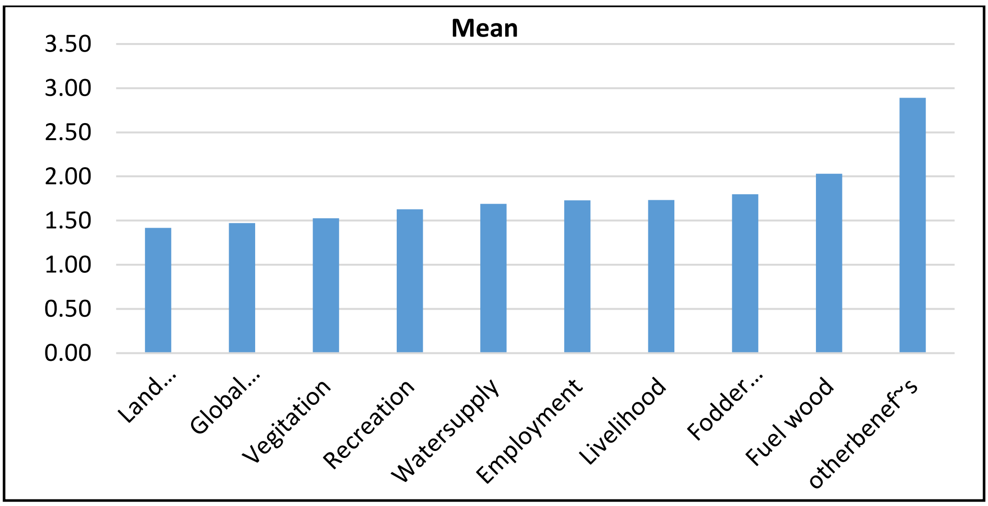
The study collected information on people's perception about the benefits of GLI. It asked respondents to indicate the advantages of this initiative using a Likert scale (strongly agree, agree, neutral, disagree and strongly disagree). Most of the respondents stated that the GLI has all the benefits such as increase in vegetation cover and hence land restoration, increase in fodder supply, improving soil fertility, and increasing water supply. In addition, they understand the role of trees in creating employment which in turn improve livelihood of the local people.

The local people were also aware of the importance of trees in mitigating global warming. During the FGDs, in each site, they argue that trees help reduce the impact of climate change as a result of increase in temperature. It is important to capitalize on these benefits in promoting the tree planting campaign so that large number of people can be mobilized for planting. This is important for post planting activities such as maintenance, protecting from free grazing, etc. Unless the local people are fully involved in the program, it will be very difficult to achieve the goals of the GLI. This is because the majority of sites where GLI tree planting takes place are communal lands legally controlled by the state on which the local communities have a strong presence. It was frequently mentioned that farmers and local communities are agents responsible for direct causes of deforestation (MEFCC, 2018). Hence, failure to involve these communities in the GLI will result in failure in the implementation of the GLI. Unlike trees planted in communal lands, tree planting on private lands has an incentive as the financial return is attractive and solely grabbed by the owner.

Table 5: Respondents' perception about advantages of GLI (%)

Types of benefits	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Vegetation	52.19	45.31	0.94	0.94	0.62
Land restoration	59.06	40.62		0.31	
Fodder supply	36.90	53.12	3.44	6.56	
Water supply	48.44	40.62	5.62	4.06	1.25
Fuel wood	31.25	50.62	4.37	11.25	2.5
Livelihood improvement	35.31	57.81	5.31	1.56	
Employment	36.25	57.19	4.69	1.25	0.62
Soil fertility	64.40	35.00	0.31	0.31	
Global warming	53.13	46.56	0.31		
Recreation	40.94	55.62	3.12	0.31	

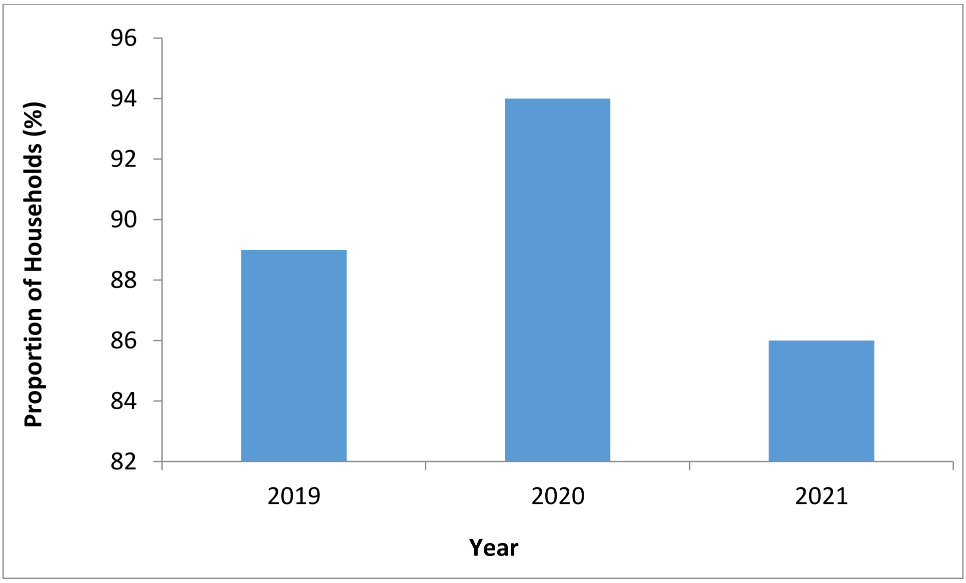
Figure 5: People's perception on the benefits of GLI



5.6. People's Participation in the Green Legacy Initiative

Most of the sampled households participated in the GLI. For example, 86-94% of the sampled households reported that they have participated in the GLI programs. The average number of seedlings planted was more or less the same in all the three periods. It is 74 in year 2019 and 2020 and 75 in year 2021.

Figure 6: People's participation in GLI for the last three years



Source: based on survey data

The overall tree planting campaign was participatory in that the youth and elderly, male and women, educated and uneducated, employed or unemployed, etc were all involved in the tree planting campaign.[10] This report can argue that the initiative was successful in terms of participating different groups of the society both at the national and regional level. While this is an encouraging step, continuous involvement of the various groups of the society in post planting activities is necessary. That is, efforts by all these groups of people in the post planting care will ensure the success of the initiative in the long term.

[10] Detailed data to verify the number of participants based on socioeconomic groups are not available.

5.6.1. Determinants of Seedlings Planted in the GLI

In this section, the study examined the role of various factors such as social, economic, environmental and location factors on the intensity of trees planted in the GLI. The study employs Heckman's (1979) sample selection model to analyze both the probability of participation and the intensity of trees planted during the 2021 GLI period. In the study areas, there are some households who do not participate. Thus, only considering GLI participants could yield inconsistent estimation results. Therefore, based on the assumption that different explanatory variables influence the decision to participate in GLI and the number of seedlings planted, we employ the Heckman full maximum likelihood method. This requires the estimation of the Probit model first and the second stage equation is estimated via ordinary least squares (OLS) by incorporating the inverse mills ratio derived from the probit equation. Estimation of Heckman model requires at least one variable that affect the participation equation but does not have a direct effect on the outcome equation. We believe that distance to the GLI site may affect the decision to participate but does not have a direct effect on the number of seedlings planted. The explanatory variables included in the regression are household characteristics such as age and sex of household, family size, education level of the head, location indicators such as distance from planting site, distance from nearest market, social capital indicators such as participation in local organizations, etc. This analysis enable us to understand the roles of various groups of the society such as the youth and elderly using age as an indicator, the poor or rich as measured by their income status, the literate or illiterate, and other characteristics of participants.

The results presented in Table 6 below shows that the explanatory variables have different effects on the probability of participation and number of seedlings planted. The estimation results shows that as the age of the household head increases then the probability of participation in the GLI may decrease and it is statistically significant at 10% level. As the age increases, the household becomes less interested to participate due to short planning horizon. But this variable has no significant effect on the number of seedlings planted. Asset or wealth indicators are included in the analysis. The result shows that number of livestock is positively and significantly associated with the decision to participate. Similarly, distance to the planting site is positively correlated to the decision to participate in the tree planting program. On the other hand, households that stayed further away from the forest areas have less .interest in tree planting. This result suggests that we need to focus on those households which are closer to the forest as these households are more likely to participate. Dummy variables were used to represent differences in agro-ecology and other unobservable factors among the regions. The results show that compared to the base category (i.e. Oromia region), the probability of participation is less in Amhara and SNNP regions.

Table 6: Determinants of the number of seedlings panted in the 2021GLI

Variables	Participation			Outcome Equation		
	Coef.	S.E.	P>z	Coef	S.E.	P>z
Age of household head	0.0518	0.04	0.227	-0.0302	0.03	0.287
Age square	-0.0007	0.00	0.085	0.0004	0.00	0.161
Sex of household head	0.2303	0.29	0.431	0.0378	0.21	0.854
Education of head	0.2490	0.24	0.292	-0.1132	0.20	0.563
Household size	0.0163	0.05	0.726	-0.0237	0.04	0.499
Distance to nearest market	0.0794	0.10	0.409	0.1206	0.07	0.100
Distance to nearest forest	-0.3607	0.14	0.012	0.0352	0.07	0.617
Microfinance	-0.0397	0.31	0.897	-0.7681	0.17	0.000
Access to Extension	0.8605	0.37	0.019	0.6016	0.29	0.037
Number of Livestock (TLU)	0.1047	0.06	0.062	-0.0180	0.03	0.597
Land area in Ha	-0.0663	0.10	0.523	-0.1885	0.08	0.013
Annual crop income	-0.0279	0.02	0.260	0.0614	0.02	0.000
Distance from the 2021 GLI site	0.0085	0.00	0.001			
DAmhara	-0.6562	0.30	0.027	1.4418	0.21	0.000
DSNNP	-0.7457	0.30	0.013	0.2047	0.21	0.323
_cons	-0.1369	1.15	0.905	3.1685	0.86	0.000
Rho	-0.7137	0.14	0.001			
N (Number of obs)			319			
Chi square		-	159.73			
Log likelihood			-479.733			

S.E. are robust standard errors. Distance and crop income are in log form.
Note: Some of the outliers for some of the variables were handled by using the median values for that particular site. Sidama region was merged with SNNP. Oromia is the base category. The dependent variables are binary for the selection equation (i.e. whether the household participate in the GLI or not during the 2021 GLI period). The dependent variable in the outcome equation is the number of seedlings planted during the 2021 GLI period (in log form). Wald test of indep. eqns. (rho = 0): chi2(1) = 10.29; Prob > chi2 = 0.0013

The number of seedlings planted is also affected by several variables. Once the household decides to participate, it seems that household characteristics do not have a significant effect on the number of seedlings planted. Distance to the nearest main market is positively related to the total number of seedlings planted. Access to microfinance is one of the main variables which affects the intensity of trees planted negatively and the result is significant at 1% significance level. We also find that households with more land size are less willing to plant more trees. On the other hand, higher income households tend to plant more trees.

Access to extension agents certainly have a positive and significant effect on both the decision to participate and the number of trees planted. It is important to use development agents as these agents have already developed strong relationship with the local communities in other agricultural activities. Hence it is advisable to provide extension agents with training on natural resources, in this case forest management, as most extension agents in Ethiopia focus on crop production or cereals (Beyene *et al.,* 2019). Finally, we find that households in Amhara and SNNP regions are more likely to plant more trees than households in Oromia region.

5.6.2. The Role of Social Infrastructure in Implementing GLI

The role of social infrastructure such as schools, public health centers, recreation or sport centers, market facilities such as shopping centers, cooperatives, etc were also assessed in the current study. Most of the respondents reported that these infrastructures are important in the implementation of the GLI. For example, nearly 70% of the respondents believe that education facilities such as schools and universities are believed to be important. However, these kinds of social infrastructure were not actively involved during the last three tree planting programs. There is a need to integrate the different kinds of social infrastructure during planning and implementation phase of the GLI.

The role of local/informal institutions such as *Idir* and *Iqub* was very low in most cases as examined in the study sites. However, some respondents states that these institutions do have significant role in regions such as SNNP. These institutions can play a better role in the initiative and need to engage them in future tree planting campaigns.

5.6.3. Willingness to Participate in the GLI

This study used the contingent valuation method to value people preferences regarding the GLI. The data was collected using experienced field workers who have worked on similar valuation surveys. During the data cleaning stage we observed some inconsistencies and problems. We revisited those households and managed to have complete data on the CVM questions. The CVM survey used for eliciting household's preferences is found in Appendix A. The CVM is one of the non-market valuation methods commonly used to find the economic value of non-market goods and services. It is a method that uses hypothetical survey questions to elicit people's preferences for public goods by finding out what they are WTP for specified improvements in them (Mitchell and Carson, 1989).

This study also applied contingent valuation (CV) with the double bounded elicitation format to estimate farm households' WTP to participate in the GLI.[11] The single bounded method requires less information, easier to implement during data collection, and can avoid systematic bias in responses that are due to the introduction of the follow-up bid. However, the double bounded contingent valuation (DBCV) method is more efficient than the single bounded dichotomous choice CVM (Hanemann *et al*., 1991). In the case of DBCV, respondents were faced with a two sequence bid offer. First, they are asked whether they would 'accept' or 'reject' the first bid. Then followed by the second bid, which may be higher or lower depending on the response to the initial bid. That is, if the individual answers 'yes' to the first question, he/she will be asked about his/her WTP for a higher amount. If he/she answers no to the first question, then a lower amount is offered. In that case, the DBCV has four possible outcomes: i) yes, yes; ii) yes, no; iii) no, yes; and iv) no, no. Let the first and second bids be represented by b_1 and b_2, respectively then each individual will be in one of the following categories:

i) $\mathrm{Yes, Yes\ ively\ b_2}$;

ii) $\mathrm{Yes, No}\ \ \mathrm{b_1 \leq bs, < b_2}$,

iii) $\mathrm{No, Yes}\ \ \mathrm{b_1} > WTP \geq \mathrm{b_2}$; and

iv) $\mathrm{No, No}\ \ \mathrm{ive < b_2}$.

[11]The Doubleb command in Stata for estimation of WTP with double-bounded value elicitation format in contingent valuation can be used for the analysis (Lopez-Feldman, 2012).

Equation (*i*) shows that the WTP is right censored because the respondent's answer to the initial and the higher bid levels are both affirmative. On the other hand, equation (*iv*) shows that the WTP is left censored as the initial and the lower bid levels are both negative. In both equations (*ii*) and (*iii*) both answers alternate in sign, and hence their WTP lies within an interval, with the second bid acting as an upper or lower bound to the respondent's unobserved WTP.

Following this:-

$$\mathrm{WTP_{ij}} = \mathrm{Z_{ij}}\beta + \varepsilon_{\mathrm{ij}} \qquad \textbf{(5)}$$

Where $\mathrm{WTP_{ij}}$ is the j^{th} individual's WTP, i=1, 2 represents the first and the second answers, respectively.

$\mathrm{Z_{ij}}\beta$ are vectors of variables related to individual and community level characteristics and their parameters, respectively.

$\varepsilon_{\mathrm{ij}}$is the error term that incorporates both individual and question specific error.

Assuming error terms ε_{1j} and ε_{2j} are normally distributed with mean zero and variance σ_{21} and σ_{22}, respectively, and allowing for correlation between dichotomous choices, expressed by ρ, Equation (5) is estimated using the bivariate probit model (Cameron and Quiggan, 1994)**.**

If the responses are random and uncorrelated, then the two errors are stochastically independent which justifies the use of probit model to estimate both models independently. However, single equation models of WTP should not be used in cases where the errors of both equations are correlated because preference parameter estimates are inefficient and standard errors of the preference parameters are upwardly biased (Greene, 1997).

$$y_1^* = \beta_1'\chi_1 + \varepsilon_1,\ \ y_1 = 1 \text{ if } y_1^* > 0,\ 0 \text{ Otherwise} \qquad \textbf{(6)}$$

$$y_2^* = \beta_2'\chi_2 + \varepsilon_2,\ \ y_2 = 1 \text{ if } y_2^* > 0,\ \ 0 \text{ Otherwise}$$

$$\mathrm{E}[\varepsilon_1] = \mathrm{E}[\varepsilon_2] = 0; \mathrm{Var}[\varepsilon_1] = \mathrm{Var}[\varepsilon_2] = 1; \qquad \mathrm{Cov}[\varepsilon_1, \varepsilon_2] = \rho$$

Where y_j is the response to WTP question j, the β_j's are vectors of preference parameters, the $x_{j's}$ are vectors of explanatory variables, and the εj's are the equation errors. To simplify the comparison and interpretation of the model results, we use the same set of explanatory variables in both equations $(\chi_1 = \chi_2)$. However, the study also estimate the single-bounded regression analysis and the results are compared. The variables included in the right hand side of the equation are already discussed in section 4.2.

Table 7: Double bounded estimation results

Description		Coefficient	Std. err.	P>z	[95% conf. interval]	
Beta	_cons	254.6207	12.84656	0.000	229.4419	279.7995
Sigma	_cons	178.7258	13.01665	0.000	153.2137	204.238

Table 7 presents the results of the double bounded estimations without control variables. In this case the WTP is approximately equal to ETB 255. The results from the bivariate probit regression estimate shows that the coefficient for both bid values is negative and statistically significant at the 1 percent level. The age of the household head is negative but significant in the first equation. Most of the control variables are not significant except that the sign is consistent with what we expected.

Table 8: Bivariate regression results

Variables	Model 1			Model 2		
	Coef.	std. err.	P>z	Coef.	Std. err.	P>z
BID1	-0.0073	0.0009	0.000			
BID2				-0.0025	0.001	0.011
Age of household head	-0.0181	0.0076	0.018	-0.0069	0.0075	0.352
Sex of household head	0.4792	0.4547	0.292	0.0602	0.3721	0.871
Marital status of head	-0.2832	0.4354	0.515	0.3857	0.3636	0.289
Education head	0.0335	0.2204	0.879	0.2627	0.1854	0.157
Household size	0.0509	0.0419	0.224	0.0036	0.0384	0.925
Distance market	0.0002	0.0012	0.834	0.0008	0.0001	0.447
Member of Agr. Producer	0.0870	0.1809	0.631	-0.2983	0.1650	0.071
Land size in ha	0.0639	0.1005	0.525	-0.0056	0.1085	0.959
Livestock (TLU)	-0.0082	0.0516	0.874	0.0876	0.0448	0.050
Household is in Amhara	-0.5645	0.2421	0.020	-0.8323	0.2244	0.000
Household is in SNNP	0.3938	0.2351	0.094	0.0315	0.2236	0.888
_cons	2.1348	0.4938	0.000	0.6251	0.4638	0.178
Rho	0.3850 (0.1505)					
Logliklihood	-327.2565					
N	320					

We also estimated the double bounded with control variables but the results are more or less the same with those presented in Table 8.

5.6.2. Determinants of Private Tree Planting

5.6.2.1. Types and Sources of Tree Species

The purpose of achieving green growth and climate resilience economy cannot be achieved through government's effort only. Smallholder farmers need to engage in tree planting activities on their farm land and in areas around their homestead. This may enable farmers to achieve food security by getting additional food and cash. Table 9 shows the distribution of the number of seedlings planted in the year 2021 across the study sites.

Table 9: Distribution of average number of seedlings planted in 2021

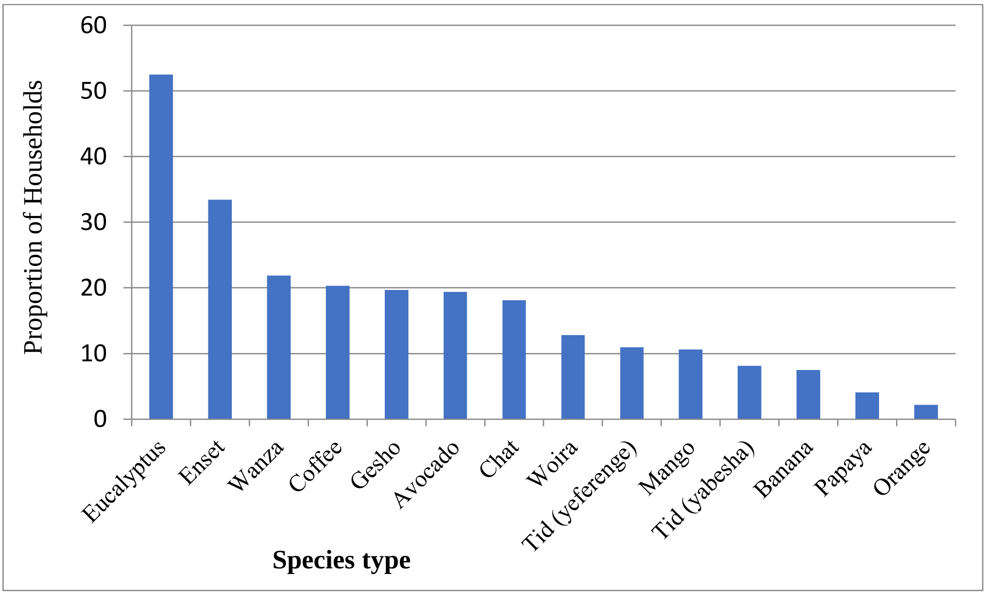
Region	Zone	Woreda/District	Mean	Std. Dev.	Min	Max
Amhara	South Gondar	Libokemkem	141.00	141.90	0	500
	Awi	Banja	90.78	129.46	0	600
SNNP	Hadiya	Lemo	46.30	75.39	0	325
	Hawassa Zuriya	Wondogenet	20.18	21.65	5	120
	Guraghe	Gumer	25.93	41.47	0	200
Oromia	East Shewa	Lume	26.58	24.78	0	100
	Arsi	Limuna Bilbilo	60.88	55.84	0	250
	West Shewa	Ejere	17.73	23.23	0	100

*Sidama region is included under SNNP.

As shown in Table 9 above, the average number of seedlings planted is greater in South Gondar and the lowest in West Shewa. It seems that the sampled households in Amhara region have, on average, large number of seedlings planted compared with sampled households in other regions. Though the samples are not representative, we learned that trees in particular woodlots are very common in both zones in Amhara region. It is also becoming common in other parts of the country. For example, growing of eucalyptus trees is expanding rapidly in the SNNP region such as Guraghe zone. A recent study by Zerga *et al.(*2021) shows that eucalyptus tree planting is expanding in the Western Guraghe Watersheds for various reasons such as economic (e.g. the growing need for fuel wood, construction materials, and demand for cash), access to markets, cultural, population growth, land degradation and conservation, and road development. Several studies also argue that the high demand for fire wood, construction materials such as poles have pushed farmers to plant more number of trees on their land.

Farmers planted various types of tree species as shown in Figure 6. The most dominant type of tree species is eucalyptus followed by other permanent tree crops such as avocado, coffee, chat and *enset*. Trees such as *Wanza* and *Woira* are also common. It was found that those farmers who did not plant trees or did not plant more trees because they believe that they do not have enough land. Other minor reasons include preference for annual crops, lack of seedlings, lack of appropriate tree species, etc. Figure 6 shows the main types of species but there are also other types of species not reported here such as *kulkual, agam, endode,* etc.

Figure 7: Types of trees and bushes owned by sampled households



Source: Survey data

Household level survey results showed that households obtain the seedlings from various sources. The main source is own source followed by purchasing from market and supply by government offices through development agents. Households also collected the seedlings from natural forests and sometimes received it from NGOs.

Table 10: Sources of seedling (for private tree planting) by tree type

Type of trees and bushes	Source of seedlings						
	Own	Purchase	Development agents / gov't offices	NGOs	Natural forest	Other (specify)	Total
Kulkual	0	0	0	0	2	0	2
Tid (yeferenge)	10	16	9	0	0	0	35
Tid (yabesha)	7	7	8	0	4	0	26
Wanza	21	3	21	0	24	1	70
Woira	6	9	9	0	16	1	41
Endode	1	0	0	0	1	0	2
Agam	1	0	0	0	1	0	2
Orange	0	4	2	0	0	1	7
Banana	12	6	0	0	0	6	24
Papaya	1	5	6	0	0	1	13
Avocado	11	27	21	1	0	2	62
Mango	6	16	12	0	0	0	34
Lemon	0	1	0	0	0	0	1
Gesho	21	25	13	0	4	0	63
Coffee	28	12	23	0	0	2	65
Chat	36	17	0	0	0	5	58
Enset	105	2	0	0	0	0	107
Eucalyptus	103	45	9	1	1	9	168
Other (specify)	29	21	23	1	12	0	86
Total	398	216	156	3	65	28	866

Source: Survey data (2021)

5.6.2.2. Determinants of Private Tree Ownership

Tree planting on farmer's land is one of the factors that can contribute to the efforts to reduce deforestation in Ethiopia. It is critical to encourage households to plant trees in order to achieve the green growth objective of the country. However, empirical evidence on the determinants of households' tree planting behavior still remains insufficient. Therefore, understanding the factors that determine the tree planting behaviour of farm households will support the government's effort in designing appropriate intervention mechanisms. In this section, we assess tree growing behavior of the sampled households. As shown in the descriptive statistics in Table 9 there are differences in the number of trees planted/grown among our sampled households. Hence we look for answers to the question: What are the factors influencing the number of trees grown by rural households in the study region? Therefore, we analyse the determinants of tree ownership and number of trees and bushes planted using the count data model which is specified as follows.

If, for example, assume that the observed data display pronounced over-dispersion, the negative binomial model (instead of the Poisson model) could be used (Greene, 2008). The model used here can be specified as follows:

$$P(Y = y) = \frac{\Gamma(y+\tau)}{y!\,\Gamma(\tau)}\left(\frac{\tau}{\lambda+\tau}\right)^{\tau}\left(\frac{\lambda}{\lambda+\tau}\right)^{y},\ y = 0,1,2\ ,\ldots;\quad \lambda,\tau \succ 0 \qquad \textbf{(7)}$$

where λ and τ are the mean and the size parameters (that quantifies the amount of over dispersion), respectively. Y is the response variable of interest, and $\Gamma(.)$ is the gamma function. The negative binomial model was employed as a functional form that relaxes the equi-dispersion restriction of the Poisson model. Here we adopted the zero-inflated negative binomial (ZINB) model as it takes in to account the excess zeros in addition to allowing for over-dispersion. Table 11 presents the result of the estimation of the determinants of tree ownership. The estimates from OLS are also presented for comparison purpose.

The Vuong test of zero inflated negative binomial models (zinb) versus the standard negative binomial (z = 3.07, Pr>z = 0.0011). The test shows that the zero inflated model is an appropriate model. So our discussion below is based on the result of estimation from the ZINB model.

Table 11: Determinants of total number of trees and bushes owned by sampled households

Variables	ZINB			OLS		
	Coef.	**Std. Err.**	**P>z**	**Coef.**	**Std. Er.**	**P>t**
Age of household head	-0.0063	0.0084	0.452	0.27	8.81	0.976
Sex of household head	-0.6034	0.5216	0.247	-410.95	501.00	0.413
Marital status of head	0.3947	0.4964	0.427	-481.14	493.45	0.330
Education of head	0.0482	0.0254	0.058	51.30	33.87	0.131
Occupation of head	-0.5580	0.4081	0.172	-727.23	705.13	0.303
Household size	0.1869	0.0408	0.000	288.67	64.52	0.000
Distance to nearest forest	0.0183	0.0864	0.833	34.26	119.16	0.774
Distance to nearest road	-0.0783	0.0624	0.210	-8.89	80.72	0.912
Distance to nearest market	-0.4432	0.0972	0.000	-576.31	148.27	0.000
Member of Agr produce group	0.4031	0.1831	0.028	43.78	224.27	0.845
Member of Credit group	0.0159	0.1741	0.927	-191.70	258.65	0.459
Land area in ha	0.4920	0.1478	0.001	474.95	208.23	0.023
Tenure insecurity	-0.5646	0.2287	0.014	-449.02	262.63	0.088
Number of livestock(TLU)	0.0945	0.0517	0.067	65.99	79.04	0.404
Damhara	0.7455	0.3146	0.018	162.66	300.27	0.588
Dsnnp1	1.5351	0.3192	0.000	1427.34	324.82	0.000
_cons	6.9588	0.7666	0.000	2264.45	1221.99	0.065
N (No. Obs)		295			295	
R-squared					0.3006	
LR chi2(16)		129.75				

Note: Distance measures are in log form.

The number of trees owned by farm households is a function of household characteristics such as education of head, family size, land size, number of livestock owned, access to infrastructure indicators such as distance to market and roads, social capita indicators such as membership in agricultural producer group, and tenure security. The sign and significance of education is not surprising as educated people are expected to be more knowledgeable about the roles of trees in climate change mitigation as well as livelihood for the family. Available empirical studies also found similar results in that there is a positive association between education of household head and number of tress grown (Oli *et al.,* 2015; Gessesse *et al.,* 2016; Mekonnen and Damte, 2011). Availability of labor is positively and significantly correlated with the number of trees owned which is in line with the findings of Mekonnen and Damte (2011). There is also a positive and significant correlation between the amount of land size and the number of trees and bushes owned by sampled households. Similarly, the size of the farm that a household owned is positively correlated with the number of trees growing behviour in other countries in Africa (e.g., Kulindwa, 2016; Etongo *et al*., 2015; Mekonnen and Damte, 2011) and Asia (Oli *et al*., 2015).

Access to infrastructure, mainly distance from market is negatively and significantly correlated with the number of trees owned. This is because availability of markets for products such as fire wood, poles, and other products will be an incentive for farmers to plant more trees. Membership in local organization such as membership in an agricultural producer groups is positively related to the number of trees grown.

Tenure security has been mentioned as one of the determinant factors for long term investment decision by households. Similarly, our result shows that if farmers are tenure insecure, then they tend to grow less number of trees and bushes and the estimate is significant at 5% level of significance. This suggests that there is a need to guarantee or provide some form of assurance to those farmers who are concerned that there might be dispute or claim of their ownership/use rights of land. In this regard, the current efforts by the government to provide farmers with second stage level land certification results in improved farmer's perceived tenure security, brought significant reductions in disputes, and enable to make additional long terms investment (Holden and Neumann, 2021). This is in line with empirical studies in Africa and Ethiopia. For example, Etongo *et al.* (2015) find that tenure insecurity is one of the main reasons for not planting trees in Burkina Faso.

5.6.2.3. Determinants of Number of Seedlings Planted on Private Land

On the other hand, we estimated the number of seedlings (trees and bushes) planted during the last two years on farmer's land. On average, farmers planted around 118.6 seedlings in the last two years. This ranges from 0 to 1580. The highest average number of seedlings planted was in Hawassa Zuria (395.8) followed by Guraghe zone (169.2) and the lowest average number of seedlings were in East Shewa (12.4). The determinants of the number of seedlings planted in the last two years are shown in Table 12. We employed the zero-inflated negative binomial regression as the-Voung test results shows that it is in favour of the ZINB model to the standard negative binomial model.

Table 12: Determinants of number of seedlings planted in the last two years (on private land)

Variables	ZINB			OLS		
	Coef.	**Std. Err.**	**P>z**	**Coef.**	**Std. Err.**	**P>t**
Age of household head	-0.0158	0.0083	0.057	-1.08	1.295	0.405
Sex of household head	-0.7748	0.5856	0.186	0.26	55.104	0.996
Marital status of head	0.8721	0.5005	0.081	-30.03	46.820	0.522
Education of head	-0.0517	0.0293	0.078	-4.93	4.873	0.312
Occupation of head	0.7034	0.5262	0.181	75.76	58.336	0.195
Household size	0.1595	0.0402	0.000	24.78	6.801	0.000
Distance to nearest forest	-0.0165	0.1018	0.871	-2.18	16.317	0.894
Distance to nearest road	-0.2442	0.0712	0.001	-26.93	17.560	0.126
Distance to nearest market	-0.3723	0.1082	0.001	-49.24	18.032	0.007
Member of Agr produce group	0.3199	0.1928	0.097	31.96	32.377	0.324
Member of Credit group	-0.3130	0.1844	0.090	-60.89	33.018	0.066
Land area in Ha	0.4280	0.1557	0.006	28.16	19.055	0.141
Tenure security	-0.1738	0.2766	0.530	67.64	30.896	0.029
Number of livestock (TLU)	0.0105	0.0497	0.833	7.56	9.161	0.410
Damhara	-0.5008	0.4110	0.223	53.03	33.614	0.116
Dsnnp1	0.7280	0.4031	0.071	231.40	40.188	0.000
_cons	6.0578	0.8264	0.000	178.09	133.348	0.183
R-squared					0.227	
N		295			295	
LR chi2(16)		88.09				

Vuong test of ZINB vs. standard negative binomial: z = 6.60; Pr>z = 0.0000
Note: Distance measures are in log form.

The age of the household head was negatively related to the number of trees planted during the last two years. This is because as age increases then farmer's planning horizon becomes too short and hence less incentive for the farmer to plant more trees/bushes. As expected, availability of more labor in the family is an important factor to plant more trees and bushes. On the other hand, those households who can read and write plant less number of seedlings which is unexpected.

One of the factors that determine the number of trees to be planted was availability of sufficient land. The coefficient of land size shows that the larger the land size, the more will be the number of seedlings planted by the farmer. This suggests that fragmented land size or further redistribution of land in the future may hinder farmers' long-term investment decisions.

Access to infrastructure such as distance to nearest main road and markets are both included in the regression. There is a negative and significant relationship between distance to markets and the number of seedlings planted. This is in line with the available evidence in that access to markets for forest products is important for farmer to plant more trees on private land (Dewees, 1995; Scherr, 1995; Mercer and Pattanayak, 2003). Similarly, access to roads was found to be important in determining the number of seedlings planted. This is also obvious as better access to roads will improve market access for product marketing (Kollert *et al*., 2017) and hence become an incentive for farmers to plant more trees.

The role of household membership in local organizations such as agricultural producer group and credit group was found to be significant. The former increases the number of trees planted while the latter is negatively related to the total number of seedlings planted in the last two years. A household who is a member of credit group is more likely to have access to credit for other kinds of investment such as nonfarm activities and might be less interested in tree planting.

5.7. The Role of Forest Related Policies and Laws in Tree Planting

This research report evaluated forest related policies and strategies as well as the various national and international commitments related to the sustainable management of forest sector of Ethiopia. We briefly highlighted the most important documents which influence or relatively play significant role in reducing the impact of climate change in general and the forest sector problem in particular.

i) National Forest Law

The 2018 National Forest Law is a revised version of the 2007 forest law. The 2007 forest law focused on state and private forests only. This created tenure uncertainty and communities lack incentive to participate in rehabilitation efforts of the government. The new law clearly recognizes the rights of communities and acknowledges their role in managing forests and establishing plantations, without compromising ecological services or biodiversity. This is critical for the success of the GLI. That is, the GLI could be successful if farmers feel that the ownership of the trees planted as well as the land in which the trees are planted are clear to the community. The integration of local ownership and private sector engagement is key to the sustainability of the current restoration efforts (EFCCC, 2020).

As shown in Table 11, if farmers feel that they are tenure insecure, measured in their perception about future land redistribution or dispute, then it may have a negative impact on the number of trees and bushes owned. The main reason is that the state can revoke use rights anytime as it sees fit following the legal procedures stated in the 2005 national land law (Boissiere *et al*., 2021). The literature indicates that tenure security is very important for long-term investment decision by farmers. For example, several studies in Ethiopia find that the current public ownership of land significantly discourages farmers' participation in tree-growing activities (Boissiere *et al*., 2021; Alemie and Amsalu, 2020; Gesesse *et al*., 2016).

ii) The national REDD+ strategy of Ethiopia

Ethiopia has been in the REDD+ process since 2008 and is now a REDD+ participant country to the Forest Carbon Partnership Facility (FCPF) of the World Bank, and submitted REDD+ Readiness Preparation Proposal (R-PP) in 2011, which was approved in October 2012. The draft strategy envisages guiding the coordination and implementation of REDD+ initiatives to ensure Ethiopia optimizes the benefits of carbon trading and other ecosystem services from sustainably managed forests. The strategy envisages that implementation of REDD+ is based on a set of principles that ensures climate benefit along with co-benefits (biodiversity and livelihoods) while respecting the rights of local communities and forest dependent communities.

As a result, the five cardinal principles of Ethiopia's National REDD+ Strategy are: equity, effectiveness, transparency, accountability, and commitment. In Ethiopia, REDD+ is evolving as an integral part of a wider green economic growth strategy and in the context of a policy environment that is promoting reforestation and afforestation as a way of tackling land-degradation. For the success of GLI, lessons obtained from REDD+ initiatives needs to be considered. For example, the need for coordination, during design and implementation, among the relevant actors including the local communities is one of the lessons from REDD+ investments programs (Fikreyesus *et al.*, 2022).

iii) The Climate Resilient Green Economy Strategy (CRGE)

Ethiopia has implemented the ambitious CRGE strategy since 2011 with the aim of achieving economic growth that is resilient to climate change and results in zero net greenhouse gas emissions. It has also committed to restore 15 million ha of degraded land by 2030 through the Bonn Challenge and AFR100. This is indeed an opportunity for the country to restore its degraded lands with the support of the international community.

The strategy identifies seven sectors that play key roles in sustainable development: forestry, soil, livestock, power, buildings/green cities, industry, and transport. Nonetheless, the strategy for a green economy is based on four pillars: agriculture, forestry, power and transport. The agriculture and forestry sectors have been identified as having the largest abatement potential. Therefore, the forestry sector is given a vital role in developing a green economy and REDD+ has been selected as one out of four initiatives to fast-track implementation (FDRE, 2011a). The strategy aims to reverse the current deforestation and forest degradation trend by tackling the major drivers, and protect and increase the economic and ecosystem services that forests provide. The implementation of the GLI on the ground should be guided by the CRGE strategy as the country's commitment to the international community is indicated in this important strategy.

There are several policies and strategies such as Ethiopia's Programme of Adaptation on Climate Change (EPACC) which updates and replaces Ethiopia's National Adaptation Programme of Action (NAPA) in 2010, Nationally Appropriate Mitigation Action (NAMA) which was prepared in 2010, National Biodiversity Strategy and Action Plan which was prepared in 2005, etc. In addition, Ethiopia has ratified several international conventions and protocols on environment. The various policies and strategies, as well international agreements can be considered as an opportunity for the development of the forestry sector. Therefore, the GLI should be aligned with these and other national and international laws as it helps the country fulfill it national and international commitments in several ways. Its contribution is not only limited to the forest sector but also other sector such as agriculture and energy.

6. CONTRIBUTION OF THE GLI IN ECONOMIC DEVELOPMENT

6.1. The Concept of Green Growth

Green growth is a means to foster economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies (OECD, 2011b). The African Development Bank defines green growth as the promotion and maximization of opportunities from economic growth through building resilience, managing natural assets efficiently and sustainably, including enhancing agricultural productivity, and promoting sustainable infrastructure. The concept of green growth aims to address the growth and development challenges without compromising future growth and development objectives of the country (OECD, 2012).

The green growth agenda is critical for developing countries like Ethiopia in many ways. First, these countries are the most vulnerable to environmental degradation that occurs due to their huge dependence on natural resources. Climate change affects various sectors of the economy of many developing countries. For example, energy, agriculture, water, and health sectors are all affected by extreme weather events. This may undermine the social and economic situation of the country.

Obviously, conventional way of development may undermine the threat of climate change as it is based on intensive use of natural resources and hence release more emissions. That is why countries must follow green growth method and ensure sustainable development.[12] Therefore, the green growth agenda for African countries including Ethiopia is sustaining rapid growth and poverty alleviation while at the same time avoiding costly environmental damage that will threaten growth over time.

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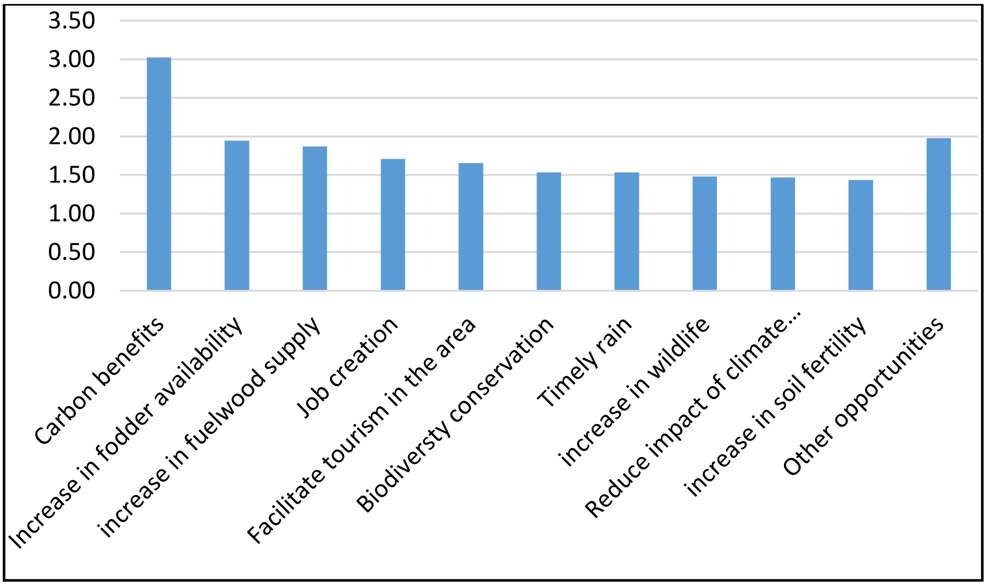
[12]The UN 2030 Agenda for Sustainable Development was adopted in 2015, with nearly all UN members voting in favor. It is structured around 17 Sustainable Development Goals (SDGs) that are interconnected, meaning success in one affects success for others.

6.2. Opportunities of GLI

The GLI may provide various opportunities to the country in general and local community in particular. This is discussed in detail at the national and local level. For example, in September 2014, Ethiopia declared its support for the New York Declaration on Forests and the Bonn Challenge by pledging to restore 15 million hectares of degraded and deforested lands by 2025 (MEFCC, 2018). The role of GLI to this and other international commitments will be tremendous. The local community could benefit from such initiative such as local job creation, resources for livestock, other resources such as wood fuel, coffee, spices, honey, etc. We assessed local community's perceptions regarding the opportunities of the GLI based on the field level survey. Households were asked to rank the importance of GLI in a five point scale (strongly agree (1), agree (2), neutral (3), disagree (4) and strongly disagree (5). In addition, the assessments are supported based on review of available literature including government documents and experts interview.

Figure 8: Households' perception on the opportunities of GLI



This means when the average is low, it suggests that households are in favor of the positive benefits of GLI. On the other hand, a higher value means households do not perceive that GLI has benefits. Figure 8 above shows that most of the sampled households do not perceive that GLI has carbon suggesting that awareness creation on these benefits of GLI should be undertaken. However, rural households are well aware of the opportunities provided by GLI. This includes opportunities in improving soil fertility, reducing impacts of climate change, increase in wildlife, timely rain, biodiversity conservation, facilitate tourism in the area, job creation, increase in fuel wood supply, and increase in fodder availability as the values lie between 1(strongly agree) and 2(agree).

The GLI creates various opportunities to the society as well as to the government's efforts in promoting green growth and tackle the impacts of climate change resulting from deforestation and desertification. The following are the main types of opportunities that arise as a result of GLI:

a) *A constant supply of forest products*: When more land is covered by trees, then more forest products will be available. This will support millions of people for their livelihood. Trees provide food, medicinal plants, spices, firewood, etc. Since biomass is the dominant source of energy for households in Ethiopia, tree planting help increase availability of energy supply. This is in line with the energy policy of the country in that renewable energy sources should increase and more trees should be planted in order to satisfy the growing demand for energy.

b) *Awareness creation*: As this is initiated by the Prime Minster, people become better aware of the role and importance of tree planting. People will get the opportunity to interact with different people and learn about tree planting skills; learn about tree maintenance and protection, and natural resource management in general.

c) *Job creation*: Several people were involved in seedling preparation, in transporting goods and services including people, in protecting the seedlings panted including watering plants, weeding, etc. Hence a large number of unskilled laborers are required to perform these activities. As already discussed more than 700,000 jobs have been created in the last four years.

d) *Carbon finance*: More efforts to cover the land with trees can help act as carbon sink, that is, trees can accumulate atmospheric CO2 as carbon in vegetation and soils. The country can claim carbon credits for tree planting. A detail exercise on carbon sequestration and associated revenue has been discussed in Section 6.3.1 below.

e) *Improve air quality*: the quality of air at the local level would be improved because trees absorb carbon and produce oxygen. Trees help airborne dust and pollutants and hence clean air.
f) *Conserve biodiversity*: trees are home to several types of species of insect, fungi, moss, mammals, and plants. For example, afforestation efforts in China results in an increase bird species diversity (Pei *et al*., 2018).
g) *Soil erosion control*: Soil erosion from surface water runoff and flooding is a critical challenge facing rural households in Ethiopia. Trees help stabilize the soil and prevent erosion by binding soil and protecting the land.
h) *Aesthetic values*: Trees provide beauty to the landscape as well as to the public facilities such as schools, health centers and residential areas.
i) *Wildlife preservation*: The number of wildlife will increase as more trees are planted and more land is covered by trees.

6.3. Contributions of Forest and Trees in the 2030 Agenda

Forests and trees have a significant role to play in green growth. As already discussed, forests are the source of food, fuel wood, honey, wild coffee, spices, medicinal plants, and other several products to the people in developing countries including Ethiopia. In sub Saharan Africa, millions of people are directly dependent on forests for their livelihood (Miller *et al.*, 2021). In addition, forests and trees planted on farm land help reduce greenhouse gas emissions and mitigate climate change. The forest sector also plays a significant role in other sectors such as agriculture, energy and water.

Planting trees in general help to achieve all 17 SDGs. As we all know, the SDGs are ending poverty (Goal 1), zero hunger (Goal 2), good health and well-being (Goal 3), quality education (Goal 4), gender equality (Goal 5), clean water and sanitation (Goal 6), affordable and clean energy (Goal 7), decent work and economic growth (Goal 8), industry, innovation and infrastructure (Goal 9), fighting inequality (Goal 10), sustainable cities and communities (Goal 11), responsible consumption and production (Goal 12), climate action (Goal 13), life below water (Goal 14), life on land (Goal 15): protect, restore, and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification; halt and reverse land degradation, and halt biodiversity loss", peace and justice strong institutions (GOAL 16), partnerships to achieve the goal (Goal 17).

The GLI, in addition to its alignments with the national commitments, is also in line with the objective of global initiatives such as the UN Decade on Ecosystem Restoration, UNEP vision for 2020 as Super Year for nature; Paris Agreement on climate change, the Targets on Land restoration, UN Sustainable Development Cooperation Framework (UNSDCF), etc.[13] In sum, forests and trees contributes directly and indirectly to achieving many of the SDGs and thus improving the well-being of the global population, especially the poor.

6.3.1. Assessment of Carbon Sequestration Potential of the GLI

Tree planting has the potential to increase carbon sequestration capacity of forests. However, the potential of the forest sector to contribute to the green economy of the country is affected by deforestation and forests degradation as well as market, policy and governance failures (Grieg-Gran *et al*., 2015). The Green Economy (GE) strategy sets out the plans for developing a low carbon economy in Ethiopia. Detailed analysis showed that GHG emissions in Ethiopia would rise from 150 MtCO2e per year in 2010 to 400 MtCO2e in 2030 under a conventional development path ('business as usual') (FDRE, 2011).

The GLI aims to achieve multiple purposes. In this section, this report attempted to estimate how much carbon dioxide will be sequestered as a result of the implementation of GLI. Standard approaches are employed to estimate the amount of carbon sequestered. It is clear that the trees have not reached at maturity stage and difficult to account for their full carbon sequestration potential. However, using certain assumptions on the survival rate, tree species, area coverage, etc, the study attempted to estimate the amount of carbon sequestrated for the already planted seedlings. In addition, projection was made till 2051.

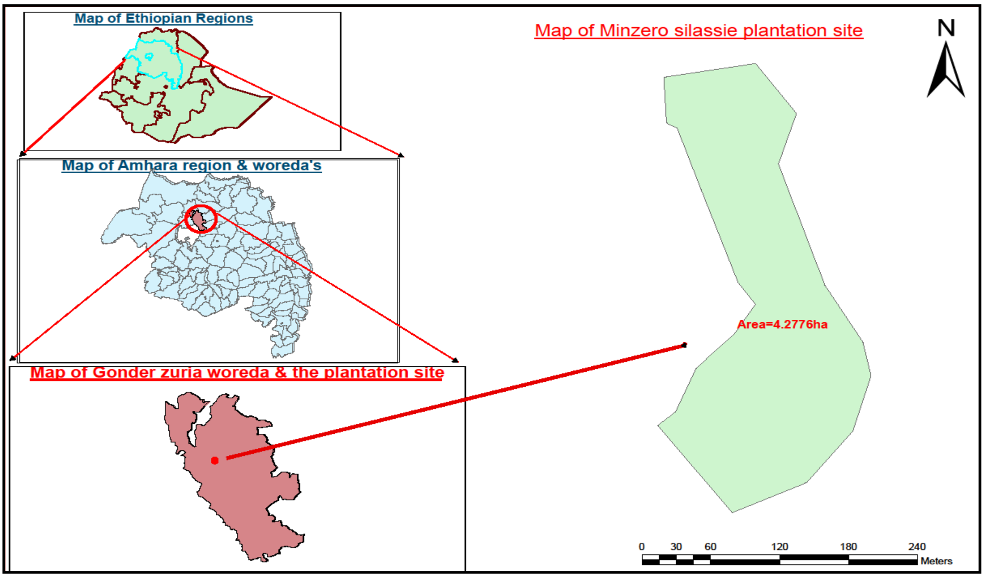
6.3.2. Assessment of Forest Carbon Stock of Gondar Zuria Green Legacy Plantation Site

Before presenting the national level estimate of carbon sequestration potential of GLI, the report takes one of the successful GLI plantations in Amhara region, Gonder Zuria woreda, known as Minzero Silassie plantation site. The forest

[13]Retrieved fromhttps://ethiopia.un.org/en/87440-united-nations-ethiopia-takes-part-tree-planting-curb-effects-deforestation-climate-change

inventory and forest carbon stock assessment of Gondar Zuria GLI plantation requires actual field level data. Hence the necessary data for the estimation of carbon sequestration potential of the plantation site were collected. We adopted standard method developed by USAID-Winrock international. The site was established in 2019, which implies that it is a 3 years old plantation. The figure below shows the picture of the plantation site.

Figure 9: Location map of Minzero Silassie green legacy plantation site



The main objective here is to determine the biomass and carbon stocks of the site and provide an understanding of the contribution of GLI programs in the country.

The materials used for this study are therefore:

- Caliper for diameter at breast height measurement
- Hypsometer for tree height measurement
- Compass for measuring bearings
- Measuring tape for plot measurement

Sampling and data collection methods

- We took 20 samples where the interval between two sample plots is 45m,
- The shape of the sample plot is circular,
- The size of the sample plot is 0.01 ha (10 m x 10 m)
- The main parameters of biomass (diameter and height) are measured.

The total data were taken from the 20 samples. Out of these, two samples do not have any trees.

Defining carbon pools: the five carbon pools are;

1. Above Ground Biomass (AGB): consists of all living biomass above the soil, including stem, stump, branches, bark, seeds and foliage.
2. Below Ground Biomass (BGB)
3. Dead wood,
4. Litter,
5. Soil organic matter

For this exercise the report considers the first two, i.e. AGB and BGB pools were considered. Some studies use AGB only to estimate carbon sequestration potential of community forests (Beyene *et al*., 2016).

Figure 10: Minzero Silassie green legacy plantation site (2013E.C) 3 years old stand

Carbon stock determination

Parameters needed to express above ground biomass (AGB) in carbon stock:

1. Diameter at breast height (DBH)-(measured from the field).
2. Tree height (H) (measured from the field).
3. Wood density factor (WD)
4. Carbon fraction (a carbon fraction of 0.5).

Assumption: IPCC (2006) values were used:

- Carbon (C) ≈ (0.50)*biomass (t/ha).
- To convert carbon in to CO2, the tons of carbon are multiplied by the ratio of the molecular weight of carbon dioxide to the atomic weight of carbon (44/12 = 3.667 tCO2).

The report adopted generic allometric equations to determine the carbon stock

$$AGB = 0.0673 * (WD * DBH^2 * H)^{0.976}$$

Where AGB=above ground biomass (in Kg dry matter),
WD refers to wood density (g/cm^3),
DBH refers to diameter at breast height (in cm), and
H is the total height of the tree (in m)

The average wood density is 0.612 g/cm3; where the minimum and maximum WD are 0.262 g/cm3 (Moringa spp.) and 1.04 g/cm3 (*Dodonaea agustifolia*), respectively.

The study used an IPCC (2006) default value to estimate the below ground biomass. The root-shoot ratio of 27% AGB is applied for Acacia-Commiphora, Combretum—Terminalia, and dry Afromontane forest. Similarly, root-shoot ratio of 24% AGB is applied for moist Afromontane and plantation trees.

The carbon calculator considers 8 activities. These are afforestation/reforestation, protection of existing forests, agroforestry, etc. In this exercise, we consider the main objective of the program which is afforestation/afforestation. The main type of species included in the calculation is assigned automatically based on IPCC value.

Emissions/removal estimate (forest)

Now we can compute the amount of emissions removed using the IPCC methodology. This method is used to calculate human-induced GHG emissions and removals in forest land:

A) Biomass (tons/ha): for each forest type.

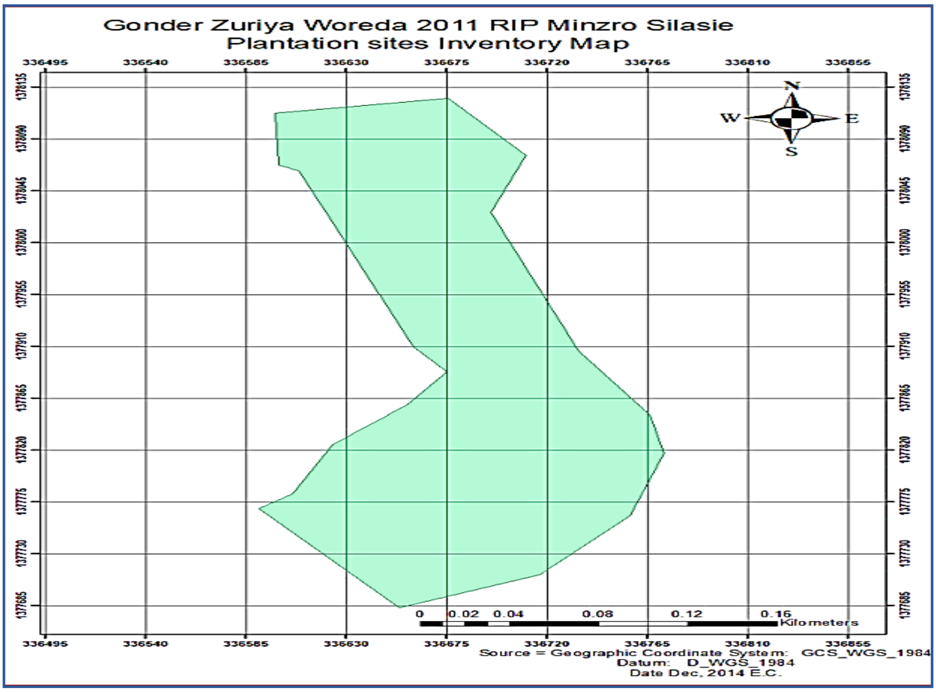
B) Carbon fraction: ~ 0.5

C) CO2 conversion coefficient: 44/12 =3.667

Therefore, the emission factors (EF) can be computed as follows:

$$\mathrm{EF(t\,CO_2/ha)} = \mathrm{Biomass(t/ha)} * 0.5 * 3.667\ \mathrm{tCO2}$$

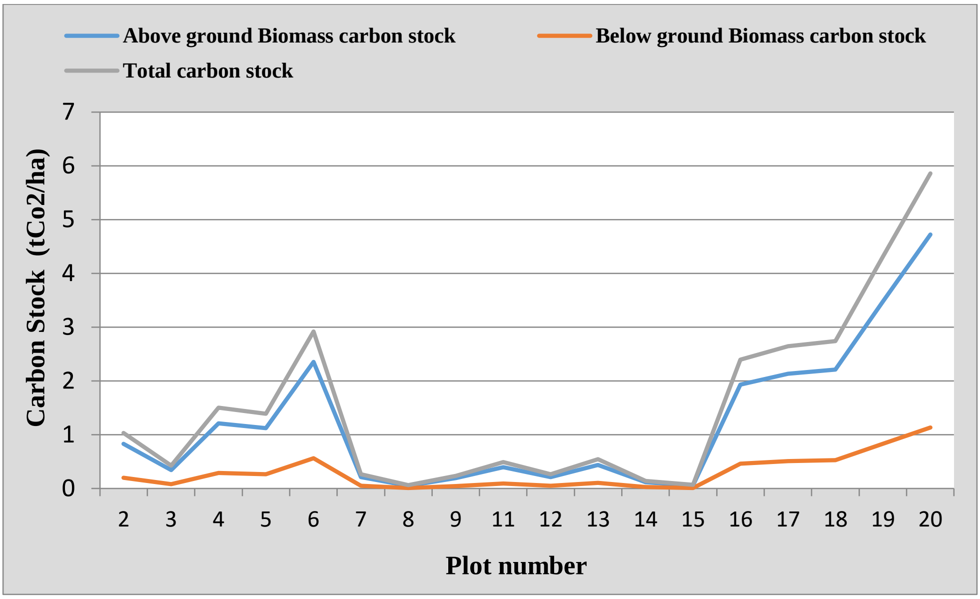
Figure 11: Gondar zuria woreda 2019 RIP Minzero Silassie plantation sites inventory map



Again the study considered the following summary of number of trees and total volume estimation (refer volume analysis sheet) to estimate the carbon content of the plantation site:

- Number of trees/ha=3800trees/ha
- Total number of trees/total plantation area=16,255 trees.
- Volume/ha=9.09m3/ha
- Total volume/total area=38.87m3.

Figure 12: Carbon stock of the GLI site in Gondar zuria



Summary of carbon analysis:

The total area of plantation site was around 4.2776 ha and the inventory data shows that the average ton of carbon per ha is 1.5 tons/ha.

Therefore, the study attempted to estimate the amount of carbon dioxide sequestered per year (tons CO_2e/year) as follows.

= (Area) X (carbon dioxide conversion coefficient of carbon fraction) X (average ton of carbon per ha)

= (4.2776ha)*(3.677)*(1.5 ton/ha) = 23.7849 tons CO2e/year sequestered/absorbed.

As a result, this is the amount of CO2 sequestered for the year 2022.

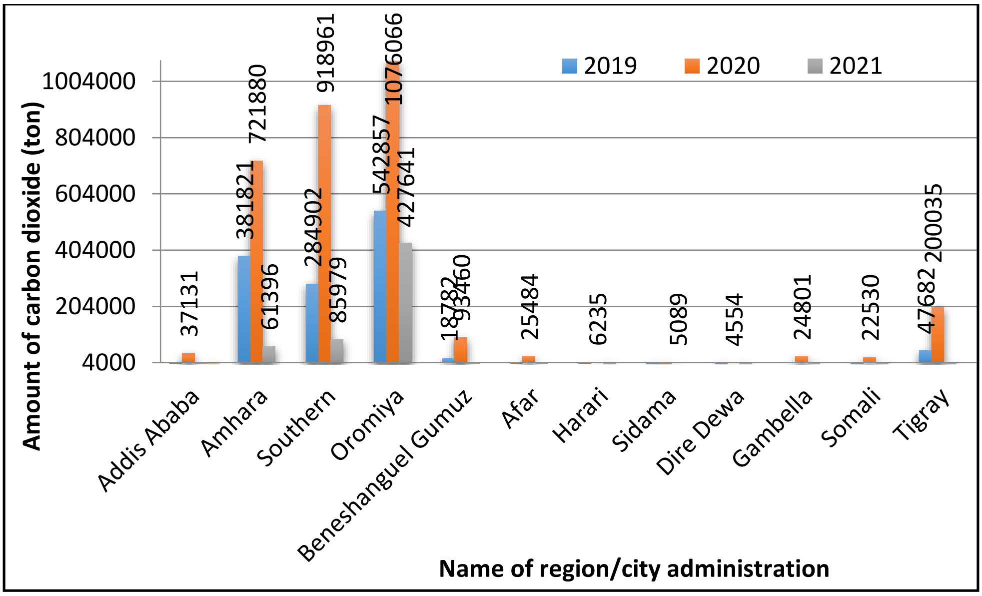
The report can also predict the carbon benefit for the next 7 years, when the plantation reaches age 10 (year 2029). Using the same methodology above, we find that the amount of carbon will reach 416 tons CO2e by 2029.

The plantation site has a higher survival rate, 98.6% in 2019 and 93% in 2020, compared to the regular survival rate in the region which is on average 75-80%. This is because of two reasons: First, though the site is planted by the green legacy program, it is one of the sites of REDD+ program of the woreda and the region as well. Second, because it is project based, post planting management activities like weeding and cultivation, mulching, watering (in dry seasons) and other necessary activities are implemented timely mainly due to availability of resources. As per our earlier discussion, the carbon benefit amount increases or decreases as we vary the effectiveness guide (which is expressed in %) which consists of the policy, institutional, management and monitoring, law enforcement and budget issues. It is obvious that project based plantation has a higher outcome but usually gets in trouble when the project period is phased out and transfer is made without proper communication to the community.

6.3.3. Carbon Sequestration Potential of GLI at the National and Regional Level

Assessment of the carbon sequestration role of the GLI was conducted using secondary data sources collected from the relevant government offices. This has been done for each region and for the country as a whole. For this exercise we consider only the area covered by trees (forestry). Areas reported to be covered by agroforestry or urban greenings were not considered in the estimation of carbon sequestration.

Figure 13: Amount of carbon dioxide sequestered (tons of CO2) by program year

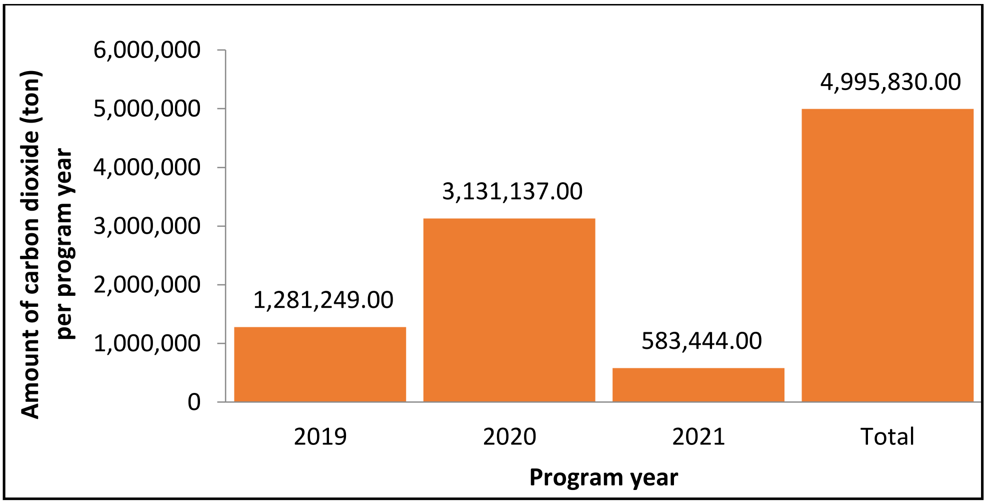


Source: Own computation based on GLI data

As shown in Figure 13, in 2019, the Oromia region has the highest amount of carbon sequestered followed by Amhara and SNNP regions. Similarly, in 2020 and 2021, Oromia region has the highest amount of carbon dioxide sequestered (tons of CO_2) followed by SNNP (including Sidama region) region and Amhara region. We also measured the amount of carbon sequestrated in two administrative cities (Addis Ababa and Dire Dawa). Despite the limited literature, urban green area has received due attention these days as they have great potential to sequester carbon from the atmosphere and hence contribute to mitigate the impacts of climate change in cities (Sharma *et al*., 2021). Therefore, this study also contributed to the limited literature on the link between urban trees and carbon sequestration.

Given the high number of seedlings planted, around 18 billion seedlings within three years, it will certainly contribute to the green growth objective and SDG goals of the country provided that the program is properly planned and managed.

Figure 14. National level amount of carbon dioxide sequestered (tons of CO2) by program year



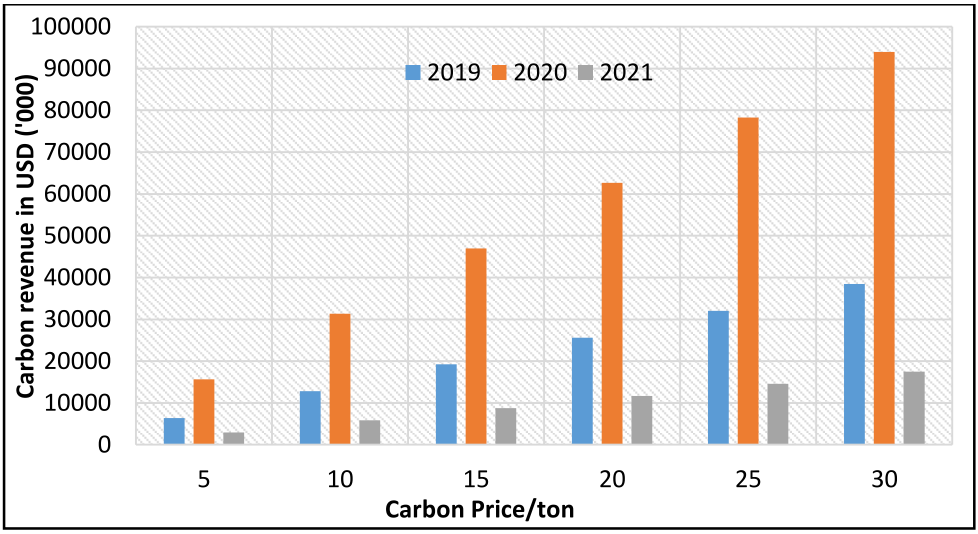
Source: Own computation based on GLI data

Note: Tigray was not included in the year 2021. There was no tree planting activities because of the conflict in the region.

As shown in Figure 13, the year 2020 has the highest carbon sequestered. This is mainly due to the relatively large area covered by trees during the year 2020 GLI campaign. The carbon sequestration potential per year and cumulative carbon sequestration both for the plantation site in Amhara region and national level estimation for the projection period (2022-2051) are found in Appendix B. It has to be noted, however, that the results are rough estimation and sensitive to the assumptions and consequently affects the projected emissions and mitigation potential of the trees planted under the GLI program.

The monetary benefits of these initiatives can be computed using price per ton of carbon sequestered. Carbon pricing can be implemented through emissions trading systems. The price of carbon per ton of CO2 sequestered depends on demand and supply. Figure 15 shows the revenue that can be derived for the year 2022 assuming that there is a market for carbon sequestered as a result of GLI.

Figure 15. Monetary benefit of GLI by program year



With the price on carbon rising to $30/ton, the country can derive a significant amount of revenue per year from such initiative. However, this exercise is too ambitious as it is based on the available information on the survival rate (i.e. government data) and assuming that all the necessary post planting management activities are undertaken by all relevant stakeholders.

Socioeconomic Benefits of Forests

6.3.4. Types and Sources of Forest Products

Millions of people in Ethiopia depend on forests for their livelihood. Forests provide food, fuel wood, medicinal plants, coffee, spices etc. People depend on these forest products for subsistence or cash generation. Table 14 presents the type of forest product collected by sampled households.

Table 13: Type of forest product

Type of forest product	Freq.	Percent	Cum.
Firewood	142	45.22	45.22
Poles	7	2.23	47.45
Craft materials	16	5.10	52.55
Tree leaves	41	13.06	65.61
Tree bark	5	1.59	67.20
Tree Roots	5	1.59	68.79
Logs	17	5.41	74.20
Grasses	48	15.29	89.49
Fodder	31	9.87	99.36
Others (Bamboo and medicinal plants)	2	0.64	100.00
Total	314	100.00	

Source, own computation, 2021

The survey result shows that most households collect fire wood from the forest (45%) followed by grasses and tree leaves. Other products reported by households include fodder, craft materials, poles, tree roots, etc. Households obtained these products from various sources. The most important source is private trees. Community forests are also important source of forest products and then followed by state or open access forests. People also purchase some of the forest products such as firewood and fodder from the market.

Table 14: Sources of forest product

Source	Freq.	Percent	Cum.
Private	211	67.20	67.20
Community forest	59	18.79	85.99
State forest/open access	20	6.37	92.36
Others property	8	2.55	94.90
Purchased from market	16	5.10	100.00
Total	314	100.00	

6.3.5. Value of Wood and Non-wood Products

As stated time and again, people depend on forests for food, medicinal values, source of fodder, etc. On average, the annual value of forest products collected by the sample households is ETB 2251. This average value becomes ETB 4866 when we exclude those households who reported that they do not collect any forest products. Table 16 shows the average annual value of each type of forest product by sources of forest products.

Table 15: Mean values of total value (in ETB) of forest products used

Type of forest product	Source			
	Private	**Community forest**	**Others property**	**Purchased from market**
Firewood	3150.837	3559.13	1325	3073.571
Poles	189	700		150
Craft materials	2315.385		1605	4500
Tree leaves	1365.135			
Tree bark	1000	350		
Logs	1838.824			
Grasses	3062.5	502.381	100	
Fodder	3646.154	499.5	200	944.286
TOTAL	16568	5611	3230	8668

Note: Forest products and services which are not tradable are not considered. Valuation of these products requires a different approach (e.g. Cavendish, 2000). In fact these types of products were not reported by sampled households.

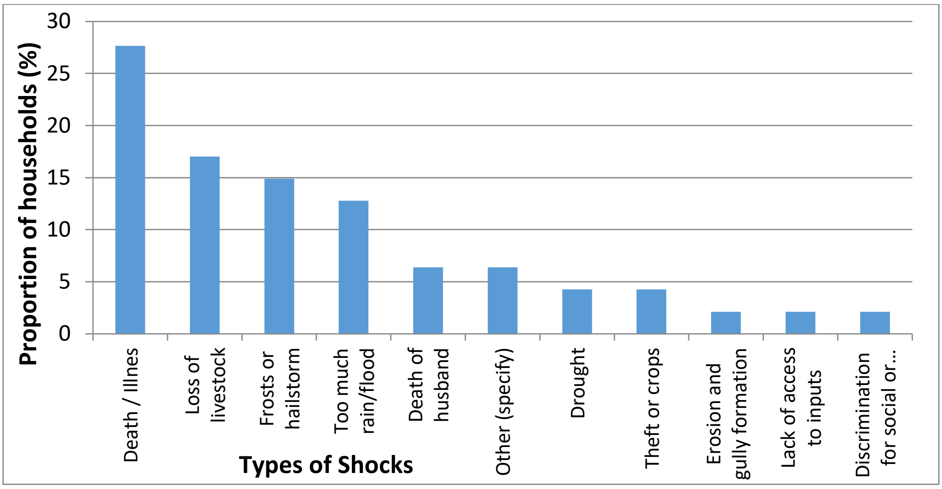
Forests are also important source of cash income for rural households. For example, Tesfaye *et al*. (2010) find that 50% of the households in their study sites in Ethiopia have reported earning more than half of their cash income from forest products. Forest cash income also helps avoid financial problems of households such as paying for purchase of agricultural inputs and other social contributions.

6.3.6. Importance of Non-cash Forest Benefits

Available evidence in Africa show that forests act as a safety net for the poor in rural Malawi. Forest resources fill the gaps in times of crises by providing food, and a source of cash for coping with weather-related crop failure (Fisher *et al*., 2010).

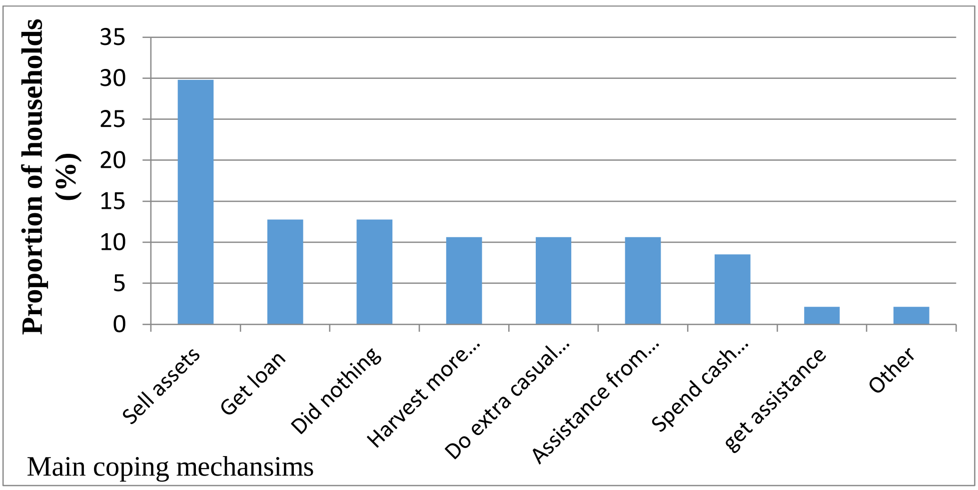
Households in our study areas face various types of shocks. The figure below shows the main types of shocks faced by households.

Figure 16: Main types of shocks



This research report shows that households mainly depend on other coping mechanisms than forest products. Some studies in Ethiopia (e.g. Beyene *et al.*, 2022) show that households may depend more on other coping mechanisms than forests in times of crises. In our survey we find that households cope with the main type of shocks by selling assets such as livestock followed by loan from money lenders or credit associations, look for assistance from friends or relatives, etc.

Figure 17: Main coping mechanisms



Women and children are the most affected when there is resource degradation. Empirical evidence in Ethiopia show that forests reduce the gaps in gender inequality and protect minority groups (Gobeze *et al*., 2009). The available evidence further shows that forests help reduce income inequality (Mendako *et al*., 2022; Gatisso and Wossen, 2015; Tesfaye *et al*., 2010) suggesting that efforts to restore the degraded lands would help contribute to the government's effort to achieve the social objective of reducing income disparities among its citizens.

6.3.7. Other Social Benefits

It is argued that forests also provide social services such as cultural or spiritual services, tourism, and recreation areas. In this study we have not accounted for these benefits of forests. Quantifying such kind of services of forests is difficult and requires the application of environmental valuation techniques.

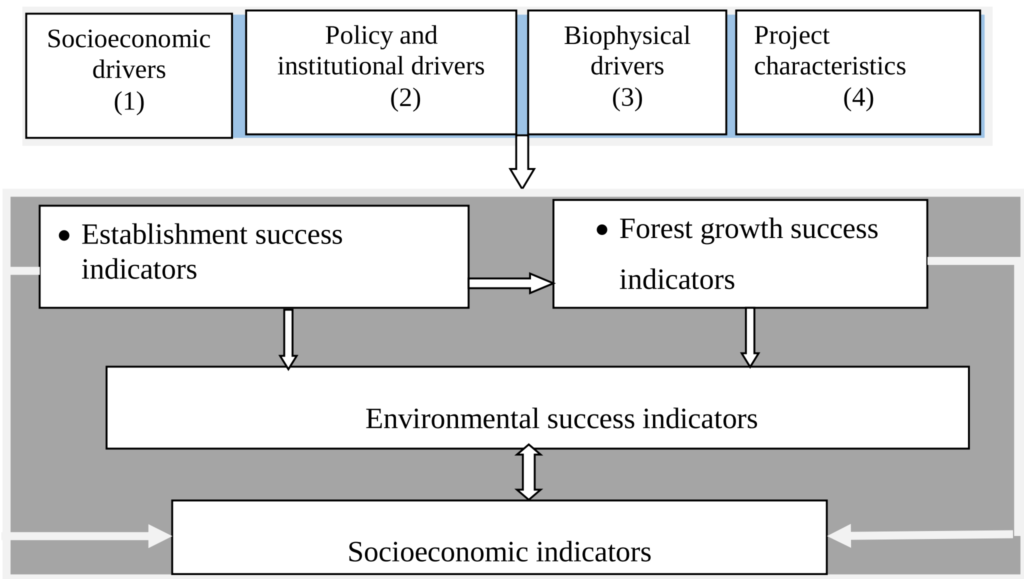
7. IMPLEMENTATION CHALLENGES OF GLI

There are various types of constraints or barriers that influence the success of reforestation or afforestation projects such as the GLI. Following Le *et al*. (2014), we broadly categorized the drivers for these challenges in to four: biophysical, socio-economic, policy and institutional, and characteristics of the project itself (please see Figure 15). While Figure 15 shows a simple relationship, there are complex relationships among the various factors and this should be taken into account while trying to understand the full picture of the driving factors behind the success or failure of reforestation programs.

7.1. Conceptual Framework

Here the study adopts the conceptual framework developed by Le *et al*. (2012), though the model is appropriate for reforestation projects reaching at its maturity stage. That is, at this stage it provides several benefits in terms of livelihood and environmental benefits such as carbon sequestration. However, one of the indicators for measuring success, which is appropriate for this study, is known as establishment success indicators.

Figure 18: Conceptual framework for assessing reforestation success (adapted from Le et al., 2012)



According to Le *et al*. (2012), the following are the list of potential drivers under each category:-

(1) includes livelihood planning, local participation and involvement, socio-economic incentives, financial and economic viability payments for environmental services (PES) scheme, social equity, corruption, degree of dependency on traditional forest products, marketing prospects, knowledge of markets for timber and other forest products and services, addressing underlying causes of forest loss and degradation.

(2) includes institutional arrangements, effective governance, forest harvesting policies and other forest policies, tenure security, conflict resolution mechanism, distribution of rights and responsibilities amongst stakeholders, long-term management planning, long-term maintenance and protection of reforested sites, forestry support programs, community leadership, and risk involved.

(3) includes site-species matching, tree species selection, site preparation, seedling production, quality of seeds or seedlings, appropriate time of planting, technical capacity of implementers, post-establishment silviculture, and site quality.

(4) includes activities such as project goals/objectives, project implementers, project location or accessibility of sites, project size, project funding, project life cycle, and private vs public land.

Based on the above conceptual framework and using the information obtained from KII and FGD we assessed how the various factors such as technical or biophysical factors, socioeconomic factors, policy and institutional factors and project characteristics itself affect the success of the afforestation and reforestation projects both in the short and long-term.

7.2. Policy and Institutional Factors

i) Land use policy and land use plan

This has been an agenda for the country as a whole, not only for the tree planting purpose but for other land uses as well. Lack of land use policy has been frequently mentioned as the main causes of natural resource depletion such as deforestation and expansion of settlements to protected areas such as national parks. In the GLI implementation, the main problem is the purpose of the sites selected for tree planting is not clearly defined. That is, absence of land use policy and land use plan, whether it is for afforestation/reforestation or communal grazing land, or agricultural land or residential areas, etc is one of the main challenges for Ethiopia. It makes it difficult to apply its policies, strategies and the international conventions. This is crucial for the sustainability of the afforestation/reforestation activities. We are aware that the government recognizes the problem caused as a result of absence of land use policy and land use planning and there is an ongoing effort to design the national land use policy and an integrated land use planning which is an encouraging effort. Hence there should be coordination between various stakeholders to finalize and implement the policy.

ii) Tenure security

This is critical as it affects the sustainability of the project. When the land tenure is not clear then there will be conflicts among the various actors over access rights and hence results in unsustainable use of resources (Le *et al*., 2014). In some areas, planting of seedlings was done in areas where the property right is not clear. The literature indicates that tenure security is crucial to reduce forest degradation and deforestation. Based on a review of over 100 empirical cases of forest outcomes under specific land tenure conditions, Robinson *et al*. (2011) find that land tenure security is associated with less deforestation, regardless of the form of tenure. In this regard, the form of tenure security is also important and need to have an arrangement whereby the community's participation is important.

The current practice of participatory forest management (PFM) can be scaled up to forest where there is weak type of property right. Tree planting on degraded communal lands, which are owned by the state, has low survival rate as the local communities' participation in maintenance is low and free grazing is not controlled (Amare *et al*., 2017b). Though the burden of planting and long-term maintenance falls on local government authorities and communities, these actors have little say on what to plant and where, how to manage the land and how to use it (Lemenih and Kassa, 2014). In general, clear land tenure help achieve the sustainable management and use of rehabilitated forests and avoid conflicts over access rights, unsustainable use and further degradation of the resource (Le *et al*., 2014).

iii) Lack of security and political instability

The ongoing conflict in the various parts of the country affects the implementation of the GLI activities. This is particularly the case in some parts of Oromia region such as Borena and Western Wollega and northern part of the country. For example, the number of seedlings planted in Tigray region is very low in 2019 and almost nil thereafter. Similarly, the performance of Amhara region in 2021 was affected by the conflict. The conflict has also contributed to forest degradation and deforestation.

iv) Challenges related to forest development implementation guidelines

A detail guideline that aims to assist us on how to plant, prepare and execute tree planting is necessary. The guideline should also provide step-by-step procedures on how to plan, plant and conduct post planting cares for the success of trees. However, the GLI started without a clear guideline for tree planting. This should be prepared by the relevant experts and distribute it to all those who are involved in the GLI implementation starting from federal to local level. The Ethiopia Forest Development (EFD) (former EFCCC) should be responsible for leading the preparation of the guideline which includes seedling preparation to post planting activities.

v) Poor institutional arrangement

In fact the discussion above (IV) is part of the institutional arrangement that should be considered in the implementation of the GLI. In addition, local level institutions, the norms and values that dictate the use of forests and forest resources are also part of the institutional arrangement. It is necessary to also exploit this local level institutional arrangement if the GLI is to be successful. In sum, strong and appropriate institutional support is critical for promoting investment and community participation as this will ensure the sustainability of the project (Le *et al*., 2014). We need to have a formalized institutional arrangement where there is a clear division of tasks, rights and responsibilities, among multiple stakeholders (Nawir *et al*., 2007).

In the last three GLI practices, we observe that there is a weak coordination among the relevant stakeholders mainly between the federal level institutions such as EFCCC, MoA and WoWIE. One of the main reasons is lack of clear responsibilities among the various government institutions. The same problem occurs at the regional and district level. Lack of clear responsibility of the institutions both at the federal and regional levels creates such problem.

It is argued that the Ministry of Agriculture has a well-developed organizational structure up to the Woreda level and relatively huge capacity. Hence the regional MoA may lead the implementation of the GLI but it should be in coordination and consultation with the regional forestry agencies.

7.3. Socioeconomic Drivers

i) Lack of sufficient budget

Mobilizing sufficient budget for the various activities related to tree planting is necessary and should be ready before the actual tree planting campaign starts. This is in fact supported by household level analysis though not representative at the national level. Proper mechanism should be put in place to make sure that the allocated budget is properly utilized for the intended purpose.

ii) Poor provision of nursery equipment and materials

All the necessary materials and equipment should be ready before tree planting time. In addition to tools and equipment, other inputs such as germplasm,[14] seedling containers, water, soil, fertilizers, nursery facilities, and labor should be available in a timely manner.

iii) Inadequate provision of transport

This has been one of the barriers for people to participate in the GLI programs. It is partly due to lack of sufficient budget allocated for this. The other related problem is weak coordination of the responsible institutions. This has to be planned ahead in order to mobilize as many people as possible.

iv) Lack of appropriate incentive mechanisms

Unless direct economic or indirect incentives (including any environmental and social services resulting from the reforestation programs) are provided to the local communities, their involvement is not likely to be sustained, and consequently the viability of afforestation/reforestation programs will be reduced (Le *et al*., 2012). Ownership of forests by the state and its weak institutional capacity for law enforcement become a challenge for local people to participate in the tree planting and management of plantations and often lead to forest degradation and deforestation (Mekonnen and Bluffstone, 2015). It is also unclear who will benefit from restoration, and for how long these benefits can be enjoyed (Boissiere *et al*., 2021).

Moreover, the specific socioeconomic condition of the local community has to be considered during the initial stage of the tree planting time. For example, the efforts to restore the degraded lands and enhance the forest cover through the GLI

[14] Genetic material (seeds, seedlings, wildings, or vegetative material) used for the purpose of plant propagation and/or conservation

should be accompanied by strategies for income generating activities for the local communities, and need to design an incentive package for people who are responsible for maintaining forests and plantations. This require preparation of clear guidelines which state on how this can be made effective and implemented (EFCCC, 2020).

v) Issues related to awareness about the initiative

While this is not a major problem in the implementation effort of the GLI, there should be a continuous effort to enhance the awareness of the local people regarding the various benefits of trees and forests. Information collected from both KII and FGD tells us that people are aware of the GLI. However, awareness creation should not be a onetime effort during the GLI implementation time, but it should be a continuous effort throughout the year and should be conducted in a more organized manner. It has to identify where the gaps are and make sure that people are fully aware of the GLI and be responsible for the project until it reaches its maturity, be it conservation purpose or production.

vi) Lack of markets

Lack of markets for some of the forest products and services may have a direct or indirect effect on the implementation of GLI. It is good to create the markets for some of the forest products so that the local community can be compensated for their effort to protect the forest. In particular, the carbon market has never delivered its promise to buy sufficient amount of carbon. It is argued that good market prospects will lead to good production outcomes for such kind of projects, and provide incentives for local people participating in the project (Le *et al.*, 2012). As shown in the estimation results for the determinants of number of seedlings planted (Table 8), access to markets for forest products is important for farmer to plant more trees on private land (Scherr, 1995; Mercer and Pattanayak, 2003).

vii) COVID-19 pandemic

COVID-19 pandemic has been a global challenge and affects various sectors of the economy in both developed and developing countries. While there are several studies on the impact of COVID-19 on food security, productivity, labor supply, etc, its role in the forest sector in general and afforestation and reforestation efforts in particular has not been discussed yet. In our study, we find that COVID-19 did not affect the tree planting activities in the last three GLI years. This was mainly due to the precautionary measures taken by all involved stakeholders.

7.4. Project Characteristics

i) Purpose of tree planting

The goal of the GLI, whether it is for conservation or production purpose, affects its success (Le et al., 2012). This is considered to be one of the main problems of the GLI. Our discussions with key informants and experts show that the trees/shrubs/herbs seedlings are not planted based on purpose. Therefore, there is a need to identify whether the planting of trees in a particular site is for conservation or production or ornamental or fodder, or food or other purpose. It is argued that the project needs to combine other objectives of the tree planting such as climate change mitigation, species conservation, water conservation, etc and achieve both conservation and development objectives (Le *et al.,* 2012). In communities where livestock production is the main means of livelihood, it may be good to select trees which can also serve as feed for livestock or fodder purpose. In the southern part of the country where agroforestry practice is very common, the type of trees species or purpose of tree planting should take in to consideration this specific farming system in addition to other environmental benefits. This has to be consulted and communicated to all stakeholders including the local people in a clear and transparent manner.

ii) Project implementers

This is obviously related to the organizations which are responsible for the implementation of the GLI. As already discussed before, the main implementer both at the federal and regional level should be the MOA as it has structure up to the district level. But it is crucial to have good coordination and relationships with other relevant stakeholders such as EFP (former EFCCC), MoWIE, and other government institutions both at the federal and regional level. The cooperation should also be with development partners which are participating directly or indirectly in the tree planting programs.

iii) Inaccessibility of some planting sites

Accessibility is a significant factor for the success of the program. It is one of the problems that hinder people’s participation in tree planting. In addition, the distance matters for the continuous follow up and monitoring of the sites. For example, it is easier for the local communities to mobilize and conduct post planting activities if it is within the reach of the community. So there is a need to consider accessibility when planning for tree planting campaigns like GLI.

iv) *Involvement of all relevant stakeholders*

All relevant stakeholders should be involved from the preparation to the planting and then to post planting activities. For example, lack of involvement of the local organizations, local community, and other stakeholders from the federal to the local level may affect the implementation of the GLI.

Despite the level of involvement of the local community, all forests in Ethiopia are owned by the government. But the capacity of forestry institutions at federal and regional levels is very weak, so de facto management (or lack thereof) often falls to communities (Beyene *et al*., 2016). That is why community management of forests such as participatory forest management (PFM) has received significant attention as a way out of the problems and challenges of the forestry sector. Therefore, afforestation and reforestation activities under the GLI program should also consider how it will be managed in collaboration with the local community in a sustainable manner. In fact, the involvement of local communities, which are users of the forest, should start from the design stage and continue to involve at all stages of development of the forest (Yami and Mekuria, 2022).

v) *Monitoring and follow up*

Unless planting of seedlings is followed by proper monitoring and follow up, it is difficult to achieve the objectives of the GLI. Follow up care requires a regular monitoring and follow up of the planting sites and necessary corrective measures should be taken early. Post planting activities such as beating up, mulching, and others activities would improve the growth of trees and hence survival rate. The main causes of failure for such kind of initiatives are uncontrolled grazing, fires, competition from weeds, and uncontrolled cutting for fuel, fodder, poles and lumber (Le et al., 2014). Therefore, a continuous effort to manage and protect the areas already covered by trees is crucial in maintaining these trees in the long term derive its benefit in a sustainable way (Chokkalingam *et al*., 2006).

7.5. Bio-physical Factors

i) *Site selection for tree planting*

One of the main implementation challenges in the success of GLI is selection of appropriate planting sites. It is clear that there is spatial heterogeneity in terms of physical and ecological characteristics. Based on the key informant discussions, we find that there were matching problems between the purposes of tree planting with appropriate sites selection. Most planting activities were held on public space like streets sides, public gathering places, etc.

Also, the physical conditions of the planting sites (discussed below) such as availability of water, soil depth, soil fertility status was not mostly considered. The suitability of climatic condition of the sites in terms of rainfall and temperature need to be considered when selecting the sites. Biological factors such as the existing flora species were not considered. Hence identifying the sites with more or less homogeneous units which can respond to different constraints and stressors will enhance the tree survival rate (Stanturf *et al*., 2019).

ii) Poor soil depth

The depth of the soil is important for the success of tree planting. Trees planted too deep or too shallow shorten the tree's life expectancy. However, in most places this has not been properly implemented and affects the success of tree planting. Therefore, it is good to pay attention to the soil type at the planting site as this will impact species selection.

iii) *Soil moisture content*

The role of soil moisture in both tree growth and survival is well understood. The findings from this study witness that people do not generally take in to account soil moisture in tree planting, which is the most important factor for tree growth. For example, Mahari (2014) finds that drought and moisture stress is one of the major factors that affect the survival of tree seedlings in the dry lands of Northern Ethiopia.

iv) Unavailability of sufficient number of seedlings

This is part of the coordination problem. Sometimes people went to the planting sites but get disappointed due to insufficient number of seedlings to plant. That is, there is a mismatch between number of seedlings and the number of people mobilized. Poor planning and coordination results such kind of problems. This will have impact on the next tree planting campaign as well as overall performance of the GLI.

v) Quality of seedlings

Quality seedlings have a higher survival rate and faster growth. Fast growth trees out compete weeds and reduce labor cost of establishment. However, when programs such as the GLI are done at larger scale, it becomes difficult to ensure that appropriate type of seedlings are planted in the soil composition, altitude and weather conditions suitable for them (Addis Fortune, 2020).

vi) Tree species types

The survival of the seedlings depends on the type of species planted in the area. Different species have different responses to the different stresses they face. It is claimed that most of the seedlings planted in the GLI are from indigenous tree species. However, we learned that the right types of species were not planted in the right site in some cases. Any reforestation effort can be successful if the tree species meet the demand for the local community and considers the specific site conditions as well (Günter *et al.,* 2009). Therefore, the right trees must be selected carefully in order to ensure their survival and hence the success of the tree planting campaign.

vii) Planting time

Poor planting time is considered to be one of the main problems for tree survival and growth. The main problem is that the starting date of the program was determined at the national level but this did not take in to account each region's unique features. So there is a need to follow the rainfall pattern and characteristics of the region and conduct the tree planting activities accordingly.

To conclude, there are several factors that affect the success of the tree planting programs such as the massive afforestation and reforestation programs of the GLI. These factors interact and cannot be considered in isolation from each other. Therefore, understanding the complex interactions among these factors and their influence on afforestation and reforestation success is crucial if we want to achieve the goals of the GLI.

8. CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH DIRECTIONS

8.1. Conclusions

Ethiopia is a country with severe environmental degradation problem. Though several direct and indirect drivers of deforestation and forest degradation have been identified, there has not been significant progress in reversing the situation. Mass tree planting program called the Green Legacy Initiative (GLI) was launched by the Prime Minister of Ethiopia in 2019 with the objective of reducing the impact of climate change and to improve contribution of forests to the green growth path of the country.

The performance of the GLI over the last three tree planting periods was well beyond the target. More than 15 billion seedlings have been planted during the last three tree planting campaigns. The survival rate of seedlings planted is higher. However, the survival rate and hence performance of GLI may not be as high as what is reported by the government because post planting activities have not received as much attention as the planting phase. To maintain this performance, continuous maintenance and protection through post planting activities are necessary.

There are regional variations in the performance of GLI implementation. Those regions with relatively better resources and expertise as well as suitable agro-climatic zone to raise and plant seedlings perform better than other regions. Political instability and the conflict that happened in the different parts of the country have affected the performance of some of the regions in the country. The situation in these regions makes it difficult to mobilize the local people and facilitate the overall coordination of the tree planting programs.

The GLI is successful in terms of engaging different groups of the society both at the national and regional level. The various groups of the society such as the youth and elderly, male and women, literate and illiterate, etc are all involved in the tree planting campaign. While this is an encouraging step, continuous involvement of the various groups of the society in post planting activities is necessary.

This study suggests that an incentive mechanism should be developed to maintain the success of the GLI. For example, it is vital to provide seedling to farmers so that they can plant it on their plot. In other words, the government should encourage farmers to plant and own more number of trees and bushes in order to reduce the pressure on forests. In addition, creating opportunities such as non-farm activities may reduce pressure on forests. In short, different incentive mechanisms should be developed taking in to consideration the specific socioeconomic and livelihood condition of the community.

The mass tree planting campaign should continue in the future by involving local communities. Interestingly the local communities expressed their interest to participate in the future tree planting programs. The results of the CVM exercise indicate that the mean annual WTP per household is ETB 255, which suggests that rural households place a fair amount of money to keep the GLI program for the next five years. This suggests that it is good to consider those households in the community that are more likely to support the tree planting program.

The success of the GLI can contribute to the fulfillments of the green growth initiatives of the country. One of the main contributions of this study is that it shows the carbon sequestration potential of the GLI both at the national and regional levels. Given the high number of seedlings planted, around 15 billion seedlings within three years; it will certainly contribute to the green growth objective and SDG goals. The country can also generate a significant amount of revenue from carbon trading. The use of money from carbon trading should involve the local community as they are the most important actors for the success of the initiative.

As already discussed, there are several challenges during the last GLI period. The various factors such as policy and institutional factors, technical or biophysical factors, socioeconomic factors, and project characteristics influence the success of the afforestation and reforestation projects both in short and long-term. To maximize the benefits from GLI, these challenges should be addressed in collaboration with the local community and other relevant stakeholders.

One of the gaps in the implementation of GLI is that the role of public infrastructures such as sport facilities, schools, public libraries, and other institutions including associations do not involve in all stages of the implementation of the GLI. It is necessary to provide them with special responsibilities to plant, manage and maintain the trees. Finally, the GLI will have tremendous contribution to the economic, social and environmental goals of the country if the initiative is institutionalized. The steps to institutionalize the GLI may start by reviewing the experiences of other similar programs in the past such as sustainable land management (SLM), the REDD+ Investment Programme and some other land rehabilitation programmes (Fkreyesus *et al*., 2021).

8.2. Recommendations

This study has several policy implications. Proper implementation of the following recommendations both in the short- and long-run may enable the country to achieve the objectives set in its various environmental and developments goals. One of the main challenges in the country is the problem caused as of absence of land use policy and planning. The draft land use policy should be finalized as it will allow the country to implement its national policies and strategies and achieve its commitment to the international community.

Similarly, though there are various policies and strategies, there are still gaps in preparing clear guidelines on how the GLI could be implemented. The detail guideline should state how the trees planted under the GLI should be managed, maintained and utilized. In addition, its relationship with the local communities should be clearly stated.

For the success of the GLI, there should be clear duties and responsibilities among the main implementing institutions (i.e., EFCCC, MoA, and MoWIE). In addition, collaboration between local government representatives and stakeholders is vital to ensure that the GLI produce lasting benefits for local communities achieving the country's economic and environmental objectives. All relevant stakeholders should be involved throughout all stages of the project implementation.

The most important part of the GLI initiative is not only to plant as many seedlings as possible. It is necessary to consider the technical or bio-physical factors such as selection of appropriate planting sites. There should be proper planning regarding the purpose of tree planting and need to make sure that there is match between the purpose of trees to be planted and the sites selected for planting. Other biophysical factors that should be considered during the tree planting phase are nature of soil depth, moisture content, type of tree species, and quality of seedlings. The timing of tree planting should also coincide with the specific characteristics of the sites.

It is equally important to properly conduct post-planting activities. The extent of post-planting activities determines the survival rate. Therefore, considerable attention should be given to perform activities such as watering, weeding, and other necessary maintenances. This should also be complemented by protecting the seedlings from free grazing. This is one of the most serious problems in both private trees planting as well as afforestation/reforestation activities undertaken in communal lands.

The success of the GLI depends on to what extent we manage the local community to participate in the process. More work need to be done to enhance the ownership, for example, in the form of participatory forest management (PFM). In addition, there is a need to consider the specific socioeconomic condition of the local community during the initial stage of the tree planting program. This includes, among other activities, creation of income generating activities, providing seedlings of appropriate tree species for private tree planting, etc. In trying to enhance private tree planting, measures that could help reduce households concern about further land redistribution should be considered as it will help them enhance their confidence on long term investment decisions such as tree planting on their plots. As already discussed, this requires preparation of clear guidelines, which state on how this can be made effective and implemented.

The current efforts of the government to involve various government and non-governmental organizations, public institutions such as schools should be strengthening further. Their participation should not be limited to planting seasons only but also requires continuous and active involvement in post-planting activities. Public infrastructure (e.g. city/town sport offices, schools, public libraries) can be provided special responsibilities to plant, manage and maintain the trees. Other similar institutions such as sport fan associations, youth and women's associations, trade unions, professional associations, producers' and consumers' associations, etc can be involved in the tree planting program.

It is clear that the tree planting program offers low cost carbon removal opportunities for the country. There are two important things that need to be considered soon. First, the government should look for buyers for its efforts to reduce carbon emissions through the GLI. Second, there should be a clear rules and guidelines on the benefit sharing mechanisms. This policy of sharing the associated benefits to be obtained from carbon finance could play a greater role in the efforts to mitigate climate change and enhance other roles of forests and tress.

In general, all these activities should be properly planned and implemented by the relevant government organization starting from the federal to the district level. In order to enhance the involvement of various stakeholders including the local community and ensure the sustainability of the initiative, the country should set up a formalized institutional arrangement, which has a clear roles, rights and responsibilities.

8.3. Future Research Issues

As a global cause, the implementation of the GLI I is an opportunity for Ethiopia to get the support of the international community. The current study was conducted in selected sites in selected regions and cannot be considered as representative of the country. A comprehensive survey covering each region would provide better picture on the green legacy initiative in the country. That means, additional estimations based on remote sensing data combined with ground truth need to be undertaken covering the GLI sites in the country. Second, further analysis on the tree planting behaviors of farm households using a nationally representative data would help to derive appropriate intervention mechanisms. Third, there is a need to establish detail data regarding the activities of the GLI such as number and type of trees planted in each site, type of trees/species, number of people participated, participation rate by socioeconomic groups, estimated contribution (both in cash and in kind) by the local community, etc supported by satellite based information. Monitoring and evaluation requires detail data on the GLI so that it will be easy to assess the progress in terms of use of resources, track performances, identify the problems or bottlenecks in implementation of the initiative, and make necessary corrections.

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