



**Land Use Land Cover Change Detections under the Green Legacy
Initiatives in Gera District, South western Ethiopia**

MSc THESIS

BY

ABDULAZIZ JEMAL

JUNE 2024

JIMMA, ETHIOPIA

**Land Use Land Cover Change Detections under the Green Legacy
Initiatives in Gera District, South western Ethiopia**

MSc. Thesis

*Submitted to Jimma University, College of Agriculture and Veterinary
Medicine, Department of Natural Resource Management in Partial
Fulfilment of the Requirements for the Degree of Master of Science in (NRM)
Specialization in Watershed Management*

By

Abdulaziz Jemal Dawud

Major Advisor: Gebeyanesh Worku (PhD, Asst. Prof.)

Co-Advisor: Dr. Ing. Wakjira Takala (Asst.Prof.)

JUNE, 2024.

JIMMA, ETHIOPIA

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholar matter that is included in the Thesis has been given recognition through citation. This Thesis is submitted in partial fulfilment of the requirement for MSc Degree at the Jimma University. It is deposited in the Jimma University Library and is made available to borrowers under the rule of the library. I solemnly declare that it has not been submitted to any other institutions anywhere for the award of any academic degree, diploma or certificate. Brief quotation from this Thesis may be made without special permission provided that accurate and complete acknowledgement of the source is made. Request for permission for extended quotation from or reproduction of this Thesis in whole or in part may be granted by the head of the school or department when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Abdulaziz Jemal

Place: Jimma University

Date of Submission: _____

Signature: _____

BIOGRAPHICAL SKETCH

The author was born on September 22/1986 G.C at Wanja Kersa kebele in Gera district, Jimma Zone of Oromia National Regional State, Ethiopia. He attended primary education at Yukro Primary School from 1994 to 1999 and joined Gera Primary School for Grade 7-8th from 2000-2001 and joined Agaro secondary School from 2002 to 2003. After successfully passed the Ethiopian Higher Education Examination, he joined Alage Technical, Vocational and Training College in 2004 and graduated with a Diploma in Natural Resources Management in July 2006. Soon after graduation, he was employed in Gera Agricultural and Rural Development Office and serving as Development Agent (DA). He joined Jimma University Agricultural and Veterinary Medicine in September 2009 for Upgrade and he graduated BSc in Natural Resources Management in June 2011. After graduated his BSc Degree he join Development Agent (DA) from 2011 up to 2013 then after he join as Supervisor of Development Agent (DA) from 2014 to 2015 then after he serve as agriculture expert at Gera District Agricultural Office from 2015 up to 2016. From January 2017 up to October 2019 he serve as Vice Head of Gera District Agricultural office and then after he serve as Head of Gera District Agricultural office from November 2019 up to November 2022 and He comes back to JUCAVM on December 2022 to follow his MSc Studies in natural resource management specialization on watershed management. Then from September 2022 up to March 2024 he serve as Head of Jimma City Agricultural office and then starting from April 2024 up to now he serve as Head of Jimma City Mineral Development office.

ACKNOWLEDGEMENTS

First of all, I would like to thank the Almighty Allah for giving me health and strength to start and complete my study. I am highly indebted to my heartfelt sense of gratitude and gratefulness to my major advisor, Dr. Gebeyanesh Worku for her immense encouragement; full guidance and valuable advice that enable me to do this research result in the right track. I would also like to express thanks to my co-advisor Dr. Ing. Wakjira Takala for his continuous valuable advice and encouragement to clear out my doubts during the whole process of this thesis work.

I would like to extend my acknowledgement to Mohammed Semman, Ali Mohammed, Umar A/Fita, Mohammedraha A/Jihad, for their support during starting up to finishing time.

I also like to express my appreciation to Ganji Chala, Sadi Loyya and Wogecha Kebeles household and administrative for their endless cooperation and participation during data collection. I would like to thank Tegang Tiki, Gezahing Tolesa, Garuma Below, Ahimad Abdurrahman, Yassin Alemayehu, Abdo Mohammed, Kadir Nasir and Nasru A/Oli for their technical supporting during the whole data collection in my study area.

I highly acknowledge Gera District Administrative and Agriculture Office for providing their support and available data. I also like to express my thanks to Jimma University soil laboratory for material supporting of soil sampling and technical supporting of soil analysis. Also, I would to thanks all JUCAVM library staff, ICT worker and all my friends for their idea sharing to organize this thesis. I am grateful to my family members, my classmates and my friends for supporting and encouraging me to complete this work.

Finally, I would like to express my deep sense of gratitude to my wife Mrs. Saliha Zeban my brother Abdulkerim A/Gero by overcoming many challenges to make fruit full my dream and moral support, strength, and encouragement in completing my thesis. I would like to express my deep sense of gratitude to my Father and Mother to make fruit full my dream and moral support and helping me by their *du'as*. I also deeply indebted to my sweetest, lovely children, Salman Abdulaziz, Sabha Abdulaziz and Iftinan Abdulaziz at all time.

LIST OF ABBREVIATIONS/ACRONYMS

CEC	Cation Exchange Capacity
CRGE	Climate Resilient Green Economy
EC	Ethiopian Calendar
EFCCC	Environment, Forest and Climate Change Commission
FGD	Focus Group Discussion
FLR	Forest and Land Restoration
GDAO	Gera District Agricultural Office
GLI	Legacy Initiative
GTP	Growth and Transformation Plan
KII	Key Informant Interview
LULC	Land Use Land Cover Change
NDC	Nationally Determined Contribution
NGOs	Non-Government Organizations
OM	Organic Matter
PFM	Participatory Forest Management
SLM	Sustainable Land Management
SOC	Soil Organic Carbon
TN	Total Nitrogen

TABLE OF CONTENTS

Contents	Page
STATEMENT OF THE AUTHOR	i
BIOGRAPHICAL SKETCH	ii
ACKNOWLEDGEMENTS	iii
LIST OF ABBREVIATIONS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
ABSTRACT	ix
1. INTRODUCTION	1
1.1 Background and Justification	1
1.2 Objectives.....	6
1.2.1. General Objectives.....	6
1.2.2. Specific Objectives	6
1.3. Research Question.....	6
1.4. Significance of the Study	6
1.5. Research Hypothesis	Error! Bookmark not defined.
1.6. Scope of the Study.....	6
2. LITERATURE REVIEW	8
2.1. Historical Context of Tree Planting in Ethiopia	Error! Bookmark not defined.
2.2 The Green Legacy Initiative in Ethiopia	8
2.3 Concept of Green Legacy and Environment	10
2.4 Determinants of Tree Planting	12
2.5. The challenge of sustaining a green legacy in Ethiopia	14
2.5.1 Involvement of all relevant stakeholders.....	14
2.5.2 Monitoring and Follow Up	14
2.5.3 Site selection for tree planting.....	15
2.5.4 Soil Moisture Content	15
2.5.5 Quality of Seedlings	15
2.5.6 Tree Species Types.....	15
2.5.7 Planting Time	16
2.5.8 Land Tenure Security	16
2.6. Opportunities to Enhance the Green Legacy Initiatives.....	16

2.7 Land use land covers change and Green Legacy Initiative.	17
2.7.1 Land Use and Land Cover Change Definitions and Concepts	17
2.7.2 Land Use and Land Cover Change Studies in Ethiopia.....	19
2.7.3 Application of Remote Sensing on LULC Change.....	20
2.8. Effect of Tree Planting on Soil Properties	21
3. MATERIALS AND METHODS	24
3.1 Description of the Study Area	24
3.2. Research Design.....	26
3.3. Nature and Source of Data	26
3.4 .Data Collection Methods.....	26
3.4.1. Sampling Techniques and Sample Size	26
3.4.2. Soil Sampling.....	28
3.4.3. Land use land cover data classification schemes	29
3.5 Statistical analysis	32
4. RESULTS AND DISCUSSION.....	33
4.1. Socio-economic characteristics of the respondents.....	33
4.1.1. Age, Gender and Family size.....	33
4.1.2. Farmland ownership.....	34
4.2. Challenges and Opportunities for Implementations of GLI.....	35
4.2.1. Community Perception, participation, and Seedling Preference on GLI.....	35
4.1.2 Pairwise Pearson Correlation result for some variables	42
4.1.3. Challenges.....	44
4.1.4 Opportunities and benefits	45
4.3 The status of land use land cover change in the context of Green Legacy Initiative.....	47
4.4. Effects of GLI on Soil Properties.....	51
5. CONCLUSIONS AND RECOMMENDATIONS	55
5.1 Conclusions	55
5.2 Recommendations	56
6. Reference	58
APPENDIXES	70

LIST OF TABLES

Tables	Page
TABLE 1: LAND USE LAND COVER CLASSES AND THEIR DESCRIPTION.....	31
TABLE 2: GENDER, AGE, EDUCATION AND FAMILY SIZE OF RESPONDENT	33
TABLE 3: MAIN ACTIVITY, FARMLAND OWNERSHIP, AND FARMLAND SIZE AND TREND IN LAND SIZE	34
TABLE 4: PARTICIPATION, SEEDLING PREPARATION, USE ASSOCIATION AND TRENDS IN ASSOCIATION	35
TABLE 5: PAIRWISE PEARSON CORRELATIONS	43
TABLE 6: CHALLENGES WITH RESPECTIVE TO CATEGORICAL VARIABLE	44
TABLE 7: OPPORTUNITIES AND BENEFITS GAINED FROM GREEN LEGACY INITIATIVE	47
TABLE 8: LULC STATUS AND CHANGE BETWEEN 2018 AND 2023.	48
TABLE 9: SOIL PHYSICAL AND CHEMICAL PROPERTIES DATA	52

LIST OF FIGURES

Figures	Page
Figure 1:Map of the study Area.	24
Figure 2: Plantation site prepared on April 2012E.C in Ganji Chala kebele Gure Ganji Water shade kore coffee cluster. Source: Gera District Agricultural office.....	37
Figure 3:Kore coffee cluster (Agro forestry plantation site) planted in GLI on 2012 E.C at 3 years stand over view in Gure Ganji Watershed; Photo taken on June 2015 E.C when data collection was conducted.	37
Figure 4: a,b,c and d shows Stand of kore coffee cluster in Gure Ganji watershed (Agroforestry plantation site) planted in GLI integrated with Banana, vetivar and disho grass; Photo taken on June 2015 E.C at 3 years when data collection was conducted.	38
Figure 5: Plantation site in sadi Loyya kebele Gicho sub watershed at Gicho secondary school, planted in GLI; planting year 2012 E.C. at 3 years stand Photo taken on June 2015 E.C when data collection was conducted.....	39
Figure 6:a and b Tree planting in Wogecha kebele Medda water shed planted on communal land in GLI; plantation year 2011 E.C Photo taken on June 2015 E.C at stand of 4 years when data collection was conducted.	40
Figure 7: Types of land use before five years.....	42
Figure 8:LULC maps of Sadi Loyya.	50
Figure 9:LULC maps of Wogecha.....	50
Figure 10:LULC maps of Ganji Challa	50
Figure 11: Percentage of land use land cover change over the period of time	51

ABSTRACT

The Green Legacy Initiative was launched in June 2019 by aiming to mitigate the climate change; however, its effectiveness by improving the degraded ecosystem, environment and watershed has not been evaluated comprehensively. The aim of this study was to assess the challenges and opportunities for implementations of Green Legacy Initiative. Qualitative and quantitative data were collected from both primary and secondary sources. Additionally, spatial data collection tools like GPS technology and photography were involved, and on-site observations along the study watershed were conducted. In addition, soil analysis was conducted to see its short-term effect on selected soil parameters (MC, pH, BD, OC and AvP) and Satellite images were also used. The collected data were analysed according to the nature of its source. Socio-economic data was analysed by using SPSS version 20. And displayed in table. Descriptive statistics such as mean, percentages, and frequency were used and then presented as tables and graphs. The satellite image was also analysed using Latest ArcGIS 10.8 software. The collected soil samples were checked in an instrument and analysed. The results of this study in case of challenges shows, failure to properly plan accounted for 19.7% and 21.4% of surveyed households represented a lack of wisdom. Additionally, 23.1% and 35.8% less caution in planting more tree seedlings and not taking care of the planted seedlings respectively. The opportunities also revealed in this study, for instance about 32% of seedlings were provided by the government to sustain the Green Legacy initiative rather than being prepared by the community. The availability of communal land in mass, it accounted for 9% of the populations surveyed. Availability of technical support accounted for 24%, and seedling availability from other sources indicated 11%. The increase in forestland in Ganji Challa is attributed to the high number of institutions established in the area for agroforestry, possibly due to good protections for the plantations by controlling free grazing. Comparatively, the Wogecha area has shown minimal change in the Green Legacy works. In Sadi-Loyya, the areas used for Green Legacy have also shown improvements in scrubland covers. The benefits of the Green Legacy campaign include widespread employment opportunities for youth, improved work culture, additional income from their land, conversion of previously vacant land into forests, and enhancing the beauty of the environment. All selected soil parameters have shown non-significant difference due to short-term effect of GLI. Through re-considering the existing problems in the area the GLI could be the best land use type. Therefor the concerned body should consider the scientific and technical support in assigning the right plant with the right place and the right conservation.

Keyword: Afforestation, Agroforestry, Climate Change, Land Use Land Cover Change.

1. INTRODUCTION

1.1 Background and Justification

Climate change has become a major global concern in recent decades and is now widely considered one of the most pressing environmental issues facing humanity. In response, the Paris Agreement was established in 2015, a global agreement among nearly 200 countries to reduce greenhouse gas emissions and limit global temperature rise to well below 2°C and provide climate finances for developing countries (Hickmann *et al.*, 2021). This agreement has been widely seen as a major step forward in tackling the challenge of climate change and is a strong reminder of the importance of taking action to ensure a sustainable future for all (Hickmann *et al.*, 2021).

Ethiopia is experiencing the impacts of both climate variability and change. Climate change has led to recurrent droughts and famines, expansion of desertification, flooding, loss of biodiversity, loss of wetlands, scarcity of water, decline in agricultural production and productivity, and increased incidence of pests and diseases. Climate change is likely to aggravate environmental degradation, food insecurity, water scarcity, disease epidemics and poverty in Ethiopia Zegeye, H. (2018). Ethiopia has shown both conservation and policy responses to combat climate change. Ethiopia is signatory to relevant international environmental conventions and protocols, such as the United Nations Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC), UNCCD, and Kyoto Protocol to the UNFCCC.

In addition, Ethiopia has been an active participant in international climate negotiations, and initiated and implemented a number of climate-related national strategies and programs. Ethiopia is taking the necessary steps to implement the two categories of responses to climate change mitigation and adaptation. Accordingly, Ethiopia prepared its National Adaptation Programme of Action (NAPA) and Nationally Appropriate Mitigation Action (NAMA) and submitted to the UNFCCC in 2007 and 2010, respectively. To increase socio-economic development and combat climate change, Ethiopia developed a CRGE strategy in 2011 (Anonymous, 2011).

Since the Bonn Challenge and the New York Declaration on Forests were established in 2011 and 2014, respectively, unprecedented political will has grown across the globe to restore bio

diversity, livelihoods, and larger environmental goals. In the context of these international initiatives, numerous nations have committed to restoring millions of hectares of degraded or otherwise unproductive land through a variety of initiatives, including native habitat conservation, the promotion of agroforestry systems, the establishment of tree plantations and natural forest regrowth (Bloomfield *et al.*, 2019). Both national agendas (Martinez-Garza *et al.*, 2021) and the Sustainable Development Goals of the United Nations are intended to be supported by these measures. In order to do this, cutting-edge planning and multi-criteria prioritization techniques have recently emerged (Strassburg *et al.*, 2019, 2020; Crouzeilles *et al.*, 2020), as well as diagnostic tools based on crucial enabling or success aspects (McLain *et al.*, 2020). Together, these developments are meant to help practitioners create and carry out restorative interventions that reduce trade-offs between competing land uses, improve the provision of environmental goods and services, encourage responsible management of restored landscapes, and provide socioeconomic benefits at various scales (Ota *et al.*, 2020).

Ethiopia made the most ambitious commitment of all the nations that joined the African Forest Landscape Restoration Initiative, promising to restore up to 15 million ha of forest cover by 2030 (Murcia *et al.*, 2016). Under the direction of the prime minister's office, Ethiopia began the Green Legacy Initiative (GLI) in 2019 as part of its 2016 commitment, a national initiative to plant 20 billion trees over the course of four years (White, 2019). On Green Legacy Day (July 29, 2019), it is estimated that more than 20 million people planted 354 million seedlings, demonstrating both a tremendous level of governmental leadership and social support (Boissière *et al.*, 2021).

Lambert, E. and Deyganto, K. O., 2023. The Green Legacy has successfully contributed to increased forest cover and has been effective in addressing deforestation and promoting reforestation, thereby enhancing carbon sequestration and mitigating climate change. The Green Legacy has wider implications beyond climate change, including social, economic, and environmental benefits. The green legacy programs are the tools to provide carbon free economy. Hence, the sustainable implementation of the green legacy initiative in Ethiopia is a big memo for the government of Ethiopia. In accordance with the intended nationally determined contribution issued by the Government of Ethiopia, the country intends to limit net greenhouse gas to 145 Mt CO₂ by the year 2030.

There are no statistics available to confirm the number of nurseries, seed collectors, or individuals engaged in tree planting. Ethiopia uses a variety of methods to plant trees. Individual farmers plant exotic, commercially viable tree species on their properties, while government led tree planting programs, which primarily take place on common area And encourage the planting of native tree species; contrast this practice (White 2019). Additionally, tree planting for biomass production takes place in areas intended for natural forest regrowth (also known as “exclosure” a type of reforestation and land rehabilitation popular in northern Ethiopia) and uses both exotic and native tree species. Whether state-owned or privately held, commercial tree plantations are always made up of exotic species (Erbaugh *et al.*, 2020).

There are several weaknesses in the GLI’s governance, particularly when it comes to institutionalizing coordination and leadership responsibilities. Ethiopia's enormous commitment to restore its forests will only be partially successful in the long run if everything that has previously been tried to plant trees is carefully examined (Hanson *et al.*, 2015). These weaknesses in the GLI Program could be a major obstacle to the achievement of the Program if not addressed. Therefore, as a government, special attention should be paid to it and the GLI should be managed in an organized manner. The government bodies who directly concerned for this issue should work in coordination to further continue the results of the GLI and eliminate these weaknesses.

Watershed management has received attention in Ethiopia since the 1990s and is currently being applied in several regions of the nation as a strategy to reverse the depletion of the country's natural resource base and boost land productivity (Lakew *et al.*, 2005). After a while, many human activities that encourage the conversion of degraded land to forest land or agroforestry may lead to an improvement in land use and land cover started to occur (Lambin *et al.*, 2003; Fikir *et al.*, 2009; Abiyot *et al.*, 2018). The main technique for managing community based watersheds is one of several natural resource management strategies that can be used to improve land cover (Abiyot *et al.*, 2018).

Watersheds are complex systems where water, soil, geology, flora, fauna, and human natural resource use practices interact. Watershed management is the integrated use of land, vegetation, and water in a geographically discrete drainage area for the benefit of its residents, with the objective of protecting or conserving the hydrologic services. The watershed provides and of reducing or avoiding negative downstream or groundwater

impacts (Darghouth *et al.*, 2008). Thus, watershed is the appropriate hydrological unit for technical efforts to manage water and soil resources for production and conservation.

The government of Ethiopia in collaboration with international donors implemented various mechanical and biological soil and water conservation (SWC) measures where farmland terracing, stone and soil bunds are among the widely implemented practices (Binyam and Desale, 2014).

Continued strong coordination between the government and the community is essential to ensure the effectiveness of the GLI. And the development of accurate and timely plans and the implementation of the plans should be monitored and evaluated by the government concerned body from time to time. On the other hand, the effects and changes brought by the GLI and the increased forest coverage in this regard should be regularly evaluated by the stakeholder's coordination. Successful implementation of the GLI significantly contributes to the fulfillments of the green growth target of the country. In addition, forests sequester and store carbon dioxide from the atmosphere, helping to reduce greenhouse gas emissions. The country can get a significant amount of revenue from sale of carbon.

This study was conducted in Gera district in the Jimma zone of south-western Ethiopia. The district is the home of the Balete-Gera National Forest priority area. According to a survey data, the district is 25.8% forested, with the remaining 22.8% being swampy, degraded, or otherwise unusable. The forest in this area is a remnant of the dry, evergreen Afromontane Forest that can still be found in southwest Ethiopia. It has been under participatory forest management since 2003 for successful management and is currently under the concession of the Oromia Forest and Wildlife Enterprise. The forest covers an area of approximately 25,597.94 hectares (Kitessa & Tsegaye, 2008).

The rate of deforestation in this area between 1980 and 2018 was 1,372.54 hectares per year. The predicted results for the year 2037 suggest that forest cover would decrease by 30,204.65 hectares within 19 years, and agricultural land would increase by 30,693.91 hectares between 2018 and 2037 (Gemmechis, 2022). Increasing vegetation cover, such integrated watershed management lowers sheet and rill soil loss rates across all LULC classes by roughly 89% (Haregeweyn *et al.*, 2012). In addition, watershed management techniques enhanced the amount of vegetation (greenness) in the watershed that was conserved and also decreased the speed of surface runoff and the effects of raindrops (Fikir *et al.*, 2009).

Improved surface cover conditions and improved vegetation cover were produced by increased shrub land, grassland, plantation, and natural forest cover as a result of the combined effects of the extensive soil and water conservation measures implemented since 2003 and the associated changes in land use and land cover (Ayele *et al.*, 2016). However, The Ethiopian government claims that the Green Legacy Initiative successfully involved over 25 million individuals in planting 25 billion tree seedlings in efforts to combat climate change and deforestation. But it will be crucial to assess the challenges and opportunities for future sustainability. Various researchers have examined the green legacy initiative, with empirical evidence from Ali *et al.* (2021), Trees for All (2023), Hamad (2022), and Phiri *et al.* (2022) indicating that green legacy contributes positively to the promotion of a healthy environment in Africa. Da Graça Carvalho's study in 2012 proposed that energy and climate change strategies in Europe also have a beneficial effect on cultivating a green environment. The research findings highlight that the Green Legacy Initiative (GLI) has significant potential to offer various products to the local community and enhance carbon sequestration capacity to alleviate the impacts of climate variability and change within the country. To enhance the role of GLI in the sustainable development of the country, it is crucial to address implementation challenges during GLI (Beyene and Shumate, 2023). One of the advantages of sustainable land management is the capacity to voluntarily mobilize millions of man days each year to engage in tree planting. (MoA, 2022).

While the Green Legacy Initiative (GLI) presents a promising approach, there is a lack of comprehensive research documenting the characteristics and opportunities within Gera district in the Jimma zone, where GLI is actively implemented. Furthermore, there is a gap in research studies that could assess past experiences, challenges, and opportunities for managing the watershed effectively in the future. Therefore, this study was concentrated on presenting empirical proof of GLI's efficiency in managing watersheds, as well as the challenges and opportunities for GLI utilizations in Gera districts.

Therefore aim of this study was assessing the Land Use Land Cover Change Detections under the Green Legacy Initiatives in Gera District, South western Ethiopia. Conducting such assessments is essential for sustainable watershed management, promoting environmental health, and ensuring the well-being of both ecosystems and communities in the future.

1.2 Objectives

1.2.1. General Objective

To assess the challenges and opportunities to enhance Green Legacy Initiatives in the study area

1.2.2. Specific Objectives

The specific objectives were to:-

- assess the challenges and opportunities for implementations of Green Legacy Initiative
- determine the status of land use land cover change in the context of Green Legacy Initiative
- analyse the effects of Green Legacy management on selected soil physico-chemical properties in the study area

1.3. Research Question

1. What are the challenges and opportunities for implementations Green Legacy Initiative?
2. Are there changes on land use land cover change of the study area due to Green Legacy implemented?
3. Are there effects of the current green legacy management on soil properties in the study area?

1.4. Significance of the Study

The purpose of this study will be to know the status of GLI and its effects on vegetation cover of watershed in the study area, which helps to harmonize such activities. The result of this study will be used to identify the major challenges encountered during implementations of GLI in the study area which is used stakeholders to be overcome such a problem in another means. It provides current information on the available opportunities for the GLI implementations for different governmental sectors such as agricultural officers, land administration as well as other concerned bodies including NGOs and local population of the study area. For different researcher it will also serve as sources of information on the GLI in the country in general and particularly in the study area for those are interested on the further research works.

1.5. Scope of the Study

The extent of this investigation is delimited both in topographical region and issue of concern. Topographically, it is delimited to the Gera districts of Jimma zone Oromia national

regional state Ethiopia. Along this line the investigation was assessing green legacy in managing watershed, challenges and opportunities.

2. LITERATURE REVIEW

2.1 The Green Legacy Initiative in Ethiopia

The national tree planting activity gained momentum in 2008 to mark the Ethiopian Millennium. Since then, successive 5-year development plans have set targets to plant large numbers of seedlings. The second growth and transformation plan (GTP II, from 2016 to 2020) of Ethiopia targeted to identify 5 million ha of land and rehabilitate the area using afforestation or reforestation to increase the national forest cover by 4.5% by 2020. The GTP II plan also envisaged to plant 21 billion tree seedlings but managed to produce and plant 15 billion seedlings on an area of 2.6 million ha [Environment Forest and Climate Change Commission (EFCCC), 2020].

The GLI was started in 2019 by Ethiopia's Prime Minister, Dr. Abiy Ahmed, with the goal of planting 20 billion seedlings in four years. To assist in achieving this objective is the forest sector plan for 2021–2025 [Environment Forest and Climate Change Commission (EFCCC), 2020]. Ethiopia's long-term commitment to a varied response to the effects of climate change and environmental degradation includes agroforestry, the expansion of the forest sector, and integrated water and soil resource management. Increasing food security is one of the main objectives of GLI. In 2022 alone, more than 500 million seedlings were planted, including high-priced fruits and vegetables like avocados, mangoes, apples, and papayas that are sold both domestically and internationally. With these programs, the nation aims to attain food independence (UN DESA, 2022).

The high-level political commitment and the ability to voluntarily mobilize millions of man-days annually to engage in tree planting are among the strengths of the sustainable land management and the green legacy initiative (SLM-GLI).

To support and guide FLR initiatives, the EFCCC in collaboration with the WRI developed a National Tree-Based Landscape Restoration Potential and Priority Map in 2018 (Wondimu Zeleke *et al.*, 2018). The map shows a total of 82 million hectares of land as having potential for tree-based restoration, of which 11 million hectares is classified as priority requiring rehabilitation. These maps identify areas where (i) existing forests can be restocked for biodiversity conservation, carbon sequestration, and flow of ecosystem services; (ii) planted forests can be established to generate economic benefits and prevent landslides and flooding;

(iii) agroforestry can be scaled up to produce food, wood, and fodder; (iv) planting trees could be planned to stabilize riverbanks and reduce sedimentation; and (v) commercial plantations can be promoted to meet the growing wood demand for industrial and domestic uses. Although biophysical parameters were used help identify these potential areas for tree-based restoration, mapping of FLR actors, their networks, and priorities in restoring landscapes was not undertaking.

The Green Legacy Initiative has garnered widespread support and participation from various sectors of society, including government institutions, schools, communities, and businesses. It has become a national movement, with millions of Ethiopians actively involved in tree-planting activities. The initiative not only contributes to mitigating climate change but also promotes environmental awareness and community engagement (UN Environment Programme, 2020). The reforestation efforts under the Green Legacy Initiative have numerous benefits for Ethiopia. They help to restore ecosystems, conserve biodiversity, and protect watersheds, which are crucial for water availability and soil fertility.

The GLI offers environmental advantages, but it also has socioeconomic effects. With operations like seedling production, tree planting, and forest management, it creates job opportunities, especially for rural populations. In order to increase food security and improve lives, the GLI also supports agroforestry and sustainable agricultural techniques (UN Environment Programme, 2020).

The GLI has gained support and recognition on a global scale. It supports international initiatives to address climate change and accomplish the Sustainable Development Goals. Ethiopia's initiative to combat deforestation and climate change has been commended by the United Nations Environment Programme (UNEP), which also highlighted Ethiopia's commitment to reforestation as a model for other nations to emulate (UN Environment Programme, 2020).

The problems in the GLI tree planting program are the lack of advance planning and proper implementation of the tree planting activities as well as the reuse of the land planted on the GLI trees for other purposes in some places. This is an issue that needs to be addressed as it is due to lack of planning in advance.

2.2 Concept of Green Legacy and Environment

The green legacy initiative in Ethiopia plays a crucial role in promoting a healthy environment through its ambitious tree planting efforts. By focusing on large-scale reforestation, the initiative aims to address environmental degradation, combat climate change, and restore the health of ecosystems (Ethiopian Monitor, 2023). Trees are known for their numerous benefits to the environment, and the green legacy initiative utilizes this knowledge to create a sustainable and resilient ecosystem in Ethiopia. The initiative's role in promoting a healthy environment is multifaceted (Kandasamy *et al.*, 2022).

Moreover, trees contribute to the goal of preserving life below water by protecting watersheds, reducing soil erosion, and providing habitats for diverse aquatic species. Additionally, their importance in the goal of eradicating poverty and promoting sustainable economic growth cannot be undermined, as they provide a renewable source of timber, fuel wood, and non-timber forest products for local communities. Overall, trees make significant contributions toward various Sustainable development goals (SDGs), emphasizing the need to protect and increase their numbers for a sustainable future (Corbett & Mellouli, 2017).

The United Nations (UN) has set several goals as part of its green legacy initiative, aimed at promoting sustainability and environmental conservation world-wide. These goals address various aspects of sustainable development, including climate change, biodiversity, and resource management.

Climate Action: One of the primary goals of the UN's green legacy initiative is to combat climate change and reduce greenhouse gas emissions. The UN encourages countries to adopt renewable energy sources, implement energy-efficient practices, and promote sustainable transportation systems. This goal aligns with the Paris Agreement, an international treaty aimed at limiting global warming.

Sustainable Cities and Communities: The UN aims to create sustainable cities and communities that are environmentally friendly, socially inclusive, and economically Prosperous. This goal involves developing eco-friendly infrastructure, improving waste management systems, and promoting sustainable urban planning. The UN's Sustainable Development Goal 11 focuses specifically on making cities and human settlements inclusive, safe, resilient, and sustainable.

Life on Land: The UN recognizes the importance of protecting terrestrial ecosystems and biodiversity. The Green Legacy Initiative emphasizes the conservation and restoration of forests, wetlands, and other natural habitats. This goal aligns with the UN's Sustainable Development Goal 15, which aims to protect, restore, and promote sustainable use of terrestrial ecosystems.

Clean Water and Sanitation: Access to clean water and sanitation is crucial for human well-being and environmental sustainability. The UN's green legacy initiative promotes responsible water resource management, including water conservation, pollution, prevention and sustainable water use.

Responsible Consumption and Production: The UN aims to promote sustainable patterns of consumption and production to minimize waste generation and environmental degradation. This goal encourages individuals and businesses to adopt sustainable practices, such as reducing waste recycling and using eco-friendly products.

Lambert, E., & Deyganto, K. O. (2023). In conclusion, the UN's green legacy initiative encompasses various goals related to sustainability and environmental conservation. These goals include climate action sustainable cities and communities, life on land, clean water and sanitation, and responsible consumption and production. By these goals, the UN aims to create a greener, more sustainable future for all.

This increased environmental consciousness can have long-term benefits for the health and wellbeing of the population. A cleaner and healthier environment directly impacts human health, as it reduces air pollution, provides access to clean water, and creates a more favourable climate. By promoting a healthy environment, the green legacy initiative contributes sustainable and prosperous future for generations to come.

Lambert, E., & Deyganto, K. O. 2023. Planting trees is the best mechanism for creating a green and healthy world and the globe needs more trees for a better climate, more biodiversity, and healthy living conditions. Trees are an important tool in the fight against climate change. They store carbon and help cool the environment. Forests are the habitat of countless species of plants and animals and serve as an important source of biodiversity.

Today the issue of the green economy has become the burning agenda of the world in general that of Ethiopia in particular. So, the agenda of building a carbon-free economy is global and needs the cooperation of all countries in the world.

For the achievement of GLI tree planting program, it is essential to understand the practical situation of the area where the trees are planted, understand the needs of the community in the area and coordinate the tree planting with local knowledge by taking community opinion as input is important. Because the resident of the area where the tree is planned to be planted is more familiar with the environments of the area, that the plants grow in the area and the acceptability of the community is essential and integrating local knowledge with scientific ones essential for sustainability of GLI effort. Similarly, in the area where the GLI tree planting planned to conduct nursery site should be established by Government as well as by organizing residents in Associations for preparation of indigenous tree species and also encouraging the community individual seedling preparation is important.

2.3 Determinants of Tree Planting

Forestry has tremendous potential to contribute to the green economy and increase household as well as state revenues in 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, 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).

However, the direction and magnitude may vary from place to place. 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 (Danquah, 2015). Tenure security is a significant factor in making long-term decision such as tree planting. Securing long-term rights and making sure that the local communities' benefits from tree planting are one of the measures to have a successful tree planting (Boissiere *et al.*, 2021). Secured land tenure rights significantly and positively influence farmers' decision to engage in voluntary tree planting (Danquah, 2015). Identified several households, environmental and geographical factors that determine the number of trees planted by farm households in Ethiopia (Mekonnen and Damte, 2011).

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 a negative effect on households' tree planting behavior (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.

Ethiopian policymakers who see tree based businesses as a way to create employment and boost household income in rural areas have yet to adequately consider the role of markets in encouraging the use of varied species and thus enhancing the resilience of planted forests. Markets insufficient finance and lack of private sector engagement hampers the production and concomitant planting of species that produce multiple forest products, such as bamboo and frankincense (Mengesha *et al.*, 2020). In addition, the requirement to have permits to cut and transport timber from selected indigenous tree species is a disincentive for farmers to plant these species. The tree *Cordia africana*, for example, which produces high quality timber is a preferred species of furniture makers in many towns in Ethiopia and is easy to produce from seedlings. However, farmers are not allowed to transport and sell.

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. 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.

2.4. The challenge of sustaining a green legacy in Ethiopia

There are various types of constraints or barriers that influence the GLI. 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.

2.4.1 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.

For the success of the GLI, there should be clear duties and responsibilities among the main implementing institutions. 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. 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).

2.4.2 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).

2.4.3 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. Also, the physical conditions of the planting sites 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. 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).

2.4.4 Soil Moisture Content

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

2.4.5 Quality of Seedlings

Quality seedlings have a higher survival rate and faster growth. Fast growth trees out compete weeds and reduce labour 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).

2.4.6 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.

2.4.7 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.

2.4.8 Land Tenure Security

Tenure security 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 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. Tenure security is crucial to reduce forest degradation and deforestation. Land tenure security is an important driver for local communities to invest and participate in tree planting. The most important tenure issues deal with communal land and lands where individuals, groups and institutions such as community based organizations do not have use rights (Lemenih and Kassa, 2014). Communal lands are owned and legally controlled by the state and are often severely degraded. Tree planting efforts in these locations are necessary, yet the burden of planting and long-term maintenance falls on local government authorities and communities, who have little say on what to plant and where, how to manage the land and how to use it (Lemenih and Kassa, 2014)

2.5. Opportunities to Enhance the Green Legacy Initiatives

Ethiopia made the largest FLR commitment in Africa when it pledged to restore 15 million hectares of degraded lands in 2016. This is in addition to the plan to manage 7 million ha of forests and woodlands as part of its Climate Resilient Green Economy (CRGE) Strategy enacted in 2011. The strategy aims to make Ethiopia a middle-income country by 2025 and to build a carbon-neutral economy by 2030.

The country will be able to better adapt to the effects of climate variability and change with the help of these projects, according to the Climate Resilient Green Economy Strategy (CRGE), a 2011 document. The total, or 22 million hectares, represents what we understand to be Ethiopia's formal declaration during the 2014 New York Declaration on Forests. In its recently updated nationally determined contribution (NDC), the government recognized the sustainable management of existing forests and woodlands as well as the establishment of new forests through afforestation and reforestation as top priorities (Federal Democratic Republic of Ethiopia, 2019). According to the Federal Democratic Republic of Ethiopia (2015), forestry is anticipated to contribute to around half of the abatement potential required to meet the goals outlined in the CRGE and the NDC.

According to Kassa *et al.* (2017), activities that improve human wellbeing both now and in the future by restoring the ecological and productive functions of damaged agricultural landscapes and forests are included in Ethiopia's understanding of FLR.

Generally speaking, the most important state-led Forest and Land Restoration (FLR) initiatives to reduce land degradation and forest degradation in Ethiopia involve community mobilization and engagement in soil and water conservation; establishing area enclosures/exclosures (AEs) to prevent human and animal interference and support natural regeneration in degraded lands; involving communities in participatory forest management (PFM) to manage state-owned natural forests; and the recently launched Green Legacy Initiative (GLI) to encourage planting trees and expand the country's forest cover.

2.6 Land use land covers change and Green Legacy Initiative.

2.6.1 Land Use and Land Cover Change Definitions and Concepts

Land cover refers to the physical and biophysical cover over the surface of earth, including distribution of vegetation, water, bare soil and artificial structures. Land use refers to the intended use or management of the land cover type by human beings such as agriculture, forestry and building construction. Land use land cover change (LUCC) is commonly grouped in to two broad categories: conversion and modification (Meyer and Turner, 2014). Conversion refers to a change from one cover or use category to another (e.g., from forest to grassland). Modification, on the other hand, represents a change within one land use or land cover category (e.g., from rain fed cultivated area to irrigated cultivated area) due to changes

in its physical or functional attributes. These changes in land use land cover systems have important environmental consequences through their impacts on soil and water, biodiversity, and microclimate (Lambin *et al.*, 2003).

Land cover changes have been influenced by both the increase and decrease of a given population (Lambin *et al.*, 2003). In most developing countries like Ethiopia, population growth has been a dominant cause of land use and land cover change than other forces. There is a significant statistical correlation between population growth and land cover conversion in most of African, Asian, and Latin American countries. Due to the increasing demands of food production, agricultural lands are expanding at the expense of natural vegetation and grasslands (Lambin *et al.*, 2003).

Increase of croplands and decrease of forest, results increase of stream flow because of the crop, soil moisture demand. Crops need less soil moisture than forests; therefore, the rainfall satisfies the shortage of soil moisture in agricultural lands more quickly than in forests there by generating more runoff when the area under agricultural land is extensive. Hence, this leads to an increases stream flow. In addition, deforestation also has its own impact on hydrological processes, leading to declines in rainfall, and more rapid runoff after precipitation (Legesse *et al.*, 2003). Therefore, such changes of land use land cover may have impacts on the stream flow during the wet and dry months, and on the components of stream flow (surface runoff and ground water flow) and assessing such impacts is the core of this study.

Generally, knowing of the impacts of land use land cover change on the natural resources depends on an understanding of the past land use practices, current land use and land cover patterns, and projection of future land use and land cover, as affected by population size and distribution, economic development, technology, and other factors. The land use land cover change assessment is an important step in planning sustainable land management that can help to minimize agro-biodiversity losses and land degradation, especially in developing countries like Ethiopia (Hadgu, 2008).

Land use/land cover (LULC) change is one of the factors responsible for altering the watershed's hydrological process by affecting the magnitude of surface runoff, aquifer recharge and river flows, which has an impact on the availability of products and services

necessary for the livelihood. The demand for some land cover classes, such as built-up area, rises along with an increase in population, whereas other land cover classes, such as bare land and vegetation, decline as a result of the higher demand for the built-up areas (Kafi *et al.*, 2014). Consequently, the impacts of LULC on the sustainability of the ecosystems are becoming more and more crucial topics in research on global to regional changes.

Over the past few decades, there has been a significant changes in the LULC in many parts of the world (Khare *et al.*, 2017). Un controlled human activities have primarily been responsible for the alteration in the LULC changes. The most notable human activities that contributed to LULC change were increased agriculture, clearing of forest and plantations for fuel wood use, intense grazing, de-vegetation, and urbanization infiltration (Khare *et al.*, 2017).

The earth is under a rapid LULC changes owing to the complex socioeconomic activities with natural systems(Murayama *et al.*, 2015). However, the changes vary spatially and temporally from global to regional and regional to local. Likewise, the impact associated with the LULC depends on the spatio-temporal dynamics, the LULC change rate and the soico-economic activities of the livelihoods.

2.6.2 Land Use and Land Cover Change Studies in Ethiopia

In Ethiopia, the land is used to grow crops, trees, animals for food, as building sites for houses and roads, or for recreational purposes. Smallholders who farm for subsistence are using most of the land in the country. With the rapid population growth and in the absence of agricultural intensification, smallholders require more land to grow crops and earn a living; it results in deforestation and land use conversions from other types of land cover to cropland. The researches that have been conducted in different parts of Ethiopia have shown that there were considerable land use and land cover changes in the country. Most of these studies indicated that croplands have expanded at the expanse of natural vegetation including forests and shrub lands; for example, Belay and Mengistu, (2021); Kindu,(2016) in northern part of Ethiopia, Zeleke and Hurni. (2001), in north western part of Ethiopia, (Kassa *et al.*,2003) in north eastern part of Ethiopia; and (Denboba, 2005) in south western part of Ethiopia.

According to Hadgu. (2008), the study identified that decrease of natural vegetation and expansion of agricultural land over a period of 41 years in Tigray, northern part of Ethiopia. He concluded that population pressure was an important deriver for expansion and

intensification of agricultural land in recent periods. (Alemu *et al.*, 2014) in the semi-arid areas of the central Rift Valley of Ethiopia, during the period 1973-2000 cropland coverage has increased and woodland cover lost. Similarly (Gala *et al.*, 2011) also reported the expansion of evergreen vegetation with increase of population.

2.6.3 Application of Remote Sensing on LULC Change

Remote Sensing (RS) is defined as the science of obtaining information about an object, area, or phenomenon through the analysis of data acquiring by a device that is not contact with the object, area, or phenomenon under investigation (Bawahidi, 2005). It provides a large amount of data about the earth surface for detailed analysis and change detection with the help of sensors.

Land use land cover is changing rapidly in most parts of the world. In this situation, accurate, meaningful and availability of data is highly essential for planning and decision-making. Remote sensing is particularly attractive for the land cover data among the different sources. (Cole *et al.*, 2003) reported that in 1970's satellite remote sensing techniques have started to be used as a modern tool to detect and monitor land cover change at various scales with useful results.

Meyer and Turner, (1994) showed that the information of land use land cover change which is extracted from remotely sensed data is vital for updating land cover maps and the management of natural resources and monitoring phenomena on the surface. The importance of land cover mapping is to show the land cover changes in the watersheds area and to divide the land use land cover in different classes of land use land cover. For this purpose, remotely sensed imagery play a great role to obtaining information on both temporal trends and spatial distribution of areas and changes over the time dimension for projecting land cover changes but also to support changes impact assessment.

Modeling LULC involves the use of artificial representations of the interactions within the land-use system to explore its dynamics and possible future development. Aerial photograph has been used commonly as the sources of information in the ancient past for LULC mapping. However the advancement of technology has brought the Remote Sensing Technology which has simplified the LULC development process. Although many satellite

data sources has emerged, Landsat is the leading data provider globally for the LULC classification systems (Murayama *et al.*, 2015).

One of the most important observations that can be made after a review of land-use/cover change models is the wide variety in approaches and concepts underlying the models. Even though there is no best standard software for LULC classification, over the years peoples have used remote sensing soft wares like ENVI, Idrisi, Illwis and ERDAS Imagine and GIS soft wares like ArcGIS, QGIS and GRASSGIS in different parts of the world for different objectives and purposes (Dibaba *et al.*, 2020). However, due to the numerous and robust image processing tools, many predefined algorithms, and simple compact interface ArcGIS software is most commonly used for LULC change dynamics study.

2.7. Effect of Tree Planting on Soil Properties

Cropland soils are depleted in soil organic carbon (SOC) as compared to soils under natural vegetation. Cultivation leads to SOC losses of 30–40% compared to natural or semi-natural Vegetation (Don *et al.*, 2011; Peplau *et al.*, 2011). Historically, between 32.5 and 35.7 million km² of natural vegetation, encompassing forests, woodlands, savannahs, grasslands and steppes have been converted to croplands (DeFries *et al.*, 1999). As a consequence, cropland soils are a huge potential global carbon sink. The world-wide necessity of food production is growing due to an increasing world population and increasing wealth of emerging economies. The potential area of cultivated land, which can be reconverted to natural vegetation or grassland, is thus limited. It is thus crucial to find effective measures to increase SOC stocks while simultaneously enhancing and maintaining high agricultural productivity.

Changes in SOC stocks are a result of the imbalance between carbon inputs, mainly in the form of dead plant material or manure and outputs, mainly caused by decomposition, leaching and erosion. An often-recommended approach for decreasing SOC decomposition in agricultural soils is to reduce or desist from soil tillage to maintain the natural aggregation of soils to protect SOC from microbial consumption. However, it has been shown that the benefit of conservation or no till agriculture was often an artefact of shallow sampling and is smaller than previously thought (Luo *et al.*, 2010). The main management option to increase SOC storage should therefore be to increase carbon inputs.

Land use practices such as deforestations, overgrazing and cultivation are known to have noticeable effects on soil properties (Biro *et al.*, 2013). The impact of these changes varies depending on the use and management practices employed on the lands (Javad *et al.*, 2014). Deforestation and cultivation of forestlands leads to depletion of soil organic matter, plant nutrients such as N, Ca, Mg, K, etc. and increase soil bulk density (Girma *et al.*, 2012; Ovie *et al.*, 2013; Teshome *et al.*, 2013). These impacts, in turn, reduce the fertility of the soils. In Ethiopia, land use changes such as conversion of natural vegetation to cultivated land results in rapid nutrient depletion from the soils (Alemayehu, 2016). Intensive and continuous cultivation without proper land management has resulted in deterioration of soil physical, chemical and biological properties (Ragassa and Bekele, 2016). Getahun and Bobe (2015) reported that the amount of OM, TN and CEC in cultivated land have declined by about 76, 61 and 39%, respectively. Tesfahunegn (2016) found the highest soil organic matter, pH, total nitrogen, available phosphorus and clay under forest land as compared to cultivated land. Alemayehu and Assefa (2016) also obtained the lowest soil OM content, total nitrogen, CEC, pH and exchangeable Ca and Mg in cultivated land as compared to forest and grass lands.

Tree planting has significant positive effects on soil properties and health, both in the short and long term. According the studies of (Chaturvedi, 2020) tree plantation increasing soil stability, reducing erosion of nutrient-rich topsoil and promoting a healthy soil food web, trees play a critical role in soil rehabilitation. Forest leaf litter and root decay which improves soil structure, water-holding capacity and nutrient availability (Katona *et al.*, 2024). Sending out deep roots that take up nutrients from deep in the soil profile and cycling them back to the surface. The studies of the effects of agroforestry on reducing of erosion (Fahad *et al.*, 2022) slowing water flow and increasing infiltration and providing a framework for soil microorganisms to thrive in complex root systems. Studies stated that integrated trees into croplands have been shown to greatly enhance soil nutrient status and reduce the erosion (Sileshi *et al.*, 2022). The GLI studies agree on agroforestry systems studies with trees like *Prosopis cineraria*, *Faidherbia albida*, and *Castanea mollissima* can significantly increase soil organic carbon, nitrogen, phosphorus and potassium levels compared to treeless systems, cropland and grazing lands.

Overall impact of trees on soils is highly beneficial, but according some studies tree potentially increased soil acidity from decomposing leaf litter and reduced crop yields near trees due to competition for light, water and nutrients (Desie *et al.*, 2020).

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The study was conducted at Gera district, Jimma zone, The Chira town (center of Gera District) is far away from Jimma town 95km and 445 km from capital city of Addis Ababa south-western direction. It is located within the longitudinal range of 35°57'00" to 36°27'40" and latitudinal range of 7°28'00" to 7°55'20" and (Figure1). It is one of the 20 districts found in Jimma zone, Oromia National Regional State. Enclosed Northwest by Sigmo, in the Northeast by Gomma, in the North by Setema, in the East by Seka Chokorsa and in the South, by Southwest Ethiopia Peoples' Region.

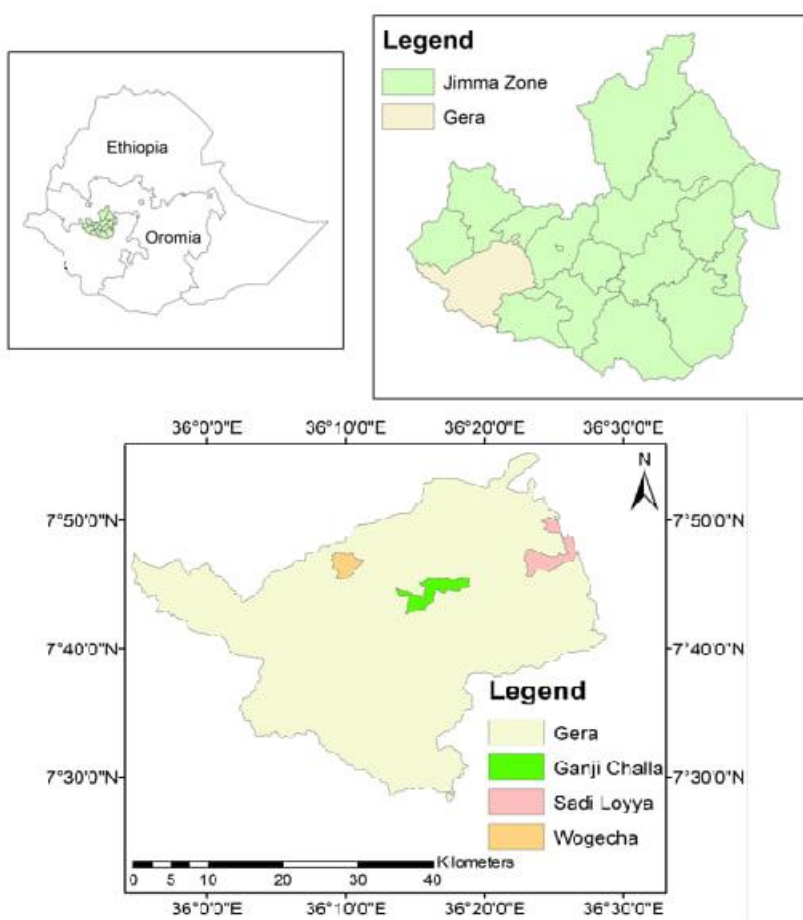


Figure 1: Map of the study Area.

Climate: The mean annual temperature is about 18.5°C and the mean minimum and maximum temperatures 12.4°C and 25.6°C, respectively. The rainfall of the study area is often in between 1880 and 2080 mm per annual and agro climate classified into Dega 46.11%, Woina dega 50.19% and Kolla 3.7% (Gonfa *et al.*, 2020).

Topography: The area is characterized by variable topography with the altitude ranging from 1500 -2200 m. a.s.l. With the concentration of many headstreams, these high lands consists of moderately undulating hills for the most parts, while in some areas steep-sloped mountains with deep valleys prevail. Steep mountains terrain can be found in some areas. In the mid land and low land area of the forest site is mainly dominated by coffee forest, but in the high land area of the forest site is dominated mainly by high land forest species and agricultural crops (Gonfa *et al.*,2020).

Soils of the study area are largely volcanic in origin and relatively fertile and the dominant soil types are Nitosol. Major soil types of the study area are Arcisol, Leptosol and Nitosol (Tulu *et al.*, 2014).

The farming system: mixed agriculture and the sector are rain-fed and characterized by low productivity. The agro-climatic condition is favourable for growing diversified crops, including annual and perennial crops. Maize (*Zea mays L*), Teff (*Eragrostis teff*), Sorghum, Barley (*Hordeum vulgare*), and finger millet are major cereals and Fruits like Avocado are grown widely by the farmers (GDAO, 2023).

Vegetables are grown by some farmers for food and income. The study area was characterized by perennial cash crops production like coffee and chat and also bee keeping is one of income generating way for the farmers in the study area. Irrigated agriculture using streams and springs is well practiced by farmers to grow vegetables, wheat, and maize for household consumption and the local market. Livestock is an integral part of the farming system of the district (GDAO, 2023).

Vegetation cover: The remnant forest vegetation at Gera area can be categorized as tropical Afromontane moist forests which have been further classified into: natural forest (virgin and disturbed) and plantation forests (Tadesse *et al.*, 2014). Within this moist, shaded curtain of vegetation, Ethiopia's rich varieties of *Coffea arabica* evolved in a wild. It is one of the remnants of broad leaf moist forest in Ethiopia comprising economically and ecologically important plants. (Mohammed and Bekele, 2014). The vegetation cover of the area was estimated to be 56% of the total area (Abakorma *et al.*, 2020).

3.2. Research Design

To undertake this research, a mixed method research design employing quantitative and qualitative methods was utilized. The researcher was engaged data triangulation as a means of seeking convergence between qualitative and quantitative methods.

The quantitative approach:- Involved utilizing various technical methods provided by GIS technologies, questioners, field survey.

The qualitative approach:- Qualitative approach concerned with the subjective phenomena that can't be numerically measured like, the perceptions, emotions, and experiences of the participant farmers on Green Legacy Initiative.

3.3. Nature and Source of Data

Qualitative and quantitative data was collected from both primary and secondary sources. Primary data was gathered through conversations. Young and elder Farmers, agricultural extension workers and agricultural supervisors are sources of primary data. Additionally, spatial data collection tools like GPS technology and photography were involved and also, on-site observations along the study watershed was conducted. Secondary source such as satellite images, Published and unpublished documents.

3.4 .Data Collection Methods

3.4.1. Sampling Techniques and Sample Size

Both non-probability and probability sampling techniques were used in this study. The study was conducted in Gera districts of Jimma zone; due to in-depth prevalence of the performances of Green Legacy Initiative in line with high, medium and low performance along the Ganji challa, Sadi Loyyaa and Wogecha respectively. The districts have 29 rural and 3 urban kebeles respectively. For identification of sample study kebeles, for questioners, FGD and key informants for interview, purposive sampling was used.

Firstly, the districts were divided in to agro-ecological categories; Dega, Woina Dega and Kolla. Then, from the total kebeles of the district, three kebele of the district from Dega and Woina dega agro ecological zone was selected. Performance, well availability of green legacy campaign along the water shade, well knowledge of researchers of the areas on tree planting initiative performance and accessibility were factors that determine the selection of kebeles.

Then, the household's respondents were randomly selected; FGD and key informants' interviewee was purposely selected from each kebele.

In these study open ended questions and close ended questions was conducted in respective to in perspective to the following data collection instruments.

Key Informant Interview (KIIs): Key informant interviews supplemented by field observation was applied to understand the status of GLI, available opportunities and major challenges in implementing this GLI. Key informant is a group of individuals from the district agricultural office expert, development agents (DAs) of the study site, community leaders, and Kebele leader and forest experts. The KII members are five individuals that composed in each kebeles was conducted.

Focus Group Discussion (FGD): Focus group discussions (FGDs) was conducted in the Study sites with purposively selected section of community such as kebele leader, village leaders, DAs, and Some individuals from youth and women groups. Hence, purposive sampling method was used for selecting focus group discussion members.

The FGD members was ten Individuals of one group was formed for each kebeles. Questions were asked in a structured conversational format; allowing us to assemble consistent data across sites, while also learning about qualitative aspects of GLI through farmers' perspectives and insights.

Household survey: To determine the household sample size for which the questionnaires was distributed, statistical formula developed by Yamane (1967) is applied with the level of precision equal to 9.1% to improve the quality of the study.

$$N = \frac{N}{1+N(e)^2} \dots\dots\dots 1$$

Where, n: designates the sample size.

N: designates/assign total number of Households of the study area= 2312

e: designates maximum variability or margin of Error = 0.091: designates the probability of the event occurring.

$$N = \frac{2312}{1+2312(0.091)^2}=117 \dots\dots\dots 2$$

The sample size of each kebele was calculated by using the following formulas.

$$n1 = \frac{N1}{N} (n) \dots\dots\dots 3$$

Where,

n1, 2, 3..... Sample size of each kebele

N1: Total number of households of each kebele

$$n1 = \frac{597}{2312} (117) = 30 (\text{Ganji challa kebele})$$

$$n2 = \frac{912}{2312} (117) = 46 (\text{Sadi Loyya kebele})$$

$$n3 = \frac{803}{2312} (117) = 41 (\text{Wogecha kebele})$$

Therefore, the collected data was analysed by using the descriptive data parts of the research using spss version 20. and described as statistics such as mean, percentages, and frequency and then Presented as tables and graphs.

3.4.2. Soil Sampling

Three kebeles were purposively chosen by the study for the purpose of collecting soil samples since they correspond to high, medium, and poor GLI performance levels. Soil samples were collected from three representative sample sites of three land scape position (upper, medium and lower slope) of the plantation site in the watershed based on FAO Guide Line of 2006. During the sample GPS point was recorded. Then the soil sample was taken from Agroforestry, Institutional and Community plantation site. From the selected site a 20 x 20 m plot were formed by considering four corners and one at a centre of x designed rectangular plot. Accordingly, a composite soil samples were taken in three replications. From each sample site (27 soil samples), which means three sample site times three replication times three slope position a depth of 0-30 cm. The parameter identified in these samples like pH, water content and porosity. In context of bulk density, the sample was taken from two depths (0-30 cm and 30-60) by using **Core Samplers**. During the sample of BD three sample site, three replication, three slope position, and two depth which is a total of 54 sample was taken.

Taking into account that the majority of tree roots may reach this depth at this level, a soil sample was taken between 0 and 30 cm down and also the sampling depth of 0-30 cm is commonly used in soil science research as it represents the topsoil layer, which is the most biologically active and nutrient-rich layer of the soil. This depth is appropriate for analyzing soil properties such as soil pH, soil moisture contents, soil porosity, bulk density and organic

matter content, as these properties are typically most variable in the topsoil layer. The choice of this depth is likely due to its relevance to agricultural productivity and soil fertility, which are key objectives of the GLI and EthioSIS projects. Despite these potential limitations, the 0-30 cm sampling depth is still appropriate for analyzing the key soil properties of interest and aligns with the research objectives of the Green Legacy Initiative and EthioSIS projects, which aim to promote soil conservation and restoration.

The collected soil samples were analyzed at the JUCAVM soil laboratory through standard procedures and soil analysis methods. Bulk density (BD) of the soil was measured from undisturbed soil samples collected and then dried the core samples were in an oven at 105 °C until it dried (Black, 1965). Then it was expressed by weight as the ratio of the mass of water present to the dry weight of the soil sample as described in the Gravimetric method and bulk density was determined by the core method (Black, 1965). The total porosity (TP) of soil samples was estimated from the values of BD and particle density (PD) (assuming an average particle density of mineral soil is 2.65 g cm³). Then the total porosity (TP) was calculated as:

$$BD = ms/vs \dots\dots\dots 4$$

Where, BD: Bulk Density, ms: mass of dry soil and vs volume of soil.

Finally, soil pore space was calculated from measured bulk density values using the following equation.

$$\text{soil porosity} = 1 - \rho_b / \rho_s \dots\dots\dots 5$$

Whereas ρ_b : Bulk density; ρ_s : Particle density

3.4.4. Land use land cover data classification schemes

Landsat imagery is relatively high-resolution earth observation data that is acquired through sensors on one of the NASA Landsat satellites. The satellite sensors acquire high integrity images of the planet surface in a systematic way that can be used to determine the health and type of vegetation, number of built surfaces, success of agriculture or apply it for a myriad other use. The operational Landsat satellites with four different sensors were available through the United States Geological Survey (USGS). The MSS (multi spectral scanner) sensor providing the oldest and lowest quality Landsat data, from 1972 to present, the TM (thematic mapper) sensor providing improved quality of Landsat data from 1984 to present

and the ETM+ (enhanced thematic mapper plus) sensor on the Landsat 7 satellite and Landsat 8 OLI providing datasets from 2013 to present.

For this study, to ensure a quality of image analysis, cloud cover and season of the acquisition were considered as a basic criterion. Consequently, a Landsat map of 2018 was collected from Landsat 8 OLI and 2023 from Landsat 9. All images are cloud free and only seven bands having similar resolution were used in both cases. To minimize the impacts of a seasonal variation in vegetation pattern and distribution throughout a year, the selection of dates of the acquired data were made in the same annual season of the acquired years.

Once the image was downloaded, seven similar bands were extracted and used to make the LULC map. Then, corrections like projection of the datasets with the standard formats were made after lay stacking.

The study of land use land cover change usually requires the development and the definition of homogeneous land use land cover units before the analysis is started to classify the various land use cover classes of the study area. These data were distinguished using the available data source such as priori knowledge of the study area, physical site observation, reports, field observation, Google earth and other relevant information and previous local knowledge. Based on the pattern, tones, textures, shapes and site associations to get information about the purposes for which lands are being used; land cover types would easily be identified. Hence, based on the priori knowledge of the study area and additional information from physical site observation in the study area, five different types of LULC have been identified. These detail description of the LULC classifications are given in table below.

Table 1: Land Use Land Cover Classes and Their Description

Land cover classes	Description
Agricultural Land	Areas used for crop cultivation, both annuals and perennials, and the scattered rural settlement that are closely associated with the cultivated fields. It includes areas currently under crop, fallow and land under preparation. The two land cover types were combined due to the reason that it was difficult to identify the dispersed rural settlements as a separate land cover type and cultivated lands exist around homesteads.
Built-up	Residential, commercial and services, roads, public installation, infrastructures. Due to their similar reflectance, bare lands were considered here.
Forest Land	Land covered with dense trees and undergrowth that formed nearly closed canopies.
Grassland	Grassy areas used for communal grazing, including wetlands, as well as bare lands that have very little grass or no grass cover (exposed rocks). It also includes other small seized plant species.
Shrubland	Areas with scattered trees mixed with short bushes, grasses and open areas

3.4.4.1. Image Classification

Image classification is the process of assigning pixels of continuous raster image to the predefined land cover classes and it is an operation of replacing the visual analysis of images with quantitative means for the identification of features in a scene (ERDAS, 2013). This operation involves the investigation of multispectral image data and the application of statistically based decision rules to determine the land cover identity of each pixel in an image.

The choice of the image classification method depends on the availability of ground truth data, Information/knowledge about the study area and purpose of the LULC map. The supervised classification relies on the prior knowledge of pattern recognition of the study area. Therefore, supervised classification is most recommended if the study area is known. On the other hand, unsupervised classification is used if you have no nay ground data/information about the study area. As the researcher was used to work in the study area

and have detail information about the study area, supervised classification supported by ground truth data was used in this study.

3.4.4.2 Unsupervised classification

Unsupervised classifications are the one used when the spectral distinctions that are inherent in the data are used to determine the classes. This enables to define contiguous and easily recognized regions. Unsupervised classification uses ISODATA (Iterative Self-Organizing Data Analysis Technique) clustering method which applies spectral distance as in the sequential method to classify pixels iteratively. Because the ISODATA method is iterative, sometimes there exists miss classification of the land use.

3.4.3.3 Supervised classification

The supervised classification type is the one in which all pixels with similar spectral value are automatically categorized in to a land cover classes or themes. The classification relies on the prior knowledge of pattern recognition of the study area. It requires the manual identification of point of interest areas as reference or ground truth within the images, to determine the spectral signature of identified features. For this study, the land cover map was produced based on the pixel based supervised classification with the maximum likelihood decision method.

3.5 Statistical analysis

Statistical software for social science (SPSS) version 20.0 was used to analyze the soil data. P-values less than 0.05 were deemed statistically significant when comparing the treatment means using the Tukey-test. Pairwise Pearson Correlation was used to see any correlation among the some variables. Socio-economic data was analysed using qualitative and quantitative data analysis and displayed in table. Data analysis and parts of the research using SPSS version 20. Descriptive statistics such as mean, percentages, and frequency were used and then presented as tables and graphs.

4. RESULTS AND DISCUSSION

4.1. Socio-economic characteristics of the respondents

4.1.1. Age, Gender, Education and Family size

The data collected from the respondent shows that the sample from the total respondent households includes 26 (22 %) female-headed and 91 (78%) male-headed. From a total of respondents interviewed their age composition shows that less than 30 years 14 (12.7%), 31-4 years 57(48%), 41-50 years 37(31.6%), 51-60 years 5(4.3%) and above 60 years 4(3.4%). From a total of respondents interviewed their education level shows that illiterate 27(23.2%), grade 1-8 63(53.6%), above grade 9 27(23.2%) see table 2.

Knowing the status of Age, gender, household family size, educational level and land ownership are important for pre planning of GLI campaign. For the Achievement of the Green Legacy Initiatives Tree Planting Campaign knowing the age of the population, the number of women in an area, and the number of households in the plantation area is important. The availability of educated manpower also plays a role in improving the quality level in this work also private land ownership is crucial for focusing of pre-planting land preparation and post-planting monitoring and follow up. And also identifying the age distribution plays an important role in the Green Legacy Initiative tree planting campaign. Because it helps to know the amount of manpower used for tree planting by identifying the under age and elders from the total population.

Table 2:Gender, Age, Education and Family size of respondent

Variable	Category	F	P
Gender	Male	91	78
	Female	26	22
	Total	117	100.0
Age	<30 years	14	12.7
	31-40 years	57	48
	41-50 years	37	31.6
	51-60 years	5	4.3
	>60 years	4	3.4
	Total	117	100.0
Education	Illiterate	27	23.2
	grade 1-8	63	53.6
	above grade 9	27	23.2
	Total	117	100.0
Family Size	1-3 children	25	21.4
	4-6 children	61	51.8
	above 6 children	31	26.8
	Total	117	100.0

Where, F: Frequency P: Percentage

4.1.2. Farmland ownership

The all respondents 117(100%) had their own farmland and from the total landholding size of respondents indicated that 38 (32.1%) had less than 1 ha, 56 (48.3%) had 1-2 ha, 23(19.6%) respondents had above 3 ha of landholding size in the study area. As 44(76.8) and 12 (21.4%) respondent indicates income of the farmers in the study area mainly generate from mixed farming and from crop production respectively. Permanent and perennial crops mainly Coffee, Avocado, Teff, Maize, and other fruit and vegetables production and also livestock and bee keeping that they were engaged.

In the villages where we conducted this study, people with extensive land are engaged in various types of agricultural activities. Their agricultural activities include crop cultivation, coffee cultivation, livestock and bee keeping. For example, in the surveyed villages, 92(78.6%) of the respondents were engaged in various agricultural activities and these farmers were also involved in GLI on the other hand, smallholder farmers in these villages are engaged only in cereal crop farming (Table 3). My finding similar to Kulindwa, 2016; Etongo *et al.*, 2015; Mekonnen and Damte, 2011 the size of the farm that a household owned is positively correlated with the number of trees growing.

Table 3: Main activity, Farmland ownership, and Farmland size and Trend in land size

Variables	Category	F	P
Main Activity	Crop production	25	21.4
	Mixed farming	92	78.6
	Total	117	100.0
Farmland Ownership	have farmland	117	100.0
Farmland Size	less than 1 hectare	38	32.1
	1-2 hectare	56	48.2
	above 3 hectares	23	19.7
	Total	117	100.0
Trend in Land Size	Increasing	15	12.5
	Decreasing	29	25.0
	no change	73	62.5
	Total	117	100.0

Where, F: Frequency P: Percentage

4.2. Challenges and Opportunities for Implementations of GLI

4.2.1. Community Perception, participation, and Seedling Preference on GLI

From sampled households of this study area, 86.1% was participated in the GLI campaign and 13.9 were not participated because of different cases. Respondents who do not participate in the GLI campaign mention various reasons for not participating in campaign. The reasons that respondents mention was include out-of-doors, illness and few women do not participate due to motherhood on the day of the campaign tree planting. These finding is good agreement with the study conducted by Gwedla et al. (2022), 75 % of residents expressed willingness to participate in tree planting and maintenance and also These finding is similar to Beyene, A.D. and Shumetie, A., (2023) From the sampled households 86- 94% participated in the GLI.

Table 4: Participation, Seedling preparation, Use association and Trends in association

Variables	Category	F	P
Participation	Participated	101	86.3
	Not participated	16	13.7
	Total	117	100
Seedling preparation	seedling preparing	74	63.3
	Not preparing	43	36.7
	Total	117	100
Use association	use association	27	23.2
	not use association	90	76.8
	Total	117	100.0

Where, F: Frequency P: Percentage

On the other hand, community seedling preparation accounted 63.3% and 36.7% are not prepare seedling and gaining the seedling from government and also from other sources.

Out of prepared seedling for GLI program 23.2% and 76.8% of the study area prepared by using association and individually by people respectively. The finding of this study shows that the planting of tree in GLI program has been well accepted by the people since it was announced by the Prime Minister in the summer of 2011 E.C. Not only accepted the planting of trees at the idea level but also the people broadly involved in the planting of tree that conducted by GLI program year after year since 2011 E.C.

Most of the seedling that planted year after year by GLI program are prepared by the people and according to my research finding, most of the people prepare different kind of seedlings at household level individually and others establish nursery site by organizing themselves in associations and prepare various types of seedlings for selling purpose and also to planting by themselves. The trend for seedling preparation has been increased since the GLI program started; this might be due to training provided by extension workers and other NGO'S that has been involving in the study area and the requirement of the seedling is also increased. In addition, the community has an experience of different types of seedling preparation in the area.

The overall tree planting campaign was participatory in that the youth and elderly, male and women, educated and uneducated, employed or unemployed, were all involved in the tree planting campaign. The initiative was successful in terms of participating different groups of the society in all three-study area where sample taken. 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 (see table 4).

According to discussions from the FGD in 2015 EC, since 2011 E.C, most of the community has been actively participating in the Green Legacy Initiative campaign. The trees planted under the Green Legacy Initiative Program over the past four years have also yielded good results. The benefits to the community include environmental beauty, additional sources of income, improved community work culture, wider employment opportunities. Agroforestry, which was previously not widely known, is becoming more common. Various benefits are being obtained from the same land, and the productivity of the land is increasing as a result of this work. Especially in the discussion conducted in Ganji Chala (Gure Ganji sub watershed), where we conducted the FGD discussion on coffee development cluster (Agroforestry plantation site), they are getting great benefits from the Green Legacy Initiative. In the previous time where we had been cultivating various types of crops for many years, eventually stopped producing, and we had no choice but to switch to livestock. As a result, we were left without food crops and income from these lands.



Figure 2: Plantation site prepared on April 2012 E.C in Ganji Chala kebele Gure Ganji Water shade kore coffee cluster. Source: Gera District Agricultural office.

However, in 2012 E.C., we were included in the Green Legacy Initiative Campaign and received technical advice and support from the government and agricultural experts to plant coffee trees on our land in a scientific way continuously. In 2014 E.C, we harvested the first product (good news) from these coffee plantations and in 2015 E.C., we started to receive a sufficient Coffee product (FGD, 2023). According to Turner-Skoff and Cavender, 2019, the current tree planting program in Ethiopia could provide our country the opportunity to meet 15 of the 17 internationally supported United Nations Sustainable Development Goals.



Figure 3: Kore coffee cluster (Agro forestry plantation site) planted in GLI on 2012 E.C at 3 years stand over view in Gure Ganji Watershed; Photo taken on June 2015 E.C when data collection was conducted.

In addition, according to Focus Group Discussion in 2023 with the community in the coffee cluster/Agroforestry plantation site, they tell us that among the results from the Green Legacy Initiative Campaign are coffee, banana, disho grass, and elephant grass, vetivar grass on

coffee fields for soil and water conservation, and in addition using vetivar grass for various construction purposes. On the other hand, the Green Legacy Initiative campaign in the area of the coffee development cluster aims to improve the culture of community work.



Figures 8: a



Figures 8: b



Figure 8c



Figure 8d

Figure 4: a,b,c,d shows Stand of kore coffee cluster in Gure Ganji watershed (Agroforestry plantation site) planted in GLI integrated with Banana, vetivar and disho grass; Photo taken on June 2015 E.C at 3 years when data collection was conducted.

The owners of large land have allocated land to their young sons who have completed their 10th and 12th-grade education. This initiative has also enhanced the work culture of youth and local communities (FGD, 2024). One of the benefits mentioned by the community is that

the bare land was planted coffee plantation with shade trees, resulting in increased forest cover. The planting of coffee has also created a favourable environment for increasing production, enabling us to actively participate in this activity and achieve good results from it.

In Sadi-Loyya villages of Gicho sub Watershed, where tree planting campaigns were conducted on the land of Gicho Secondary School, we discussed with the Focus Group Discussion (FGD) in 2024 about the community. The growth rate of the Gravellia and Pine (Gaতিরaa) trees planted under the Green Legacy Initiatives Program is promising and expected to bring many advantages to the school. Among the results of the Green Legacy Initiatives is the transformation of land previously unused for other activities into a more attractive area by planting Gravellia and Gaতিরaa trees. The community members mentioned that they have also planted trees in their own home garden, enhancing the beauty of the neighbourhood. Additionally, by planting food plants such as Avocado, Gishxa and different types of fruit trees they expect to profit from these plants in a short period of time.



Figure 5: Plantation site in sadi Loyya kebele Gicho sub watershed at Gicho secondary school, planted in GLI; planting year 2012 E.C. at 3 years stand Photo taken on June 2015 E.C when data collection was conducted.

According to conducted survey and KII trees planted on communal land in Wogecha village in Medda sub watershed and we observed that the conservation of the planted trees is much lower than that planted on private land and school land. During the discussion with the FGD team in 2024, the idea raised in the area was that the communal land on which the trees were planted was previously used by the local community for grazing. It was mentioned that by allowing livestock to moving freely and graze amongst the newly planted trees, there's a risk

of damaging the vegetation. As the researcher conducted KII, there were an expressed concern that they are more accustomed to utilizing the land for grazing rather than appreciating and protecting the vegetation that has been planted in the case of communal land. These finding is similar to Amare et al(2017b) Tree survival rates in communal lands tend to be low, as maintenance is not carried out and grazing is not controlled.

During the FGD with the community, it was suggested that when planting trees on communal land, the selection of tree species should not align with the needs of the local community, rather than solely relying on the types of trees supplied by the government. The community proposed that the trees planted on public land should primarily consist of food plants that can benefit both humans and wildlife, thereby attracting animals back to the area. The seedlings currently planted on the land do not match the community's needs, as they were selected from a variety of tree species provided by the government. Consequently, the community lacks interest in conserving these plants (FGD, 2023). My finding is similar to Beyene, A.D. and Shumetie, A., (2023) 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.



Figure 12a

Figure 12b

Figure 6:a and b Tree planting in Wogecha kebele Medda water shed planted on communal land in GLI; plantation year 2011 E.C Photo taken on June 2015 E.C at stand of 4 years when data collection was conducted.

Further discussions during the FGD sessions on the tree planting initiatives in the sub watershed of these sadi Loyya villages highlighted that the tree planting efforts are often not aligned with the needs of the residents. Instead, the focus has been on planting exotic tree species like *Grevillea* and *Pine* (Gaতিরূপ). It was noted that only a few locations have indigenous tree species such as *Woddessa* (*cordia africana*) planted. It was suggested that

future plantings should prioritize the needs of the community, emphasizing the importance of planting tree species that are beneficial and relevant to the local residents.

The community mentioned that if they were to be supported by the government in their area, they would prefer planting crops such as coffee, avocado, bananas, inset, Woddessa from indigenous tree species, and also increasing the planting of apple seedling to enhance food security to increase their income. They believe that planting apple and avocado trees among other edible fruit plants could provide them with additional income opportunities. Moreover, they highlighted the importance of focusing on selected high-quality seedlings for plant cultivation and improving the variety of grasses for livestock breeding and fattening. The community feels that prioritizing better plant seeds and grass varieties would be more beneficial for their agricultural practices.

The study collected information on people's perception about the benefits of GLI 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. These finding is similar to Beyene, A.D. and Shumetie, A., (2023) 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 and also creating employment as well as improve livelihood of the local people.

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. According to the FGDs result on this study area, they said that planting of trees was sustaining our environment and coffee yield increased. These ideas of the farmers were similar to the study conducted by Fentaw *et al.*, (2022) was evidenced of the green legacy initiative's positive effects on biodiversity conservation and ecosystem restoration which promotes healthy environment.

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 and Government institutional has an incentive as the financial return is attractive and solely grabbed by the owner. This finding is similar to Mwambusi et al.(2021), Local people have been encouraged to plant trees on their own land for better access to non-timber forest products such as fruits and nuts.

As shown in figure 7 below majority of the study area was covered by grazing land and next to grazing land covered by crop land and degraded land respectively before green legacy initiative campaign.

To continue the success of the GLI, the people should continuously participate in the GLI tree planting program as well as the concerning body should conduct monitoring continuously in the post-planting follow up and management. The research finding shows that people in many places have benefited from the trees planted by GLI program in different directions and the results from the GLI in these few years are crucial for the sustainability of the initiatives

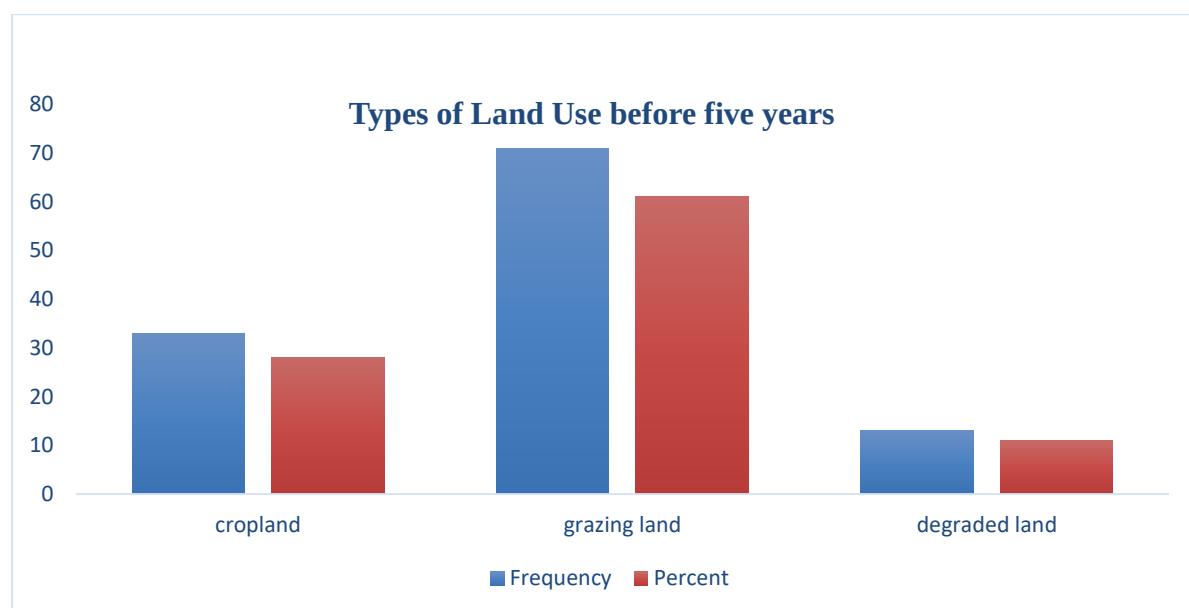


Figure 7: Types of land use before five years

4.1.2 Pairwise Pearson Correlation result for some variables

To determine if there is a positive or negative association for a given variable, we performed pairwise Pearson correlations in this study. The selection of a site is significantly correlated negatively with the status of the green legacy establishment. This suggests that in order to

implement GLI, we should take into account the land use classes from earlier. For example, since most GLI coordinators are not specialists, most of them plant trees on agricultural and wetland areas. They lack a thorough understanding of the purpose of GLI and the significance of wetlands. The research site has the same experiences as we have with our GLI implementation. For the most part, GLI practice has been done without enough planning. Any policy implementation should consider the environment and social aspects. The study also observed seedling preference as a constraint in the study area. Furthermore, as most farmers prefer to produce food crops over non-edible ones, it has a detrimental effect on GLI. It might be beneficial to honor their choice while planting trees as a GLI activity.

Table 5: Pairwise Pearson Correlations

Independent variables	Dependent variables					
	Trends in association		Types of LU before 5 year		GL site selection criteria	
Status of GL	P-value	r ²	P-value	r ²	P-value	r ²
	0.008	0.353	0.000	0.536	0.020	-0.310
Challenges					0.014	-0.328

Independent variables	Dependent variables					
	Main Activity		Seedling preference		Livestock	
Opportunities	P-value	r ²	P-value	r ²	P-value	r ²
	0.014	0.327				
Constraints			0.003	-		
				0.396		
GL Site selection criteria					0.007	-0.356

Tree roots can increase soil porosity by creating macro pores and improving soil structure (Bodner *et al.*, 2021). The above research results suggest a positive linear relationship between tree root density and soil total porosity and non-capillary porosity and restoring soil

porosity is critical for successful tree establishment the long term effects according (Busse *et al.*, 2021). Studies on the soil organic matter content, which increases with tree litter input, is an important factor influencing soil porosity and bulk density and higher organic matter generally leads to increased porosity. The effects of trees on soil properties depend on many interacting factors like tree species, age, soil type, climate (Bosela *et al.*, 2023). Simple linear correlations may not fully capture these complex relationships and more research is needed to quantify the effects of tree planting on soil physical properties across different contexts.

4.1.3. Challenges

According to community survey conducted and discussions with the FDG and KII teams in June 2015 E.C., one of the problems in the Green Legacy Initiatives campaign is that the seedling offered by the government for planting are not based on community needs.

Table 6:challenges with respective to categorical variable

Variable	Category	Frequency	Percent
Challenges	Failure to properly plan	23	19.7
	There is a lack of wisdom	25	21.4
	Less caution to plant more tree seedlings.	27	23.1
	Not taking care of the planted seedling	42	35.8
	Total	117	100

Where F: Frequency; P: percent

As table 6 indicated failure to properly plan is accounted 19.7% and 21.4% of surveyed HH represented that there is a lack of wisdom. And also 23.1% and 35.8 represented less caution in order to plant more tree seedlings and not taking care of the planted seedlings respectively.

From these finding everyone can understand that, failure to properly plan is an efficient way of planning planting tree during GLI is not planned in advance for the planting period to be limited by the agro ecology of the area where the tree is planted and to start on such date and end on such date, the widespread problem in identifying and planning planting sites in this initiative. There is a widespread difficulty in planning and preparing the seedlings that the community needs in an efficient manner. On the other hand, it was understood from our interviews and discussions with FGDs and KIIs that there are widespread problems in selecting the right place for planting trees in advance and making adequate site preparation.

Especially in areas where GLI planting is conducted on common land and roadsides in many places the land used for planting is on common livestock pastures and wetland areas and priority planting arrangements, adequate site selection are widespread problems and also clearing and preparing planting sites are other problems that the plants do not germinate properly and there are problems in growing properly. Discussions with FGD and KII revealed that the problem of Green Legacy Initiative tree planting sites is not conducted properly in advance due to the lack of proper site selection.

In many places where the trees were planted on common land, the trees were not properly maintained, and adequate monitoring and control was not done by the government authorities the biggest problem appears in the GLI. Among the study area this problem is also evident in Wogecha village of Medda sub watershed where common land is planted on communal land of public livestock grazing area. The community inefficiency in GLI tree planting program and post-planting care was led to wisdom because of lack of adequate technical support by the relevant professionals in a continuous manner as well as the main problem in GLI tree planting program is the lack of advance and in adequate planning. This issue is an obstacle to the success of GLI program and should be addressed by the relevant government bodies.

4.1.4 Opportunities and benefits

The bellow table 7 presented the opportunities and benefits that enhance the GLI program in the future. For instance, majority of the households (32%) accounted have awareness in tree plantation. And also, to sustain these GLI around 24% of seedling was provided by government rather than preparing by community. And also, in case of availability of communal land in mass accounted 9% of the entire populations surveyed. Availability of technical support accounted 24% and seedling availability from other source indicated 10%. If the trend continuous in these way it is essential for sustainability of the GLI at all level. This finding is similar to the study conducted by Beyene, A.D. and Shumetie, A., (2023) 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.

It was evident from the questionnaires collected from the community and discussions conducted with FGDs and KIIs in 2015 E.C at the three research sites that the people are

widely benefiting from the Green Legacy Initiative campaign. In table 7 below the result show that out of the total respondents interviewed 41% improved their work culture, 34% gained additional income from their land and 25% of them indicate the GLI created employment opportunities for youth; In addition, the afforestation of the environment has created new opportunities for increasing production. These finding is similar to Kassa *et al.* (2017), activities that improve human wellbeing both now and in the future by restoring the ecological and productive functions of damaged agricultural landscapes and forests are included in Ethiopia's understanding of FLR. For example, full technical support was provided to the farmers through experts, and the Coffee planted by the Green Legacy Initiatives Program was based on the needs of the people. Many coffee plants from previously unproductive private farmland, converted to coffee land are now starting to yield enough. Farmers have begun to improve their livelihoods as they earn sufficient income from this land, using coffee for income, improved fodder grass like disho planting to provide better grass for their livestock. The experience of agroforestry is becoming familiar and spreading among the community, while soil and water conservation works are being widely coordinated with these activities around this watershed.

The farmers who planted coffee in clusters under the GLI Program have started improving their livelihoods with the benefits they gained from coffee production. My finding is similar to study conducted by Wiebe *et al* (2022) ; Ali *et al* (2020); Beyene *et al* (2019) Forest products play a significant role in the livelihood of rural communities in Ethiopia.

The benefits they have gained from the coffee production visited and experience was shared by the farmers of the Gera district and Jimma zone as well as in various directions as Oromia state and as a country level. And the coordinated soil and water conservation work done here has started to give importance. On the other hand, in this GLI work, experience of Agroforestry practice gained which was not previously known in the district.

Table 7: Opportunities and benefits gained from Green Legacy Initiative

Variables	Categories	F	P
Opportunities	Supply of Seedling from Government	29	24
	Communities awareness in tree plantation	38	32
	Availability of communal land for tree plantation in mass	8	9
	Availability of technical support	29	24
	Seedling availability from other sources	13	11
	Total	117	100
Benefits gained from GLI	Employment opportunities for youth	29	25
	Improved work culture	48	41
	Additional income from their land	40	34
	Total	117	100

Where F: Frequency; P: percent

4.3 The status of land use land cover change in the context of Green Legacy Initiative

The study from the ground truth data and classified Landsat images of 2018 and 2023 revealed that, the three-plantation site considered in this study has undergone LULC changes over the past four years. However, the rate of the LULC changes varied with the LULC classes in each case (Table 7). Agricultural land and Forest land were the dominant LULC classes of the areas. However, the forest land cover is smaller in Wogecha compared to the Sadi loyya and Ganji Challa. Built-up covers the smaller portions of the areas in all cases except for Ganji Challa where Grassland was the smaller LULC in 2023.

Both the communal and private grazing lands are decreasing as land areas are used for cultivation as the trend of the area is to use the lands for cultivation. In this regard, small area of land is used for grazing which leads to overgrazing. Furthermore with current status of the catchment the need to use charcoal and fuel, timber and wood works are the other factors for which the forests are destroyed.

From the field observation, it was seen that some farmers are destroying natural forests to own the land. After cutting the natural forests they used to plant trees like eucalyptus which will be considered as a private property, by doing this, they expand the land informally.

Information from the key informant interview indicates that urban development, declining of soil fertility, scarcity of water for agricultural uses, lack of profitability of farming and relative depreciation of agricultural lands are the major factors that drives socio- economic activity of the community to contribute to land use change. Furthermore, assessment on how the demographic activities of the community contribute to land use change revealed the need to farm more land, grazing land mismanagement, the use of inadequate and improper agricultural practices were the major driving factors.

Table 8:LULC status and change between 2018 and 2023.

LULC Class	Sadi Loyya		LULC Change	Wogecha		LULC Change	Ganji Challa		LULC Change
	Area in Ha		2018-2023	Area in Ha		2018-2023	Area in Ha		2018-2023
	2018	2023	%	2018	2023	%	2018	2023	%
Agricultural Land	933.57	940.59	0.75	856.44	867.87	1.33	954.99	857.52	-10.21
Built-up	57.06	59.49	4.26	14.04	14.4	2.56	63.99	76.59	19.69
Forest Land	761.58	731.52	-3.95	57.06	61.2	7.26	620.73	649.98	4.71
Grassland	162.18	145.35	-10.38	51.93	30.42	-41.42	75.51	59.85	-20.74
Shrubland	164.43	201.87	22.77	40.86	46.44	13.66	174.78	246.06	40.78
Total	2078.82	2078.82		1020.33	1020.33		1890	1890	

*negative in the table shows a decreasing change/trend of the LULC type

The LULC change analysis indicates that it is only the Built-up and shrub land, which have continually increased in all areas whereas grassland have continually declined in all areas. Agricultural land area has increased in Sadi Loyya and Wogecha while it has declined in Ganji Challa areas. Forestlands are increased in Wogecha and Ganji Challa and have shown a declining rate in Sadi Loyya. However, the change rates of each class are different.

The continuous declines of the grasslands in all areas are attributed to the increasing agricultural land. This could be resulted from the need of an increasing population demand to get the resources and farm more land. The field observations and ground truth data revealed that, youths are organized by the Government to cultivate the communal grazing lands to create work opportunities for the youth in all areas. As a result, the coverage of these fresh resources is getting diminished. On the other way, population growth persuades LULC changes through the use of more land for cultivation reducing the land occupied with natural

ecosystems. An increase of built-up areas would be as a result of the increase in infrastructures.

With respect to the initiation of the green legacy in the areas, Ganji Challa has shown a promising increase in shrub lands and forest covers than the other areas. The increase in forest land in Ganji Challa is attributed by the high number of institutions established in the area for agro forestry. This could be attributed to the good protections for the plantations by controlling free grazing. Comparatively, the Wogecha area has shown a minimal change for the green legacy works. Field observations to the sites have shown that, there are not any protections for the plantation in Wogecha area and animals are used to graze the areas without any control. In Sadi Loyya, the areas used for green legacy have also shown improvements in Shrubland covers. However, large areas in the Northern part of Sadi Loyya have shown a high decline of forest cover due to agricultural expansions.

From the result analysis, unless the mode of utilizing and handling of the resources are changed, we are going to lose the grasslands resources in shortly if the current trend continues. This would necessitate human intervention at different level (governmental and non-governmental involvements), for proper utilization of the resources without damaging the resources so that the future generations will get it.

Physical observations, FGD and KII information reveals that LULC change was derived by both anthropogenic and natural process. However, anthropogenic activities are found to be predominant and immediate than the natural process and they also enhances the natural process which worsens the effects of the land use land cover. Some of the natural processes like aridity, drought and climate change are cumulative. However, the effect of these processes will take time and requires huge resources to reverse. Erosion process, landslide, gully, flooding and climate changes were the major natural process that were identified as the major driving factors of LULC change in the study area. Demographic activities, socio-economic drivers, rural-urban immigration and fast increase of urban plot land prices were among the major anthropogenic factors that drives the land use/land cover change in study area.

The spatial LULC maps of the areas are shown in Figure 8, 9 and 10 for Sadi Loyya, Wogecha and Ganji Challa respectively.

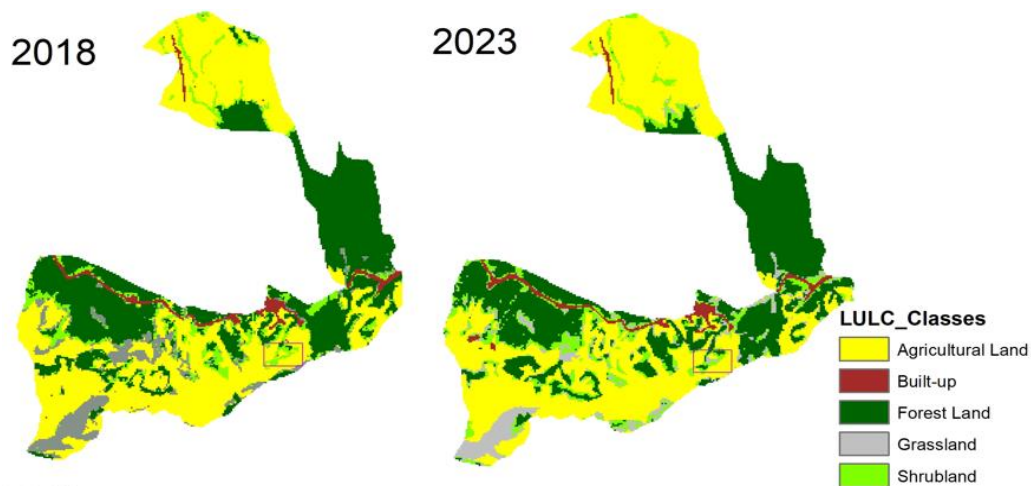


Figure 8:LULC maps of Sadi Loyya.

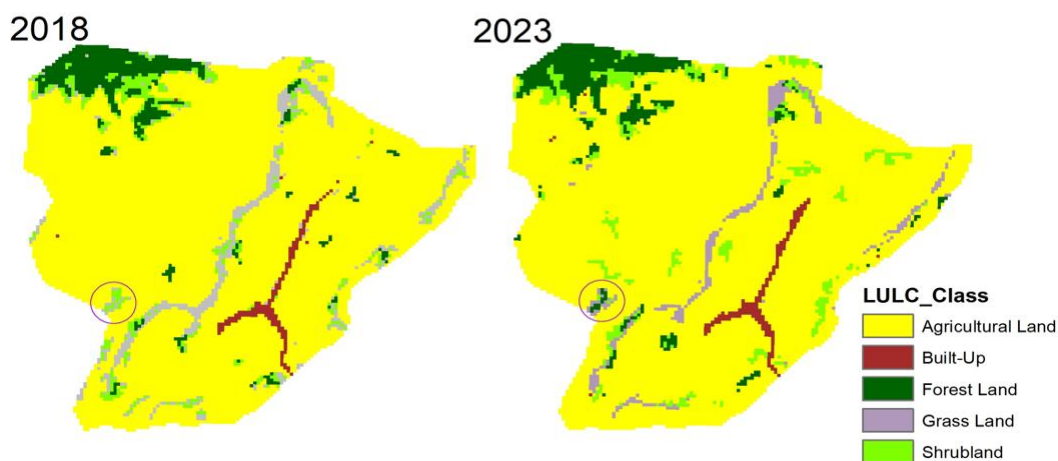


Figure 9:LULC maps of Wogecha

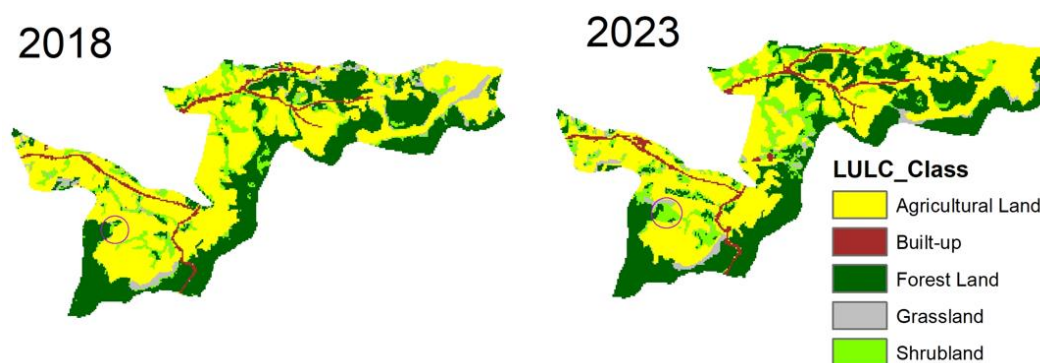


Figure 10: LULC maps of Ganji Challa

Comparative analysis of the LULC changes in the three areas revealed that, the highest increase by shrubland is found in Ganji Challa followed by Sadi Loyya. On the other hand, Wogecha followed by Ganji Challa shows the highest decline in grassland. The needs to cultivate more land have not been limited to deforestation only but also draining the swamp and wetlands for farm. This could in turn have resulted in decreased grassland areas.

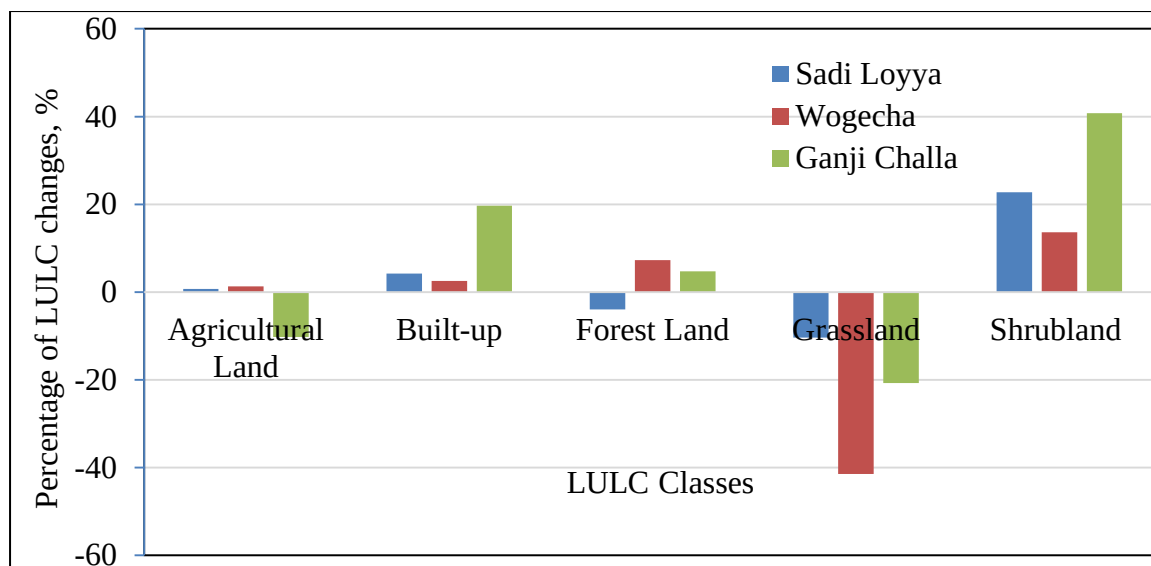


Figure 11: Percentage of land use land cover change over the period of time

4.4. Effects of GLI on Soil Properties

To observe the short-term effect of GLI on some selected soil properties, we conducted soil analysis and observed the following results. In table 7 the soil parameters have shown non-significant variations among the three sites. This might be explained, the effect of GLI (tree planting) could take sometimes to show visible effects.

Table 9: Soil Physical and Chemical Properties data

ANOVA Table			Sum of Squares	df	Mean Square	F	Sig.
pH	Between Groups	(Combined)	.083	2	.041	.398	.676
	Within Groups		2.496	24	.104		
	Total		2.579	26			
BD (mg/cm ³)	Between Groups	(Combined)	.035	2	.017	.989	.387
	Within Groups		.424	24	.018		
	Total		.459	26			
Porosity (%)	Between Groups	(Combined)	56.000	2	28.000	1.182	.324
	Within Groups		568.667	24	23.694		
	Total		624.667	26			
MC (%)	Between Groups	(Combined)	30.005	2	15.003	2.202	.132
	Within Groups		163.536	24	6.814		
	Total		193.541	26			
OC (%)	Between Groups		7.786	2	3.893	0.623	0.544
	Within Groups		149.893	24	6.245		
	Total		157.68	26			
AvP	Between Groups		0.0274	2	0.0137	2.518	0.102
	Within Groups		0.131	24	0.0054		
	Total		0.158	26			

The research finding suggest that reforestation in the study area during the GLI has a non-significant effect on soil Porosity, MC, BD, AvP, and OC with ($p < 0.05$). However, there is slight difference for porosity, Bulk Density, MC and AvP, among groups, which is crucial for improving soil quality and ecosystem health (Berio Fortini *et al.*, 2021). The positive increment on soil porosity is attributed to factors such as organic matter addition of initial leaves from young trees in the topsoil, all of which are enhanced through reforestation efforts as reported by (Seifu *et al.*, 2023). Therefore, the research indicates that reforestation as part of the GLI might slightly improve soil porosity, contributing to the restoration of degraded ecosystems and promoting sustainable land-use practices in the study area.

The study indicates that afforestation has shown non-significant effect on soil properties, this might be due to the shortest time result. To observe the significant effect of GLI on soil physico-chemical properties, we should wait minimum above four years. The previous study

indicated that forest soils typically have low bulk density due to organic matter content and affecting compaction levels (Kiumarsi *et al.*, 2024). According to Tenkir *et al.*; 2024, afforestation can alter soil density, affecting physical, chemical and biological soil quality. Therefore, when comparing several studies with My findings, the impact of forests on soil bulk density varies depending on factors such as organic content, compaction from logging operations and specific responses of tree species to several soil bulk density changes, (Nazari *et al.*, 2023, Guo *et al.*, 2023 and Yao *et al.*, 2023).

The results of this study show that within four years afforestation, there is small improvement on soil properties in the study area. However, the research findings by (Eshete *et al.*, 2023) suggest that short-term reforestation impacts on soil moisture can be significant, especially in areas where the land has been deforested or degraded. The other studies indicate that in intensively farmed lands targeted for forest restoration, key hydrological processes may not be fully restored through forest regrowth or reforestation (Filoso *et al.*, 2017). Additionally, the positive feedbacks between forest vegetation and its physical environment needed to restore the system back to its original state may not always be achieved (Zeleeke and Vidal, 2020) because it focuses only on the visible and the larger plants, but those that are the basis for the large plants it is invisible to the naked eye and (Wassie, 2020) landscapes that have been unable to recover spontaneously after a prolonged period without forest cover.

Melese Z., 2022. Reforestation can have positive impacts on soil moisture in the long term and while the short-term effects may vary depending on the specific conditions of the deforested area and the success of the restoration efforts.

The GLI reforestation combating deforestation, increasing forest cover and restoring ecosystem services in the study area where the specific impact on soil pH levels may not be significant difference with ($p > 0.05$) according to My research findings. GLI primarily focus on combating deforestation, increasing forest cover and restoring ecosystem services. According to Garuma 2020, Soil pH levels are influenced by various factors, including vegetation types, soil composition and agricultural practices, which may not be directly addressed by tree planting.

To ensure the validity of soil test results, we were used laboratories use quality control measures such as reference materials, blanks and replicates. Reference materials are soils with known nutrient content, which are analyzed regularly to verify the accuracy of the

testing methods. Blanks are samples with no added nutrients, used to detect any contamination or interference during the testing process. Replicates are multiple analyses of the same sample, used to assess the precision of the results.

My studies have consistently shown that afforestation leads to a decrease in soil bulk density. This decrease is attributed to the increase in soil organic carbon (SOC) content, which is a common outcome of afforestation efforts. The higher SOC content in afforested soils contributes to a lower bulk density due to the lower density of organic matter compared to mineral soil particles, accordingly (Varnagiryte *et al.*, 2021). The decrease in bulk density green legacy initiative tree planting has several implications in future on soil health and ecosystem function and also to improve soil structure, increase water infiltration and aeration and enhance root growth and microbial activity, overall developments of ecosystems.

In the short term, the Green Legacy Initiative may not significantly alter soil properties especially chemical properties. The planting of trees and other perennial crops can initially disrupt soil ecosystems, leading to temporary changes in soil structure, nutrient cycling and microbial communities as reported by (Bodner *et al.*, 2021).

However, in the long term, the initiative is expected to have a profound impact on soil properties. As trees and perennial crops mature, they can enhance soil organic matter, improve soil structure and increase nutrient availability. The roots of these plants can also help to stabilize soil, reducing erosion and increasing water infiltration. Furthermore, the initiative's focus on agroforestry and conservation agriculture practices can lead to improved soil health, increased carbon sequestration and reduced greenhouse gas emissions.

The difference between short-term and long-term effects is essential in interpreting the results of the Green Legacy Initiative. If assessments are conducted too early, it may not capture the full benefits of the initiative on soil properties. Conversely, long-term monitoring and evaluation are necessary to fully understand the initiative's impact on soil health, fertility and ecosystem services. The Ethiopian government's commitment to sustainable growth and climate resilience, as outlined in its Long-Term Low Emission and Climate Resilient Development Strategy, underscores the importance of considering both short-term and long-term effects in evaluating the initiative's success.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

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. The initiative was successful in terms of participating different groups of the society in all. While this is an encouraging step, continuous involvement of the various groups of the society in post planting activities is necessary. The growth rate of the trees planted under the Green Legacy Program is promising and expected to bring many advantages to the community.

Conservation of trees planted on communal land in Wogecha kebele Medda sub watershed was much lower than that planted on private land and school land. The community concern that, they are more accustomed to utilizing the land for grazing rather than appreciating and protecting the vegetation that has been planted in the case of communal land. The community suggested that when planting trees on communal land, the selection of tree species should not align with the needs of the local community, rather than solely relying on the types of trees supplied by the government. The community proposed that the trees planted on public land should primarily consist of food plants that can benefit both humans and wildlife, thereby attracting animals back to the area rather than the resident garden.

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. 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.

This study was focused on Land Use Land Cover Change Detections under the Green Legacy Initiatives in Gera District, South western Ethiopia. Future researchers can expand the study by expanding its scope to Jimma Zone or the Oromia Regional State in order to have generalized views. Also, the future researcher will add variables to expand the scope of this topic.

5.2 Recommendations

The following listed recommendations should be considered in Green Legacy Initiative.

- **There are 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.
- **Seedling species planted under Green Legacy Initiative program should be based on the needs of the community:** The selection of seedling species should be based on the specific needs and preferences of the community. Consideration should be given to factors such as environmental benefits, cultural significance, and local demands.
- **Planting should focus on edible plant species:** Emphasizing the cultivation of edible plant species can have dual benefits of greening the environment and providing additional food resources for the community. This can contribute to food security and promote sustainable agriculture practices. In addition, focusing on specific socioeconomic condition of the local community during the initial stage of the tree planting program is important to the success of the initiatives. This includes, among other activities, creation of income generating activities, and also providing seedlings of appropriate tree species for private tree planting in GLI program.
- **Where trees are planted, the focus should be on local trees:** Prioritizing the planting of native or locally adapted tree species can enhance ecosystem resilience, preserve biodiversity, and support the local ecosystem. Local trees are more likely to thrive in the existing environmental conditions and require less maintenance compared to non-native species.
- **Attention should be paid to technical support and post-planting follow-up on the Green Legacy Initiative planting campaign:** Due to lack of technical support, the seedlings planted by the Green Legacy Initiative Campaign have been exposed to various problems in different places. The most important part of the GLI is not only to plant as many seedlings as possible. It is necessary to consider the technical support such as giving training for stake holders and awareness creations for the community on pre planting and post planting handling. There should be proper planning and selection of appropriate planting sites 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 technical support that should be considered during the tree planting phase are nature of soil depth, type of tree species, and quality of seedlings. The timing of tree planting should also overlap with the specific characteristics of the sites. The concerning government body should pay attention to follow up before and during planting as well as post-planting monitoring follow up collaborating with stake holders.

6. REFERENCE

- Adgo, E., Teshome, A. and Mati, B., 2013. Impacts of long-term soil and water conservation on agricultural productivity: The case of Anjenie watershed, Ethiopia. *Agricultural Water Management*, 117, pp.55-61.
- Alemayehu, A. and Bewket, W., 2016. Local climate variability and crop production in the central highlands of Ethiopia. *Environmental Development*, 19, pp.36-48.
- Alemu, B., Garedew, E., Eshetu, Z., & Kassa, H. (2014). Land Use and Land Cover Changes and Associated Driving Forces in North Western Lowlands of Ethiopia Binyam. *International Research Journal of Agriculture and Soil Science*, 4(8), 150–158. <https://doi.org/10.14303/irjas.2014.055>
- Ali, E. B., Anufriev, V. P., & Amfo, B. (2021). Green economy implementation in Ghana as a road map for a sustainable development drive: A review. *Scientific African*, 12, e00756. <https://doi.org/10.1016/j.sciaf.2021.e00756>.
- Amare, D., Mekuria, W., Belay, B., 2017b. Willingness and participation of local communities to manage communal grazing lands in the Lake Tana biosphere, Ethiopia. *Society & Natural Resources* 30 (6): 674–89. <https://doi.org/10.1080/08941920.2016.1264649>
- Antwi, E.K., Boakye-Danquah, J., Owusu, A.B., Loh, S.K., Mensah, R., Boafo, Y.A. and Apronti, P.T., 2015. Community vulnerability assessment index for flood prone savannah agro-ecological zone: A case study of Wa West District, Ghana. *Weather and Climate Extremes*, 10, pp.56-69.
- Atsbha, T., Desta, A.B. and Zewdu, T., 2019. Woody species diversity, population structure, and regeneration status in the Gra-Kahsu natural vegetation, southern Tigray of Ethiopia. *Heliyon*, 5(1).
- Balana, B.B., Muys, B., Haregeweyn, N., Descheemaeker, K., Deckers, J., Poesen, J., Nyssen, J. and Mathijs, E., 2012. Cost-benefit analysis of soil and water conservation measure: The case of exclosures in northern Ethiopia. *Forest Policy and Economics*, 15, pp.27-36.
- BAWAHIDI, K. S. Y. (2005). *Integrated Land Use Change Analysis for Soil Erosion Study in Ulu Kinta Catchment Khaled Saleh Yaslam Bawahidi*. SAINS MALAYSIA.
- Bayleyegn, D., Ericksen, P.J. and Solomon, D., 2018. Climate Resilient Green Economy Strategy: Sector-wise GTP II Implementation Monitoring Checklist.
- Bayleyegn, D., Ericksen, P.J. and Solomon, D., 2018. Climate Resilient Green Economy Strategy: Sector-wise GTP II Implementation Monitoring Checklist.

- Bekele, T.H., Covic, N., Alemayehu, D., Trijsburg, L.E., Brouwer, I.D., Feskens, E.J. and de Vries, J.H., 2016. The feasibility of implementing the Ethiopian food-based dietary guideline's messages and food graphics: a qualitative study. *Tesfaye Hailu Bekele*, p.95.
- Belay, T., & Mengistu, D. A. (2021). Impacts of land use / land cover and climate changes on soil erosion in Muga watershed , Upper Blue Nile basin (Abay), Ethiopia. *Ecological Processes*. <https://doi.org/10.1186/s13717-021-00339-9>
- Berio Fortini, L., Leopold, C.R., Perkins, K.S., Chadwick, O.A., Yelenik, S.G., Jacobi, J.D., Bishaw, K.E. and Gregg, M., 2021. Landscape level effects of invasive plants and animals on water infiltration through Hawaiian tropical forests. *Biological Invasions*, 23(7), pp.2155-2172.
- Bewket, W. (2003). *Towards Integrated water shed Management in highland Ethiopia : the chemoga watershed case study*. <https://doi.org/90-6754-708-5>
- Beyene, A. D., & Shumetie, A. (2023). *Green Legacy Initiative for Sustainable Economic Development in Ethiopia*. Ethiopian Economic Association (EEA).
- Bieng, M.A.N., Oliveira, M.S., Roda, J.M., Boissière, M., Herault, B., Guizol, P., Villalobos, R. and Sist, P., 2021. Relevance of secondary tropical forest for landscape restoration. *Forest Ecology and Management*, 493, p.119265.
- Bieng, M.A.N., Oliveira, M.S., Roda, J.M., Boissière, M., Herault, B., Guizol, P., Villalobos, R. and Sist, P., 2021. Relevance of secondary tropical forest for landscape restoration. *Forest Ecology and Management*, 493, p.119265.
- Binyam, A., Desale, K. (2014). The Implication of integrated watershed management for rehabilitation of degraded lands: Case study of Ethiopian Highlands. *J. Agric. Biodiver. Res.* 3(6): 78-90.
- Biro, K., Pradhan, B., Buchroithner, M. and Makeschin, F., 2013. Land use/land cover change analysis and its impact on soil properties in the northern part of Gadarif region, Sudan. *Land Degradation & Development*, 24(1), pp.90-102.
- Bloomfield, E.F. and Tillery, D., 2019. The circulation of climate change denial online: Rhetorical and networking strategies on Facebook. *Environmental Communication*, 13(1), pp.23-34.
- Bodner, G., Mentler, A. and Keiblinger, K., 2021. Plant roots for sustainable soil structure management in cropping systems. *The root systems in sustainable agricultural intensification*, pp.45-90.
- Boissiere, M., Atmadja, S., Guariguata, M. R., Kassa, H., Sist, P. (2021).

- Bosela, M., Rubio-Cuadrado, Á., Marcis, P., Merganičová, K., Fleischer Jr, P., Forrester, D.I., Uhl, E., Avdagić, A., Bellan, M., Bielak, K. and Bravo, F., 2023. Empirical and process-based models predict enhanced beech growth in European mountains under climate change scenarios: A multimodel approach. *Science of the Total Environment*, 888, p.164123.
- Bodner, G., Mentler, A. and Keiblinger, K., 2021. Plant roots for sustainable soil structure management in cropping systems. The root systems in sustainable agricultural intensification, pp.45-90.
- 937 lessons. *Forests* 5 (8): 1896–1909. <https://doi.org/10.3390/f5081896>
- Bronstert, A., Niehoff, D., & Brger, G. (2002). Effects of climate and land-use change on storm runoff generation: Present knowledge and modelling capabilities. *Hydrological Processes*, 16(2), 509–529. <https://doi.org/10.1002/hyp.326>
- Busse, M., Zhang, J., Fiddler, G. and Young, D., 2021. Compaction and organic matter retention in mixed-conifer forests of California: 20-year effects on soil physical and chemical health. *Forest Ecology and Management*, 482, p.118851.
- Chaturvedi, R.K., 2020. The Role of Tree Plantations in Improving Soil Fertility and Carbon Sequestration on Coal Mine Spoils. *Agroforestry for Degraded Landscapes: Recent Advances and Emerging Challenges-Vol. 2*, pp.297-317.
- Chemeda, D., Mukand, E., & Babel, S. (2010). Drought Analysis in the Awash River Basin , Ethiopia. *Springer Science*, 1441–1460. <https://doi.org/10.1007/s11269-009-9508-0>
- Chokkalingam, U. ed., 2006. *One century of forest rehabilitation in the Philippines*. CIFOR.
- Cole, C., Wentz, E., & Christensen, P. (2003). EXPERT SYSTEM APPROACH FOR CLASSIFYING LAND COVER IN NEW DELHI INDIA USING ASTER IMAGERY. *Analysis*, 2001.
- Connor, R., 2015. *The United Nations world water development report 2015: water for a sustainable world* (Vol. 1). UNESCO publishing.
- Corbett, J. and Mellouli, S., 2017. Winning the SDG battle in cities: how an integrated information ecosystem can contribute to the achievement of the 2030 sustainable development goals. *Information Systems Journal*, 27(4), pp.427-461.
- Corbett, J., & Mellouli, S. (2017). Winning the SDG battle in cities: How an integrated information ecosystem can contribute to the achievement of the 2030 sustainable development goals. *Information Systems Journal*, 27(4), 427–461. <https://doi.org/10.1111/isj.12138>.

- Crouzeilles, R., Beyer, H.L., Monteiro, L.M., Feltran-Barbieri, R., Pessôa, A.C., Barros, F.S., Lindenmayer, D.B., Lino, E.D., Grelle, C.E., Chazdon, R.L. and Matsumoto, M., 2020. Achieving cost-effective landscape-scale forest restoration through targeted natural regeneration. *Conservation Letters*, 13(3), p.e12709.
- Da Graça Carvalho, M. (2012). EU energy and climate change strategy. *Energy*, 40(1), 19–22. <https://doi.org/10.1016/j.energy.2012.01.012>.
- Darghouth, S., Ward, C., Gambarelli, G., Styger, E., Roux, J. (2008). Watershed management approaches, policies, and operations: lessons for scaling up. Water sector board discussion paper series. Paper No. 11. The World Bank, Washington, DC.
- DeFries, R.S., Field, C.B., Fung, I., Collatz, G.J. and Bounoua, L., 1999. Combining satellite data and biogeochemical models to estimate global effects of human-induced land cover change on carbon emissions and primary productivity. *Global biogeochemical cycles*, 13(3), pp.803-815.
- Denboba, M. A. (2005). *soil degradation - farmers ' perception nexus : Implications for sustainable land use in the southwest of Ethiopia* (Vol. 49, Issue 0). Bonn.
- Desai, B.H., 2020. 14. United Nations Environment Programme (UNEP). *Yearbook of International Environmental Law*, 31(1), pp.319-325.
- Desie, E., Vancampenhout, K., van den Berg, L., Nyssen, B., Weijters, M., den Ouden, J. and Muys, B., 2020. Litter share and clay content determine soil restoration effects of rich litter tree species in forests on acidified sandy soils. *Forest Ecology and Management*, 474, p.118377.
- Dikau, S. and Volz, U., 2018. Central banking, climate change and green finance.
- Duriaux-Chavarría, J., Frédéric Baudron, F., Gergel, S.E., Yang, K.F., Edd I.M.S., Environment Forest and Climate Change Commission (EFCCC) (2020). Five Year (2021–2025) Development Plan of the Environment, Forest and Climate Change Commission of the Federal Democratic Republic of Ethiopia. Addis Ababa: EFCC. Elbert, C., Gessese, N. and Konishi, Y., 2016. Value chain analysis for polo shirts. *Attracting Investment in Bangladesh—Sectoral Analyses*, p.129.
- Erbaugh, J.T., Pradhan, N., Adams, J., Oldekop, J.A., Agrawal, A., Brockington, D., Pritchard, R. and Chhatre, A., 2020. Global forest restoration and the importance of prioritizing local communities. *Nature Ecology & Evolution*, 4(11), pp.1472-1476.
- Eshete, A., Teshome, S., Edaso, A., Yilma, G. and Furo, G., 2023. Selection of Soil and Water Conservation Technologies and Native Tree Species for Rehabilitation of Degraded Arid Lands in Southeast Ethiopia. *International Journal of Forestry Research*, 2023.

- Fahad, S., Chavan, S.B., Chichaghare, A.R., Uthappa, A.R., Kumar, M., Kakade, V., Pradhan, A., Jinger, D., Rawale, G., Yadav, D.K. and Kumar, V., 2022. Agroforestry systems for soil health improvement and maintenance. *Sustainability*, 14(22), p.14877.
- Fentaw, G., Mezgebu, A., Wondie, A., & Getnet, B. (2022). Ecological health assessment of Ethiopian wetlands:
- Fikir Alemayehu, F.A., Nurhussen Taha, N.T., Nyssen, J., Atkilt Girma, A.G., Amanuel Zenebe, A.Z., Mintesinot Behailu, M.B., Deckers, S. and Poesen, J., 2009. The impacts of watershed management on land use and land cover dynamics in Eastern Tigray (Ethiopia).
- Filoso, S., Bezerra, M.O., Weiss, K.C. and Palmer, M.A., 2017. Impacts of forest restoration on water yield: A systematic review. *PloS one*, 12(8), p.e0183210.
- Filoso, S., Bezerra, M.O., Weiss, K.C. and Palmer, M.A., 2017. Impacts of forest restoration on water yield: A systematic review. *PloS one*, 12(8), p.e0183210.
- Fortune, A., 2020. Cost of vegetables, cereals increase as inflation creeps higher. *Addis Fortune*.
- Fowler, H.J., Ali, H., Allan, R.P., Ban, N., Barbero, R., Berg, P., Blenkinsop, S., Cabi, N.S., Chan, S., Dale, M. and Dunn, R.J., 2021. Towards advancing scientific knowledge of climate change impacts on short-duration rainfall extremes. *Philosophical Transactions of the Royal Society A*, 379(2195), p.20190542.
- Gala, T., Pazner, M., & Beyene, S. (2011). Evaluating Biophysical Attributes of Environmentally Degraded Landscapes in Northern Ethiopia using LANDSAT ETM data and GIS. *Environmental Studies and Management*, 4(1). <https://doi.org/10.4314/ejesm.v4i1.1>
- Garuma, G., 2020. MONITORING ENVIRONMENTAL CONDITIONS FOR URBAN TREES PLANTATION AND GROWTH USING INTERNET OF THINGS (IOT): THE CASE OF GREEN LEGACY PROGRAM (Doctoral dissertation, St. Mary's University).
- Gash, D., Ferede, T., Tafesse, A.S. and Mehare, A., 2023. Ethiopian Economics Association (EEA).
- Gashaw, T., 2015. The implications of watershed management for reversing land degradation in Ethiopia. *Research Journal of Agriculture and Environmental Management*, 4(1), pp.5-12.
- Gemmechis, W. A. (2022). Land use land cover dynamics using CA-Markov chain a case of belete gera forest priority area south western ethiopia.

- Getahun, B. and Bobe, B., 2015. Impacts of land use types on selected soil physico-chemical physico chemical properties. *Science, Technology and Arts Research Journal*, 4(4), pp.40-44.
- Gonfa, N., Tulu, D., Hundera, K. and Raga, D., 2020. Ethnobotanical study of medicinal plants, its utilization, and conservation by indigenous people of Gera district, Ethiopia. *Cogent Food & Agriculture*, 6(1), p.1852716.
- Guo, J., Feng, H., McNie, P., Liu, Q., Xu, X., Pan, C., Yan, K., Feng, L., Goitom, E.A. and Yu, Y., 2023. Species mixing improves soil properties and enzymatic activities in Chinese fir plantations: A meta-analysis. *Catena*, 220, p.106723.
- Gwedla, N., Shackleton, C.M. and Olvitt, L., 2022. Trees stocks in domestic gardens and willingness to participate in tree planting initiatives in low-cost housing areas of the Eastern Cape, South Africa. *Urban Forestry & Urban Greening*, 68, p.127484.
- Hadgu, K. M. (2008). *Temporal and spatial changes in land use patterns and biodiversity in relation to farm productivity at multiple scales in Tigray , Ethiopia*.
- Hamad, K. J. (2022). Green economy and sustainable development concepts, principles and requirements for transformation in Iraq. *Journal of STEPS for Humanities and Social Sciences*, 1(3). 1–14. <https://doi.org/10.55384/2790-4237.1089>.
- Hanamirian, J., 2011. The Right to Remain Anonymous: Anonymous Speakers, Confidential Sources and the Public Good. *Colum. JL & Arts*, 35, p.119.
- Hanley, N., Shogren, J. and White, B., 2019. *Introduction to environmental economics*. Oxford University Press.
- Hänsel, M.C., Drupp, M.A., Johansson, D.J., Nesje, F., Azar, C., Freeman, M.C., Groom, B. and Sterner, T., 2020. Climate economics support for the UN climate targets. *Nature Climate Change*, 10(8), pp.781-789.
- Hickmann, T., Widerberg, O., Lederer, M. and Pattberg, P., 2021. The United Nations Framework Convention on Climate Change Secretariat as an orchestrator in global climate policymaking. *International Review of Administrative Sciences*, 87(1), pp.21-38. <https://doi.org/10.1002/ldr.3806>
- Girma, Z., Mamo, Y. and Ersado, M., 2012. Species composition, distribution and relative abundance of large mammals in and around Wondo Genet Forest Patch, Southern Ethiopia. *Asian Journal of Applied Sciences*, 5(8), pp.538-551.
- Kafi, K. M., Shariff, H. Z. M., & Shariff, A. B. M. (2014). An analysis of LULC change detection using remotely sensed data ; A Case study of Bauchi City. *Earth and Environmental Science OPEN*, 20, 2–10. <https://doi.org/10.1088/1755-1315/20/1/012056>

- Kandasamy, J., Nadeem, S. P., Kumar, A., Nikhil, H. B., & Solanki, N. H. (2022). Economic and environmental feasibility of re-routing the Indo-Sri Lankan shipping channel: A green initiative of sustainable development. *Sustainable Development*, 30(4), 726–750. <https://doi.org/10.1002/sd.2269>.
- Kassa, H., Dondeyne, S., Poesen, J., Frankl, A. and Nyssen, J., 2017. Impact of deforestation on soil fertility, soil carbon and nitrogen stocks: the case of the Gacheb catchment in the White Nile Basin, Ethiopia. *Agriculture, Ecosystems & Environment*, 247, pp.273-282.
- Katona, M., Véghe, P., Balázs, P., Bidló, A. and Horváth, A., 2024, February. Impact of forest organic matter on soil water holding capacity. In *6th International Symposium of Soil Physics* (Vol. 117, p. 19).
- Kebede, G., Feyissa, F., Assefa, G., Alemayehu, M., Mengistu, A., Kehaliew, A., Melese, K., Mengistu, S., Tadesse, E., Wolde, S. and Abera, M., 2016. Chemical composition and in-vitro organic matter digestibility of Napier grass (*Pennisetum purpureum* (L.) Schumacher) accessions in the mid and highland areas of Ethiopia. *International Journal of Livestock Research*, 6(4), pp.41-59.
- Khare, D., Patra, D., Mondal, A., & Kundu, S. (2017). Impact of land use / land cover change on run-off in the catchment of a hydro power project. *Applied Water Science*, 7(2), 787–800. <https://doi.org/10.1007/s13201-015-0292-0>
- Kindu, M., Schneider, T., Teketay, D., & Knoke, T. (2016). Changes of ecosystem service values in response to land use/land cover dynamics in Munessa-Shashemene landscape of the Ethiopian highlands. *Science of the Total Environment*, 547, 137–147. <https://doi.org/10.1016/j.scitotenv.2015.12.127>
- Kitessa, H., & Tsegaye, G. (2008). Woody species composition and structure of the Belete Forest, Jimma Zone, SW Ethiopia. *Ethiopian journal of the Biological sciences* 7(1), 1
- Kiumarsi, F., Jourgholami, M., Jafari, M., Lo Monaco, A., Venanzi, R. and Picchio, R., 2024. Restoring soil properties in the Hyrcanian forests from machine induced compaction: Reforestation of N₂-fixing black alder (*Alnus glutinosa* (L.) Gaertn.). *Land Degradation & Development*.
- Kulindwa, Y.J., 2016, February. Key factors that influence households' tree planting behaviour. In *Natural Resources Forum* (Vol. 40, No. 1-2, pp. 37-50). Oxford, UK: Blackwell Publishing Ltd.
- Lambert, E. and Deyganto, K.O., 2023. The role of green legacy in promoting sustainable development and combating climate change. *Qeios*.

- Lambert, E., & Deyganto, K. O. (2023). The Impact of Green Legacy on Climate Change in Ethiopia. *Green and Low-Carbon Economy*.
- Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. *Annual Review of Environment and Resources*, 28, 205–241.
- Le, H. D., Smith, C., Herbohn, J. (2014). What drives the success of reforestation projects in tropical developing countries? The case of the Philippines. *Global Environmental Change* 24: 334–348.
- Le, H. D., Smith, C., Herbohn, J., Harrison, S. (2012). More than just trees: Assessing reforestation success in tropical developing countries. *Journal of Rural Studies*, 28(1):5-19.
- Legesse, D., Vallet-Coulomb, C., & Gasse, F. (2003). Hydrological response of a catchment to climate and land use changes in Tropical Africa: Case study south central Ethiopia. *Journal of Hydrology*, 275(1–2), 67–85. [https://doi.org/10.1016/S0022-1694\(03\)00019-2](https://doi.org/10.1016/S0022-1694(03)00019-2)
- Lemenih, M., Kassa, H., 2014. Re-greening Ethiopia: history, challenges and
- Luo, Z., Wang, E. and Sun, O.J., 2010. Can no-tillage stimulate carbon sequestration in agricultural soils? A meta-analysis of paired experiments. *Agriculture, ecosystems & environment*, 139(1-2), pp.224-231.
- Mahari, A., 2014. Factors affecting survival of tree seedlings in the drylands of Northern Ethiopia. *Journal of Natural Sciences Research*, 4(16), pp.26-28.
- Martínez-Garza, C., Méndez-Toribio, M., Ceccon, E. and Guariguata, M.R., 2021. Ecosystem restoration in Mexico: insights on the project planning phase. *Botanical Sciences*, 99(2), pp.242-256.
- Mazzucato, M., 2023. Financing the Sustainable Development Goals Through Mission-oriented Development Banks: UN DESA Policy Brief Special Issue.
- McLain, R., Monterroso, I. and Adhikary, A., 2020. Is community tenure facilitating investment in the commons for inclusive and sustainable development?. *Forest Policy and Economics*, 111, p.102088.
- Mekonnen, A. and Damte, A., 2011. *Private trees as household assets and determinants of tree-growing behavior in rural Ethiopia* (No. dp-11-14-efd).
- Melese, Z., 2022. Impacts of Agroforestry, Afforestation and Ex-closure Practices on Soil Loss, Runoff and Soil Moisture Storage in Ethiopia.
- Mengesha, T., Edosa, M., Firdu, G., Shiferaw, M., 2020. Trees, forests and profits in Ethiopia: an assessment of tree-based landscape restoration investment opportunities

- in Ethiopia. Addis Ababa, Ethiopia: Environment, Forest and Climate Change Commission.
- Meyer, W. B., & Turner, B. L. (2014). Modeling land use and cover as part of global environmental change. *Climatic Change*, 28(1–2), 45–64. <https://doi.org/10.1007/BF01094100>
- Mohammed, A., & Bekele, L. (2014). Changes in Carbon Stocks and Sequestration Potential under Native Forest and Adjacent Land use Systems at Gera, South-Western Ethiopia. *Global Journal of Science Frontier Research: D Agriculture and Veterinary*, 14(10), 1–11.
- Mohammed, A., Bahmud, S. and Abdulahi, A., The Status of Forest Development in Ethiopia: Challenges and Opportunities: A Review Paper.
- Murcia, C., Guariguata, M.R., Andrade, Á., Andrade, G.I., Aronson, J., Escobar, E.M., Etter, A., Moreno, F.H., Ramírez, W. and Montes, E., 2016. Challenges and prospects for scaling-up ecological restoration to meet international commitments: Colombia as a case study. *Conservation Letters*, 9(3), pp.213-220.
- Naji, H.R., Bakar, E.S., Soltani, M., Ebadi, S.E., Abdul-Hamid, H., Javad, S.K.S. and Sahri, M.H., 2014. Effect of initial planting density and tree features on growth, wood density, and anatomical properties from a *Hevea brasiliensis* trial plantation. *Forest Products Journal*, 64(1-2), pp.41-47.
- Nazari, M., Arthur, E., Lamandé, M., Keller, T., Bilyera, N. and Bickel, S., 2023. A meta-analysis of soil susceptibility to machinery-induced compaction in Forest ecosystems across global climatic zones. *Current Forestry Reports*, 9(5), pp.370-381.
- Negassa, M. D., Mallie, D. T., & Gemed, D. O. (2020). Forest cover change detection using Geographic Information Systems and remote sensing techniques: a spatio-temporal study on Komto Protected forest priority area, East Wollega Zone, Ethiopia. *Environmental Systems Research*, 9(1), 1–14. <https://doi.org/10.1186/s40068-020-0163-z>
- Ota, T., Lonn, P. and Mizoue, N., 2020. A country scale analysis revealed effective forest policy affecting forest cover changes in Cambodia. *Land Use Policy*, 95, p.104597.
- Ovie, S., Nnaji, G.U., Oviasogie, P.O., Osayande, P.E. and Irhemu, P., 2013. Effects of composted oil palm bunch wastes and chemical fertilizer on growth of oil palm seedling under water stress condition. *Agro-Science*, 12(1), pp.17-31.
- Phiri, A. T., Toure, H. M. A. C., Kipkogei, O., Traore, R., Afokpe, P. M. K., & Lamore, A. A. (2022). A review of gender inclusivity in agriculture and natural resources management

under the changing climate in sub-Saharan Africa. *Cogent Social Sciences*, 8(1), 2024674. <https://doi.org/10.1080/23311886.2021.2024674>.

planting: A case study of Ethiopia. *Forest Ecology and Management* 497:

Poeplau, C. and Don, A., 2015. Carbon sequestration in agricultural soils via cultivation of cover crops—A meta-analysis. *Agriculture, Ecosystems & Environment*, 200, pp.33-41.

Poeplau, C., Don, A., Vesterdal, L., Leifeld, J., Van Wesemael, B.A.S., Schumacher, J. and Gensior, A., 2011. Temporal dynamics of soil organic carbon after land-use change in the temperate zone—carbon response functions as a model approach. *Global change biology*, 17(7), pp.2415-2427.

Ravichandran, S.R., Venkatachalam, C.D., Sengottian, M., Sekar, S., Kandasamy, S., Subramanian, K.P.R., Purushothaman, K., Chandrasekaran, A.L. and Narayanan, M., 2022. A review on hydrothermal liquefaction of algal biomass on process parameters, purification and applications. *Fuel*, 313, p.122679.

Review and synthesis. *Environmental and Sustainability Indicators*, 15, 100194. <https://doi.org/10.1016/j.indic.2022.100194>

Rimal, B., Sharma, R., Kunwar, R., Keshtkar, H., Stork, N. E., Rijal, S., Rahman, S. A., & Baral, H. (2019). Effects of land use and land cover change on ecosystem services in the Koshi River Basin, Eastern Nepal. *Ecosystem Services*, 38(March), 100963. <https://doi.org/10.1016/j.ecoser.2019.100963>

Seifu, W., Elias, E., Gebresamuel, G., Feyisa, G.L. and Tefera, W., 2023. Characterization and Mapping of Soil-Landscape for Site-Specific Soil Management in Ayiba Watershed, Northern Highlands of Ethiopia. *Applied and Environmental Soil Science*, 2023.

Sileshi, G.W., Mafongoya, P.L. and Nath, A.J., 2020. Agroforestry systems for improving nutrient recycling and soil fertility on degraded lands. *Agroforestry for Degraded Landscapes: Recent Advances and Emerging Challenges-Vol. 1*, pp.225-253.

Stanturf, J.A., Kleine, M., Mansourian, S., Parrotta, J., Madsen, P., Kant, P., Burns, J. and Bolte, A., 2019. Implementing forest landscape restoration under the Bonn Challenge: A systematic approach. *Annals of Forest Science*, 76(2), pp.1-21.

Strassburg, B.B., Beyer, H.L., Crouzeilles, R., Iribarrem, A., Barros, F., de Siqueira, M.F., Sánchez-Tapia, A., Balmford, A., Sansevero, J.B.B., Brancalion, P.H.S. and Broadbent, E.N., 2019. Strategic approaches to restoring ecosystems can triple conservation gains and halve costs. *Nature Ecology & Evolution*, 3(1), pp.62-70.

- Tadesse, S., Woldetsadik, M. and Senbeta, F., 2017. Forest users' level of participation in a participatory forest management program in southwestern Ethiopia. *Forest Science and Technology*, 13(4), pp.164-173.
- Tanner, T., Mitchell, T., Polack, E. and Guenther, B., 2009. Urban governance for adaptation: assessing climate change resilience in ten Asian cities. *IDS Working Papers*, 2009(315), pp.01-47.
- Tenkir, E., Bekele, T., Demissew, S. and Aynekulu, E., 2024. Site Suitability, Early Survival, and Growth Performance of Five Indigenous Tree Species to Integrate in Urban Green Space of Addis Ababa, Ethiopia.
- Terry Sunderland, T., 2021. More people, more trees: a reversal of deforestation trends in Southern Ethiopia. *Land Degradation & Development* 32 (3): 1440–51.
- Tesfahunegn, G.B., 2016. Soil quality indicators response to land use and soil management systems in northern Ethiopia's catchment. *Land Degradation & Development*, 27(2), pp.438-448.
- Tolessa, T., Senbeta, F., & Kidane, M. (2017). The impact of land use/land cover change on ecosystem services in the central highlands of Ethiopia. *Ecosystem Services*, 23(June 2016), 47–54. <https://doi.org/10.1016/j.ecoser.2016.11.010>.
- Trees for All (2023). Plant trees together for a green and healthy world. Retrieved from: <https://treesforall.nl/en/> United Nations (2015). The Paris Agreement. Retrieved from: <https://www.un.org/en/climatechange/paris-agreement>.
- Tsehay, y.a., 2023. *woody species diversity, structure, and biomass carbon stock in washa amba abune tekelehymanot monastery forest, northwest ethiopia* (doctoral dissertation, hu).
- Varnagirytė-Kabašinskienė, I., Žemaitis, P., Armolaitis, K., Stakėnas, V. and Urbaitis, G., 2021. Soil organic carbon stocks in afforested agricultural land in Lithuanian hemiboreal forest zone. *Forests*, 12(11), p.1562.
- Wassie, S.B., 2020. Natural resource degradation tendencies in Ethiopia: a review. *Environmental systems research*, 9(1), pp.1-29.
- White, M.P., Alcock, I., Grellier, J., Wheeler, B.W., Hartig, T., Warber, S.L., Bone, A., Depledge, M.H. and Fleming, L.E., 2019. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific reports*, 9(1), pp.1-11.
- Yami, M. and Mekuria, W., 2022. Challenges in the governance of community-managed forests in Ethiopia. *Sustainability*, 14(3), p.1478.
- Yao, W., Nan, F., Li, Y., Li, Y., Liang, P. and Zhao, C., 2023. Effects of different afforestation years on soil properties and quality. *Forests*, 14(2), p.329.

- Zegeye, H., 2018. Climate change in Ethiopia: impacts, mitigation and adaptation. *International Journal of Research in Environmental Studies*, 5(1), pp.18-35.
- Zegeye, H., 2018. Climate change in Ethiopia: impacts, mitigation and adaptation. *International Journal of Research in Environmental Studies*, 5(1), pp.18-35.
- Zelege, A. and Vidal, A., 2020. Contributing to scaling up forest landscape restoration in Ethiopia. Restoration Diagnostic Applied in Sodo Guragie (SNNPR) and Meket (Amhara Region) Woredas.
- Zelege, G., & Hurni, H. (2001). Implications of land use and land cover dynamics for mountain resource degradation in the Northwestern Ethiopian highlands. *Mountain Research and Development*, 21(2), 184–191. [https://doi.org/10.1659/0276-4741\(2001\)021\[0184:IOLUAL\]2.0.CO;2](https://doi.org/10.1659/0276-4741(2001)021[0184:IOLUAL]2.0.CO;2)
- Zhang, J., Qian, X. and Feng, J., 2020. Review of carbon footprint assessment in textile industry. *Ecofeminism and Climate Change*, 1(1), pp.51-56.

APPENDIXES

Appendix Table 8: Table GPS point at Ganji Challa, Sadi Loya and Wogecha Water Shed

No	Kebele	Coordinate	Coordinate	Altitude
1	Ganji Challa			
	Upper Slope			
	R1	196215	854971	2044
	R2	196195	854905	2048
	R3	196553	854887	2053
	Medium Slope			
	R1	196321	854915	2020
	R2	196320	855000	2020
	R3	196272	855038	2025
	Lower Slope			
	R1	196414	854202	2008
	R2	196397	854983	
	R3	196383	855014	2007
2	Sadi Loyya			
	Upper Slope			
	R1	215857	860957	1936
	R2	215893	860911	1941
	R3	215936	861009	1938
	Medium Slope			
	R1	215821	860989	1926
	R2	215878	860814	1928
	R3	215872	860930	1926
	Lower Slope			
	R1	215853	860916	1918
	R2	215828	860949	1922
	R3	215822	860989	1923
3	Wogacha			
	Upper Slope			
	R1	186439	860001	2429
	R2	186435	859992	2425
	R3	186427	859970	2428
	Medium Slope			
	R1	186454	859992	2416
	R2	186450	859968	2428
	R3	186431	859930	2418
	Lower Slope			
	R1	186474	860050	2409
	R2	186494	860029	2404
	R3	186499	859996	2398

Household Survey Questionnaire

These questionnaires are designed for my MSc thesis work at Jimma University in 2023 academic year. The general objectives of the study were to evaluate the green legacy in managing watershed; challenges and opportunities found in communities for meeting the success of green legacy. The findings of this thesis would contribute much for the plan of watershed managements in the future and important for the awareness creation of the societies. I therefore, kindly request you to fill each question honestly. (Researcher: Abdulaziz Jemal Dawud).

I. General information

1. Name of the enumerator _____
2. Enumeration kebele _____
3. Date of the enumeration _____

II. Personal information

1. Name of the respondent/Code: _____
2. Sex of the respondent: 1, male 2, female
3. Age of the respondent: 1, <30___ 2, 31-40___ 3, 41-50___ 4, 51-60___ 5, >61___
4. Religion: 1, Orthodox 2, Muslim 3, Protestant
5. Marital Status of the respondent: 1, single___ 2, married___ 3, divorced___ 4, widowed___
6. Educational status of the respondent: 1, illiterate 2, grade 1-8 3, above grade 9
7. Family size: 1, 1-3 2, 3-6 3, above 6

III. Economic activities

1. What is your main economic activity? 1, crop production 2, animal rearing 3, mixed farming 4, petty trade 5, mixed farming and petty trade
2. Do you have your own farmland? 1, yes 2, no
3. If your answer is 'yes', what is the estimated total size of your farmland? 1, less than 1ha 2, 1-2ha 3, above 3 ha
4. How is the trend in your land holding size? 1, increasing 2, decreasing 3, no change
5. If your answer is 'increasing', what are the reasons behind the increment? (Multiple answers are possible) 1, encroachment into forest area 2, land reallocation 3, cultivation of marginal land
6. If your answer is 'decreasing', what are the root causes? (Multiple answers are possible) 1, increase in human population 2, increase in marginal land due to loss quality 3, land redistribution 4, land taken away by government
7. What are the constraints to crop production in your area? (Multiple answers are possible) 1, labour shortage 2, less access and increase price of input 3, land shortage 4, pest and disease 5, lack of technical support.
8. Do you have your own livestock at present? 1, yes 2, no

9. If your answer is 'yes', what is the number of livestock you have? 1, 1-10 2, 11-20 3, 21-30 4, >31
10. What is the trend of your livestock holding? 1, increasing 2, decreasing 3, no change
11. If your answer is 'decreasing', what are the reasons (Multiple answers are possible) 1, shortage of grazing land 2, lack of money to buy animals 3, prevalence of livestock disease
12. How do you feed your livestock? 1, free grazing on communal grazing land 2, Using on private grazing land 3, others
13. How do you see the size of grazing land overtime? 1, increasing 2, decreasing 3, remain the same
14. If your answer is 'decreasing', what are the reasons? (Multiple answers are possible) 1, expansion of farm land 2, grazing land distribution among people 3, area enclosure.

IV. Local community participation, perceptions, challenges and opportunities regarding green legacy implementation

1. Do you know that our country is the first country in the world to plant 350 million tree seedlings per day? 1.Yes 2. No
2. What type of seedling preferred by community in your area for plantation in green legacy.
1.Fruit tree species 2.Coffee 3.indiginious tree species 4.Exotic tree species
3. Have you ever participated in the movement tree planting? 1. Yes 2. No
4. Have you ever prepared a tree seedling every year? 1. Yes 2. No
5. What are the biggest opportunities created by this green legacy?
1.Job opportunities 2.improving livelihood status of the community 3.increasing communities income
6. Are there young people and women in your area who have formed associations to prepare and sell tree seedlings to improve their livelihoods? 1. Yes 2. No
7. If these associations exist, what is their growth before and after the launch of the green legacy? 1. Increasing, 2. Decreasing, 3. Remain the same
8. What are the challenges to achieving/expanding green legacy initiative? (Multiple answers are possible) 1. Failure to properly plan and prepare all the required types of tree seedlings. 2. There is a lack of wisdom in choosing the location of the tree seedling planting permanently. 3. Less caution in order to plant more tree seedlings. 4. Not taking care of the planted seedling during dry season.
9. What are the available opportunities to expand the green legacy in your area? (Multiple answers are possible) 1. There is supply of seedling from government, 2. Communities' awareness in tree plantation uses, 3. Availability of communal land for plantation in mass, 4. Availability of technical support from DA and Experts, 5. Seedling availability from other sources like forest, private nursery.

V. Land use and land cover trends in the study area

1. What was the major land use type in the study area before 5 years ago?
a) cropland, b) grazing land, 2) wetland, 3) forest land, 4) degraded land,
2. If it was changed currently why they converted to the current land uses?
a) because of green legacy, 2. because of low benefit arise from future land use, 3. because of relocation to other area,
3. If your response for above question is (1), how do you identify the planting area?
4. through expert advice, 2. traditionally I know site selection for plantation, 3. Because of the site is nearest to forest, What kind of seedling is more preferable and why? 1. Those used for construction, 2. Multipurpose tree species, 3. Those used for soil and water conservation, 4. Those I get their seedling freely, 5. I didn't prefer any species.
5. How is the status of your land productivity? 1. Increasing, 2. decreasing, 3. constant.

Appendix I Questionnaire for key informant interview

1. What is the average landholding of households?
2. What is the trend of land holding size over a period and what are the reasons?
3. What is the trend of productivity of land through time?
4. What is the trend of livestock holding by the farmers in the area?
5. Describe the major feed sources of livestock in your locality?
6. How is the nature of land degradation in your locality?
 - 6.1.What are the common types of land degradation in your area?
 - 6.2.What are the major causes of land degradation in your area?
 - 6.3.What do you think the impacts of land degradation in your area?
 - 6.4.What are the intervention measures practiced to minimize the problem of land degradation?
7. How did you see the movements of green legacy or watershed management practices in your area?
8. How do you see the effectiveness of this practice in terms of social, economic and ecological?
9. What are the constraints to the sustainability of green legacy practices in your area?
10. What measures do you suggest for the sustainability of green legacy?

Appendix II Checklist for focus group discussions

1. What are the major economic activities of the community in your locality?
2. What are the major challenges in undertaking these economic activities?
3. What is the trend of households' landholding size overtime?
4. What are the major livestock feed sources in your area?
5. What is the trend availability of livestock feed sources in your area? If changes, what are the major causes?
6. What is the trend in livestock holding by the community in the area?
7. What are the challenges in undertaking livestock production? What are the causes?
8. Is there land degradation in your area?
9. What are the causes for land degradation?
10. What are the consequences of land degradation?
11. How did you see the contribution of national green legacy movement launched by PM Abiy Ahmed (PhD) in your area for last 3-4 years?
12. What are the major problems being encounters in relation to this initiation?
13. What you suggest to promote and sustain natural resource conservation in effective manner is your area?

Figure of Appendix



