SOCIAL ECONOMIC EVALUATION OF CARBON SINK PROJECTS:

THE CASE OF GEPAT PROJECT

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THE CASE OF GEPAT PROJECT

By

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A Dissertation Submitted in Partial/ Fulfillment of Requirements for Award of the Degree of Master of Science in Project Planning and Management (MSc-PPM) of Mzumbe University

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CERTIFICATION

We, the undersigned certify that we have read and hereby recommend for acceptance by the Mzumbe University, a dissertation that is entitled: ***Evaluation of Social Economic Carbon Sink Projects: The Case of Gepat Project,*** It is a partial fulfillment of the requirements for award of the degree of Master of Project Planning and Management of Mzumbe University

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DECLARATION

I, **Adam Minzi**, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

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DEDICATION

This dissertation is dedicated to my lovely wife Maria Amoni Komba, and my children Andrew Minzi, Fausta Minzi and Felista Minzi for their support since I was away for some time but they kept in touch and supportive throughout. May the Grace of God be with them always.

ABBREVIATIONS AND ACRONYMS

CO_2	Carbon dioxide
GEPAT	Green Education for Poverty Alleviation in Tanzania
GHG	Green House Gases
IPCC	Intergovernmental Panel for Climate Change
masl	Metres above sea level
N_2O	Dinitrogen Oxide
O_2	Oxygen
SDG	Sustainable Development Goals
UN-FCCC	United Nations Framework Convention on Climate Change
TMA	Tanzania Metrological Agency

ABSTRACT

Climate change mitigation is a global initiative to curb the social economic impact, global warming has in the society. To build resilience of communities in the wake of climate change, many projects have been launched that involve education and tree planting exercise in an effort to reduce green house gases by carbon sequestration. Despite of these projects the problem of climate change is still very much pronounced in the society. There has been the need to evaluate such kind of the projects so as to improve their performances in mitigating climate. This study used Green for Education and Poverty Alleviation in Tanzania as a case study which was launched in Kagera region. The project focuses on addressing socio-economic issues related to climate change and forestation activities. A thorough evaluation of the impact of the GEPAT project to the community in regards to climate change mitigation was conducted. The study focused on homesteads in Karagwe district specifically in Kituntu , Kanoni and Igurwa wards. It was found that approximately 103.5 ha were dedicated to forestation due to the education given to farmers by the project coordinators, activities with the tree species *Eucalyptus grandis* and *Pinus patula* being the dominant ones. Other trees included the *Markhamia zanzibarica* and *Mangifera indica*, The dominant labor force in the forestation activities were women of the age group 21-40 years old. However, the men own all the land and are the heads of the homesteads.

Despite of intercropping activities, food security is at a minimum with only 7.2% of the homesteads declaring that they have enough food this has been one of the causes of variations in individual efforts on combating climate change through tree planting. However there are 40.45 ha of arable land that has been left empty and could be put to use to curb the situation. Education level has played a positive role in the GEPAT project with over 80% of the homestead members having received formal education at least to the Primary education level. They remain keen on the importance of the project and know its impact with respect to CO_2 sequestration. The carbon stock present in the *Eucalyptus grandis* trees in the study area amount to 3.9 tonnes C equivalent to 3.54 mettric tonnes of CO_2 sequestered. Similarly, 0.39 metric tonnes of CO_2 has been

sequestered in the *Pinus patula* trees. Hence a total of 4.29 metric tonnes of CO_2 have been reduced from the carbon inventory of the study area by activities related to the GEPAT project, a feat that can be considered a success. If these types of projects will be implemented in all areas of the country will contribute much in mitigating the climate which has affected agricultural production which employes about 80% of Tanzanian population.

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

Agriculture is an important sector of the Tanzanian economy which contributes to about 30.1% of its gross domestic product (GDP) (NBS 2016). Most of the farming activities are usually carried out by small holder farmers who mostly depend on it for their livelihoods (Covarrubias 2012). In an agro ecological ecosystem, successful farming is a derivative of a number of complex factors. Some of these factors include good agronomic practices, integrated pest management and a favourable climate (Stockdale *et al*., 2001). However, Tanzania has fallen victim to climate change. A shift in rainfall patterns and increase in temperatures (global warming) have made agriculture in rain fed farming systems difficult (Fanzo *et al*., 2017). Some changes in climate create favourable conditions for invasive pests that wouldn't have otherwise adapted to the agro ecosystem had the climate remained stable. This causes eruptions of new pest populations and diseases that cause loss of yield and lower market value of produce (Eigenbrode *et al*., 2018). Agricultural consignments being exported to foreign markets are in danger of being intercepted due to contamination of quarantine pests that break out due to climate change. This is a direct affront to the economy.

In consideration of other social economic impacts of climate change, global warming is known to cause drying of water sources. This makes life unsustainable in affected areas. As food security and nutrition continue being threatened, the society is required to take action to reduce impacts of climate change by improving community resilience. Initiatives in reducing global warning, the main cause of climate change, should comprise strategies of reducing emission of greenhouse gases. These gases (GHGs) deplete the ozone layer and leave holes through which UV rays from the sun reach earth unfiltered. The wavelength of the emissions increase and get trapped by the gases causing the globe to get warmer creating a scenario commonly known as the Greenhouse effect. These gases include Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O),

and Fluorinated gases emitted from industrial processes, vehicles, power generation plants, pesticides and chemical fertilizers. Other major human activities that drive climate change include deforestation for construction projects or firewood, petroleum drilling, mining use of weapons of mass destruction.

Carbon dioxide comprises 76% of all the GHGs in the atmosphere and makes it a suitable target for mitigation strategies. Amongst the most effective methods to achieve carbon sequestration is forestation. Forestation not only absorbs carbon dioxide from the atmosphere but also has economic advantages linked to it. There have been different projects initiated by governments through resolutions of the United Nations to mitigate global warming. Financing such projects will help curb the effects of climate change in Tanzania.

The current study evaluated the impact of the project titled "Green Education for Poverty Alleviation in Tanzania (GEPAT) on climate change mitigation at community level since its conceptualization in 2005.

1.2 Background of the Study

Climatic change is caused by global warning. Global warming is the change of weather patterns from how it was used to be, to behaving differently by increased temperature raising around the global. It is caused by emission of heat trapping gases or greenhouse gases (GHGs). These GHGs are in the form of compounds that can trap heat through long wave radiations that are emitted in the atmosphere to warm earth surface, the phenomenon known as, greenhouse effect.

The world has witnessed a number of natural calamities caused by climatic change. Among others is the 2011 Tsunami which occurred in Japan which had magnitude of 9.1 richer that caused 15,894 deaths. Floods, melting of ice in the oceans have caused increase in water volume, melting of ice in ice covered mountains such as Mount Kilimanjaro and excessive drought are the outcome of global warming due to depletion of ozone layer caused by Green House Gases (GHGs) (Latake, P.T, Pawar, P, 2015).

No country can be ready to go back to the pre-industrial era when the emissions were almost naturally occurring through photosynthesis among abundant trees in the forest. After industrial revolution in the 18th century, more factories supporting different industries value chain which emits GHGs were contracted mainly in Europe and America (Todaro, 2014). There is strong correlation between industrialization which allows different factories to be established, road constructions, mass production, mass transportation, tower buildings and condominiums construction which destroy forests at the same time emitting GHGs. Also as population increases the need for tree cutting increases because the population increase is also correlated with demand for fossil energy source and tree cutting for firewood in developed countries and other activities that requires trees logs and timber. Two forces of population increase and that of industrialisation exacerbate GHGs emissions.

It is evident that as developing countries such as China, India and South Africa are currently striving to increase industrialization process. Likewise, Tanzania is focusing on industrialization stated in the five years' plan (2016/17-2020/2021) while determining to mature industrialization for economic transformation and human development (URT, 2016). Since human development is associated with industrialisation all poor (less) developing, developing countries and developed countries are striving to increase industrialization pace associated with GHGs emissions.

The great debate in the world now is how to mitigate the climate change. It is possible to solve this through controlling greenhouse gases (GHGs) emission from industries. This is embedded in the 1992 United Nations Framework Convention on Climate Change (UN-FCCC) and 1997 Kyoto protocol which set the emission target for the developed countries. This did not work as United States of America rejected to abide with this, the reason being when reducing emission means decreasing industrial activities and hence decreasing economic growth of the country which each nation strives to achieve. This misunderstanding revealed that setting the emission limit alone does not qualify the country in participating in mitigation of the climate through

reduction of the emitted GHGs. Henceforth, the Paris Agreement came up with more emphasis on carbon credit provision strategy to create a win-win situation among the emitters and the mitigating agents of GHGs by paying carbon offset credit. Carbon offset credit is the money paid to remove carbon from the atmosphere. The money paid for carbon credit is used in different mitigation strategies such as establishing the carbon sinks e.g. forests and promoting the use of clean energy like solar and wind energies.

There have been different projects initiated by governments through the United Nations resolutions to mitigate global warming causing climatic changes. Mitigation of climatic change efforts involve financing projects using Green climate fund (GCF), The climate investment fund (CIF) and Clean development mechanism (CDM) the few to mention, that could remove GHGs from the atmosphere and keep the air clean despite of industrialised and industrializing countries such as Tanzania's strategy. Global warning has an economic impact worldwide. As the global is increasingly getting warmer than before economic activities get affected as diseases such as cancer are accelerated by bad weather, resources required for sustaining lives get reduced and scarcer than before such as lack of water for drinking, cooking and for industrial use. Global warming and climatic change affect agricultural productivity as it affects rainfall patterns. In developing countries such as Tanzania, climatic change exacerbates poverty because developing countries depends on agricultural outputs.

One of the key elements in an operational framework of climate change mitigation is monitoring and evaluation. Effective use of resources allocated to alleviate communities and build resilience against impacts of climate change is of the utmost necessity due to scarcity. Periodic assessments of progress of projects help generate new information that can otherwise be used to improve intervention methods, re allocate resources and determine level and direction of scaling.

The United Nations Sustainable Development Goal number 13, “Climate action” advocates the importance of strengthening adaptive capacity and resilience of communities to climate related hazards. The deforestation levels in Karagwe projected

possible desertification due to heavy deforestation, a thing that could have led to spells of drought and famine. The GEPAT project advocated for tree planting in the affected communities whilst educating them on climate change and its effects.

The expected outcomes of the implementation of the GEPAT project were increased income due to carbon credits and carbon sequestration by forestation. However, there exists cross cutting issues that may influence dynamics of project implementation and subsequently its impact to the society. Some of these factors include gender equality, farming systems and education levels. Assessing how these factors influence implementation of the projects' activities is a key to reduce risk of underachievement. Women form 51% of the labour force in agriculture even though most of the land is usually owned by men. Their participation in the project is paramount if it's to succeed and be sustainable.

The magnitude of carbon sequestration in the project area by its related forestation activities is determined by the potential of the chosen tree species to retain carbon stock from the atmosphere (qualitative factor) and amount of land allocated for planting them (quantitative factor). Reasons why less land may be allotted to forestation activities is crop farming. Use of heavy pesticides and heavy metal inorganic fertilizers defeat the purpose of climate change mitigation of the project activities.

This study established the level of success the GEPAT project has had by measuring its impact on resolving these cross cutting issues and its contribution to reduction of CO_2 in the carbon sink. It establishes the baseline for scale up and points out future indicators that can be adopted to quantify long term success.

1.3 Problem Statement

Climatic change has become a daily topic in the daily media and different UN resolutions have been put in place to combat climatic changes for climate resilience. Since climatic change directly affects different tradable goods from industry production to consumption behavior, carbon trade markets have been established to make the

producers buy their carbon footprint. These markets are well developed in the most industrialized countries in Europe and other parts of the world. Buying carbon footprint means paying for decarbonation of industries because industrialization is the source of GHGs and CO_2 is the most gas emitted from those industries. This made a call to economists to get embarked on conducting researchers related to climatic change mitigations and one of the ongoing research projects is GEPAT which this study intended to evaluate as the case study.

The global impact of climate change on the environment resonates across multisectoral economic platforms with spillover effects into the social ways of life. Emissions of greenhouse gases causing alteration of the carbon inventory has had detrimental effects on cropping systems causing shifting in rainfall patterns, prolonged drought spells and pest outbreaks. Households of small holder farmers have had to bear economic loss due to the negative impact of climate change effects on crop yields. Such circumstances lead to a chain reaction of social life difficulties including food insecurity, inability to cover school fees and extra labor to make up for economic loss. Inspite of the difficulties smallholder communities have to endure, industrialization in developing countries will not only keep growing rapidly, but is necessary for sustaining the economy. Sustainable industrialization and agriculture are mutually inclusive in Tanzania. In that regard, climate change must be mitigated as industrialization takes place so as to reduce its impacts on the environment. In that regard, Tanzania participates in the Paris agreement signed in 2015 which advocates for climate change mitigation through reduction of greenhouse gases (GHGs). Projects seeking to reduce the carbon emissions and sequestering CO_2 from the carbon inventory have been carried out and some are still ongoing. However, the withdrawal of the USA from the Paris agreement is a significant sign of the challenges climate scientists are currently facing with respect to the belief in the significance of the threat it poses. This, unfortunately, has a bearing in the amount of funding donors are willing to commit in ensuring the fight stays alive. Evidence has shown that climate change funding has been dropping steadily. It's therefore important that hands on evaluation of impact climate change projects have on communities be

evaluated and documented. Due diligence and scientific proof for small scale projects will support bid for fund mobilization required for scale up of results. Charles, (2013) was the first pioneer in Tanzania to work on this she evaluated the contribution of provision of carbon credit incentives for combating climate change through tree plantation. She used both qualitative and quantitative methods in her study. she found that the provision of carbon credit incentive which are seeds, seedlings, and cash paid to farmers have positive impact in increasing the rate of tree planting for combating climate change. This study did not determine the cause of the variations in contribution of carbon inventory of each farmer regardless of having the same incentives for tree planting and the level of carbon reduced through the project. This study unveils the carbon stock volume GEPAT members reduced and cross cutting issues that made such contributions vary between homesteads in spite of having the same incentives.

In this study, the socio economic impact of the GEPAT climate mitigation project was evaluated. The amount of actual carbon sequestered by forestation activities conducted by farmers involved in the project was estimated and weather parameters in five years consecutively after project implementation were compared. The impact of forestation activities on crosses cutting issues such as gender and education levels were also estimated. In doing so, it's expected that results from this evaluation will provide a stepping stone towards expansion of efforts in terms of scope and geographical coverage.

1.4 Objectives of the Study

1.4.1 General Objective

To evaluate the social economic impact of carbon sink projects on mitigating climate change

1.4.2 Specific Objectives

i. To identify socio-economic factors influencing forestation activities within the projects sphere of influence.

ii. To elucidate farm related issues causing variation in contribution to carbon inventory.
iii. To estimate the carbon stock sequestered by the forestation initiatives of the project.
iv. To examine the weather patterns in five years after the project implementation as a justification of climatic change mitigated by Project in the area, ceteris peribus.

1.5 Hypotheses

i. H1: Gender equality, education and food security boost homestead forestation activities

ii. H2: Proper agronomic practices and use of extension services in tree planting conform to climate change mitigation strategies

iii. H3: Forestation activities in the GEPAT study area capture a significant portion of CO_2

iv. H4: The GEPAT project has mitigated climate change in its project area

1.6 Significance of the Study

i. The findings have potential to influence policy makers to consider an even playing field and support women in the education sector as a strategy for successful climate change mitigation
ii. To the project, the study sets a foundation upon which future envisaged actions can be built
iii. To the community, queries arising during study will gain platform to reach decision makers
iv. To the researcher, the study is a partial fulfilment of completion of my Masters degree which paves the way towards promising future prospects

1.7 Limitations and Delimitations of the Study

The limitation of this study is the knowledge on carbon inventory and GIS technology; these were solved through borrowing the knowledge from forestry and GIS experts.

The researcher tried to accommodate research questions in the questionnaire but some parameters could not be properly addressed by the GEPAT members and hence had to be excluded from the analysis. Some members of the homesteads in Karagwe only speak Nyambo hence a translator had to be employed.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Climate change mitigation is one factor leading to sustainable economic development. However wariness creation among individual consumers of resources that the natural clean environment gives, this is because countries are mainly dealing with the economic development while less effort is put on mitigation of climate change so as to have sustainable economic development. This chapter presents the literature related to the topic under study. It first begins by defining key terms used in the study. It then presents theoretical and empirical studies related to climate change mitigation by using carbon sequestration through tree planting. It also presents the conceptual framework.

2.2 Definition of Terms

2.2.1 Sustainable Economic Development

"A pattern of development that permits future generations to live at least as well as the current generation generally requires at least a minimum environmental protection." (Todaro, 2014)

2.2.2 Sustainable Project Evaluation

This is the systematic and objective assessment of ongoing or completed project, on its design, implementation and results. The aim is to determine the success or failure of the objectives of the particular objectives.

2.2.3 Afforestatation

This is the establishment of a forest (forestation) in an area where there were no previous trees. Or planting trees where there was no tree.

2.2.4 Reforestation

Reforestation is the process of planting trees to the place where there were trees previously. Trees which have been cut or burnt are replaced by replanting new ones.

2.2.5 Forestation

Is a growth of trees and other plants covering the large area.

2.2.6 Primary Forest

This is the forest of native tree species, where there are no human activities in planting those trees. The ecology of the forest is not significantly disturbed.

2.2.7 Secondary Forest

This is the forest which has regenerated from the primary forest after has been cleared by human activities such as agriculture or ranching. Here Man is involved.

2.2.8 GEPAT Community Tree Planting

This is the organization of the nursery risers and tree farmers found in Karagwe and Kyerwa districts who participate in the tree planting project under GEPAT (Green Education for Poverty Alleviation in Tanzania).

2.2.9 Agroforestry

A collective name for land-use systems and practices in which trees and shrubs are deliberately integrated with non-woody crops and (or) animals on the same land area for ecological and economic purposes.

2.2.10 Breast Height

Breast height is the height of 1.3 m from the ground level, or if the ground level cannot be defined, from the seeding point. See more explanations and special cases in the section *Tree diameter measurements.*

2.2.11 Carbon Inventory

According to Ravindranath (2008), Carbon inventory is the process of estimating the stock and fluxes of carbon from different land uses systems in a given area under a given management system. They further explain that, this involves emission and removal of carbon in the form of CO_2. This is estimated by comparing the baseline CO_2

concentration before the mitigation approach and the concentration after the mitigation approach have been established.

2.2.12 Carbon Sequestration

U.S. Geological Survey (2008), defines Carbon sequestration as both natural and deliberate process by which CO_2 is either removed from the atmosphere or diverted from the emitter and stored in terrestrial environment (vegetation, sediments and soils), oceans and geological formation.

Terrestrial carbon sequestration is also called biological sequestration in which forests are used to capture atmospheric carbon in the form of CO_2. Mitigating CO_2 emission and hence climate change, requires reducing emission from the sources and increasing uptake from the atmosphere. Reducing emission means reducing industrial activities which are vital for economic development. But increasing the uptake of CO_2 from the atmosphere can be done through different approaches like reforestation and forestation.

2.3 Theoretical Literature Review

Theoretical literature review is the collection of interrelated ideas based on the theories. It enables the use of theoretical framework to explain in detail the phenomena. With that reflection in mind also it attempt to give out clear explanation why thing occur the way are in relation to the theories. From that point of view this research will employ the following theories;

2.3.1 Anthropogenic Influences on Climate Change

Scientific evidence shows that the climate system has been affected by human activity. Greenhouse gases in the atmosphere absorb and re-emit solar radiation that warms the surface of the earth. Fossil fuel use and human agriculture generate greenhouse gases, which include carbon dioxide, methane, and nitrous oxide. Of these, carbon dioxide may well be the longest lasting. Although the atmospheric lifetime of carbon dioxide is difficult to determine, the Intergovernmental Panel on Climate Change (IPCC) and others agree that a significant percentage of carbon dioxide released into the air, 20

percent or more, can remain in the atmosphere for thousands of years or longer (IPCC 2007; Archer et al. 2009). Greenhouse gas emissions have incrementally grown since the Industrial Revolution, leading to an all-time-high concentration of atmospheric greenhouse gases of more than 400 parts per million in 2014 (Watts et al. 2015; Whitmee et al. 2014). Humans have made other changes to the environment that have a negative impact on natural ecosystems, though these changes do not definitively cause climate change. Humans have converted approximately one-third of all ice- and desert-free land into cropland or pasture and use about half of the entire world's accessible freshwater each year. Since 2000, 2.3 million square kilometers of primary forest have been cut down. Roughly 90 percent of monitored fisheries are harvested at or above maximum sustainable yields. More than 60 percent of the world's rivers have been dammed to control water resources and produce energy. Human activity has led to species extinction at rates that are more than 100 times those observed in the fossil record. The 2005 Millennium Ecosystem Assessment found that 60 percent of ecosystem services are being degraded or used unsustainably (cited in Whitmee et al. 2014).

2.3.2 Current Impacts of Climate Change

Major changes in the planet's climate system have been observed in the atmosphere, oceans, cryosphere, and sea level. What we are now witnessing is a warming planet, rising seas, and melting glaciers. Changes in the climate system have numerous effects on the planet's natural systems. The Earth's surface temperature has warmed more over the last three decades than during any other time since 1850 (IPCC 2014). Ocean warming accounts for the primary increase in energy stored in the climate system, this type of warming represents more than 90 percent of the energy accumulated between 1971 and 2010; in contrast, approximately 1 percent of energy is stored in the atmosphere (ASC 2016; IPCC 2014). Globally, ocean warming is greatest near the surface: the upper 75 meters warmed by 0.11°C per decade from 1971 to 2010. In the cryosphere, glaciers have shrunk over the last two decades almost everywhere in the world. The Greenland and Antarctic ice sheets have lost mass over the same period.

Spring snow cover in the northern hemisphere has continued to decrease in extent (IPCC 2014). Between 1901 and 2010, the global mean sea level rose by 0.19 meters (ASC 2016; IPCC 2014). Since the mid-19th century, the rate of sea level rise has been greater than the mean rate during the previous two millennia (IPCC 2014). The rate of sea level rise has grown to more than 3 millimeters per year since the 1990s, though this change cannot be entirely attributed to climate change (ASC 2016). Changes in the climate system have serious implications for human systems (Figure 2.1). Many regions have experienced changing precipitation that alters hydrological systems and, subsequently, impinges upon the quality and quantity of water resources (IPCC 2014; Whitmee et al. 2014). Crop yields have also been adversely influenced by climate change. Though the global burden of ill health caused by climate change has not yet been extensively quantified, there are indications that heat-related mortality has risen and the distribution of disease vectors and waterborne illnesses has shifted due to changing temperature and rainfall (IPCC 2014). Extreme climate and weather events have also changed in association with a warming planet. Globally, the number of warm days and nights has increased while the number of cold days and nights has decreased (ASC 2016; IPCC 2014). The frequency of heat waves has grown in large parts of the world (ASC 2016). Heavy precipitation events have risen in many land regions (ASC 2016; IPCC 2014). Extreme sea levels have likely been heightened as a result of mean sea level rise since 1970. However, it remains difficult to causally link anthropogenic climate change to the frequency and magnitude of fluvial floods, drought trends, or tropical cyclone activity. Weather-related disasters have led to a sharp increase in direct and insured losses in recent decades. Climate variability has resulted in significant vulnerability to some ecosystems and many human systems, a fact that has been made especially clear by the impacts of extreme climate-related events globally and regionally (IPCC 2014).

2.3.3 Millennium Development Goal Seven (MDG 7)

In year 2000 countries members of United Nations came out with eight Millennium development goals to eradicate poverty by 2015. The seventh goal was about ensuring environmental sustainability (Todaro, 2014). According to the seventh millennium development goal, forests are the safety nets especially for the poor. But they are disappearing at an alarming rate due to deforestation and poor forestation programmes. The goal came up with the following four targets;

1. Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.

2. Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss
3. Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.

4. Achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers. (Todaro, 2014)

2.3.4 Sustainable Development Goals (SDG)

Sustainable development goals came into effect since January 2016 following the success of millennium goals with the aim of ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity. They are also known as Agenda 2030. They have many areas for improvement following MDGs; one of them is SDG number 13 which is about climate change issues.

The goal stands as; Take urgent action to combat climate change and its impacts. This argues that, climate change is currently affecting all countries on economy and lives of people and it endangers tomorrow of these countries. It further outlines the observable effects of the change of climate as change in weather patterns, rising in sea level and other fatal weather events. The change in climate is caused by greenhouse gas emission from human activities. It emphasises that if no action is taken, the world's average

temperature was projected to rise and cause much effect with some areas being affected even more. The poorest people were stated in the goal as the most vulnerable ones.

Climate change is not limited by borders it is the global challenge. Emission anywhere in the world affects people everywhere. Its solution requires international cooperation to be effective. Developed countries have to help the developing countries to move towards the low-carbon economy.

It came with three strategies which have to be implemented to get rid of this situation. This has to be taken by developed country parties of National Framework Conversion on Climate Change (NFCCC), by mobilizing jointly $100 billion annually by 2020 known as Green Climate Fund (GCF) to address the need of developing countries to act on mitigation measures as soon as possible. This fund should be used to implement projects to mitigate climate change such as forestation, use of clean energy in order to reduce carbon emission to the atmosphere (UN, 2016)

2.3.5 Climate Change Mitigation Challenge

Currently there is a global debate globally focusing on how to mitigate the climate change by controlling greenhouse gases (GHGs) emissions from industries. Controlling GHGs emission is embedded in the 1992 United Nations Framework Convention on Climate Change (UN-FCCC) and 1997 Kyoto protocol (UN,1998) which set the emission target for the developed countries (Annex B of these protocol, in the Kyoto protocol to the United Nations Framework Convention on Climate Change, 1998) sets the limit of each country on emmision of carbon.

The Paris Agreement came up with new strategies of carbon credit and carbon offsetting credit because these allow different countries to contribute in UNFCC without reducing industrialization. Polluter pays the right to emit pollution. The paid money is directed to pay to different strategies relevant to climatic change mitigation such as carbon sinks e.g. forest preservation.

2.3.6 Carbon Credit

Carbon credit is found in the article 6 of Paris agreement (UN, 2015). The article was proposed to address and reduce GHGs emissions which have caused global climate change. The article orders the commercial entities emitting $CO_{2,}$ not to exceed the allowed limit. Or to cut down emissions to the required level or else they should buy carbon credit certificates which can be traded in the market or alternatively been charged for the emissions which is known as carbon tax. Another financial solution set to reduce CO_2 emission is carbon offset credit. This is equivalent to the reduction of one metric ton of CO_2 from the atmosphere through promoting use of clean energy like solar and wind energy and funding projects on reforestation and nature conservation. This method is mainly used by highly industrialized developed countries by funding kind of projects in developing countries. (Gupta, 2011)

Carbon credit and carbon offset credit follows the polluter pays principle. This is the acceptable practice of which those who produce pollution should bear the costs for managing it for prevention of the damage to human health and environment. This principle has mainly been used to the emission of greenhouse gases which cause climate change (Hicks 2014).

Callan (2013) explains that, pollution is the negative externality which causes negative effect to human beings and environment that are not directly involved to the source of the pollution. Therefore the motivation follows which is called polluter pays principle whereby the polluter should bear the costs to keep the environment in acceptable quality level. (Todaro 2014) argues that, developed countries are the main polluters of air and sea; therefore they must commit themselves in cleaning environment. If they don't it will be difficult for them to convince developing countries to reduce emission of GHG since their capital emission levels are far below those of the industrialized countries.

2.3.7 Climate Financing

Climate financing is an important mechanism for funding projects designed to mitigate and adapt to the impacts of climate change in developing countries that are likely to

experience some of the greatest impacts of climate change, but often lack the necessary resources to develop infrastructure and institutions to address its effects. Such projects include renewable energy development, habitat restoration, afforestation, sustainable infrastructure development, and capacity building to develop climate-resilient livelihoods practices (Sellers 2016). In the past 25 years, several international mechanisms have been developed to finance these projects, including:

2.3.7.1 The Green Climate Fund (GCF)

GCF was established by the UNFCCC in Cancun in 2010, with a goal of directing funding to adaptation and mitigation projects in developing countries, receiving $10.3 billion in pledges to date.

2.3.7.2 The Climate Investment Funds (CIF)

CIF Is sponsored by the world's multilateral development banks, which consist of four separate funds totaling $8.3 billion in pledges, with the bulk of pledges ($5.6 billion) targeted at expanding the use of clean technologies, such as renewable energy or sustainable transport.

2.3.7.3 The Global Environment Facility (GEF)

GEF works closely with United Nations-backed institutions and multilateral development banks to channel funding to environmental projects around the world, including projects focusing on climate change, and was on the edge to spend $4.3 billion on an assortment of these projects between 2014 and 2018.

2.3.7.4 The Clean Development Mechanism (CDM)

CDM is the mechanism in which developed countries that are signatories to the Kyoto Protocol have to finance the development of climate mitigation projects in developing countries.

2.3.7.5 The Adaptation Fund (AF)

According to UN (2016) AF was also established under the Kyoto Protocol to finance adaptation projects in developing countries, until 2016 it committed over $300 million towards such efforts.

2.3.8 Theory of Change

"Theory of change is a tool for developing solutions to complex social problems. A basic theory of change explains how a group of early and intermediate accomplishments set the stage for producing long-range results" Harris (2017). Theory of change creates a picture of steps required to reach a goal. According to Anderson (2005) in Harris (2017), steps for creating theory of change are;

i. Identifying the long term goal (The outcome)
ii. Conducting the backward mapping to identify the pre-conditions necessary to achieve that goal.
iii. Identifying the interventions that your initiatives will perform to create these preconditions
iv. Develop indicators for each preconditions which will be used to assess the performance of the intervention
v. Write a narrative that can be used to summarise the various moving parts of the theory.

A Theory of Change map looks a bit slight like a driver diagram or a logic model. It differs from these by offering a nonlinear map of a project or programme approach, which shows how different components are expected to interact, and the multiple pathways through which change is expected to happen. It terms these components as intermediate outcomes; the specific changes expected as a result of the project or programme being implemented. These are linked together by causal pathways, which determine the direction of the relationship between these changes and show how they lead to the long term outcomes and impact to which the project or programme intends to contribute. Between these intermediate outcomes, interventions (the concrete activities

undertaken as part of the project or programme), rationale (the justification or existing evidence that suggests that a specific approach is likely to work in this context), assumptions (the uncertainties to be tested through formative research or implementation) and indicators (metrics of change linked to each intermediate outcome, determining whether and how much change has been achieved towards reaching this intermediate outcome) are plotted. (Silva, 2014)

2.4 Empirical Litera Review

The possible mitigation on land-use sectors, principally forests and cropland, has been estimated by several studies at the global, national and, in a few cases, at the project level. (IPCC 2007)

Mitigation programmes and projects normally engage estimation of verifiable changes in carbon stocks over a given period, and estimation of the mitigation potential of a project or programme requires measurement, estimation and reporting of carbon stock changes in a given area under the without-project or baseline scenario that is in absence of a mitigation programme or project activities as well as carbon stock gain due to implementation of the mitigation programme or project activities under the mitigation scenario. Land-use-based mitigation activities normally involve conserving the existing carbon stocks or increasing the carbon stocks or density in low-carbon-degraded areas or biomass energy replacing fossil fuels, leading to a net CO_2 emission reduction. Mitigation through conservation of carbon stocks and expansion of carbon sinks due to a programme or project activity could be captured by estimating stock change between two points in time. (Ravindranath, 2002).

This part will review some studies which have covered on climatic change mitigation projects, carbon sequencing through tree planting, carbon measuring techniques and willingness to plant trees.

2.4.1 Carbon Sequestration Through Tree Planting

Forests play very essential part in climate change due to that truth that trees naturally absorb and release carbon dioxide throughout their life cycle. During photosynthesis, they remove carbon dioxide from the air and store it as organic matter in their trunks, branches, foliage, roots, and soils. This practice is known as carbon sequestration. When trees decay or burn, they release their stored carbon back into the atmosphere, the amount of carbon a particular tree absorbs or releases throughout its lifecycle is negligible. However, due to their global abundance, the cumulative effect is very large.

The Intergovernmental Panel on Climate Change (IPCC), winner of the 2007 Nobel Peace Prize, is the world's leading authority on climate change. One of their recommendations is that we need to mitigate future impacts of climate change by reducing current and future emissions. One way to reduce emissions is to reduce the amount of forests that are clear-cut or degraded, since these activities account for about 20% of global greenhouse gas emissions. Preserving existing forests is considered a much better alternative to reforestation, as it takes decades for a new tree to grow and absorb the amount of carbon that is released when a mature tree is lost.

Some studies have shown that forest trees store carbon in the stem, branch and leaves which is the result of photosynthesis process whereby the plant manufacture food by using water from the ground and carbon dioxide $CO_2$from the atmosphere which is the results of the emission from both natural and anthropogenic activities. For example, (Gajasen, 2011) conducted a comparative study of carbon sequestration potential in above ground biomass in primary and secondary forests at Khao Yai national park. They used allometric method to estimate above ground biomass and carbon stock. They found that these two types of forests had common species but the primary forest had more carbon content which is 342.99tonnes C/ha compared to secondary forest which had only 99.10tonnes C/ha. They concluded that this was because of the plant density difference between the forests. Primary forest had low plant density i.e. 919trees /ha while secondary forest had high plant density i.e. 2192tree/ha. This caused the primary

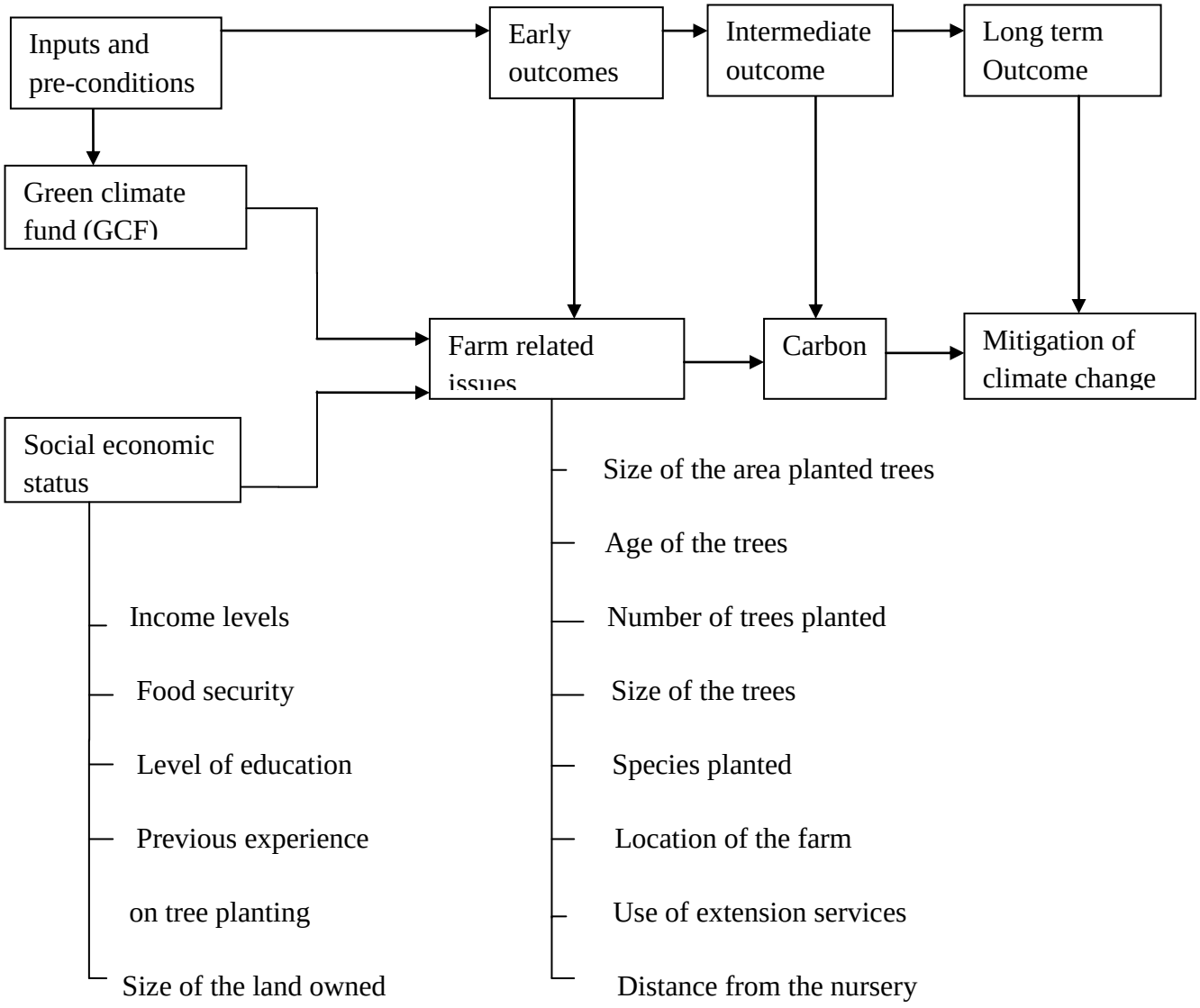
forest to have large trees with higher density at breast height (DBH) compared to those in secondary forest which were small with low DBH.

2.4.2 Estimation of Carbon Stock as Carbon Credit Project Evaluation Techniques

Ministry of natural resources and tourism (MNRT) of Tanzania, through its organ called Tanzania forestry services (TFS) with collaboration with the government of Finland and Food and Agriculture Organization (FAO) conducted national forest resources monitoring and assessment (NAFORMA) in Tanzania mainland from 2009 to 2014 and came up with the report in 2015 (MNRT, 2015). They used allometric method to analyze biophysical data which are number of stems per plot, diameter at breast height, and the height of the tree collected from the trees of natural forests in Tanzania mainland to get biomass and carbon inventory in them.

2.5 Conceptual Framework

Figure 2.1 Conceptual Framework for GEPAT Project in Mitigating the Climate



Source: Researcher (2018)

This conceptual framework is derived from the theory of change. According to the steps stated by *Anderson (2005*) in Harris (2017), in this project the long term goal is the mitigation of climate change. It consists of four steps to attain this long-term outcome. The pre condition necessary to attain the long term outcome is the Carbon sequestrated in trees planted. The carbon sequestrated is the results of the farm related issues. These

issues influence the amount of carbon to be removed from the atmosphere through forestation. These are the early outcomes from the Global climate fund from donors through project organization to farmers and the socio economic status of the farmers which influence the implementation of the project.

2.6 Summary of the Chapter

This chapter presented very important components of the study in the sense of having the definitions of key terms and concepts used in the study. The theoretical debates as proposed by scholar with each weakness and relevance to the study and indeed literature review, and the conceptual framework. This part as stated makes the research more scholarly because it looks into other writings and theories critically to necessitate building gaps and coming with new model for analysis of similar issues.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is a systematic approach towards solving of the research problem (Kothari, 2014). In it we study various steps that are generally adopted by the researcher in studying his/her research problem with logic behind them. From what has been stated above we can say that research methodology has many dimensions in which a researcher explains them logically with the concrete justification.

The chapter presents the research design and methodology used in the study. It begins by explaining the research methodology and research design. It also presents the area of the study, type of data, source of data, the sample design study population, sampling technique, sampling frame, sampling unit, sampling size, unit of analysis, methods of data collection, Data analysis, validity and reliability.

3.2 Research Design

3.2.1 Case Study

This study will employ the case study research design because it focuses in one organization that is GEPAT. According to Yin, (2003) Case studies are preferred strategy when how or why questions are posed, and when the investigator has little control over events. This case study was trying to how the Theory of change has been implemented. The information will be collected from the area where the project is undertaken.

3.2.2 Triangulation

Triangulation is the use of two or more independent sources of data, or collection methods of data. This study employed both qualitative and quantitative research methods. Quantitative research method is based on quantitative measure; this was employed because of the measure of Carbon in the stem of the tree. While qualitative

method is the measure of the quality or kind. This was employed to evaluate the improvement of climate as the result of the project.

3.3 Area of Study

This study was conducted at Kituntu , Kanoni and Igurwa wards which are found at Karagwe District in Kagera region. These are among areas where GEPAT project is implemented. The area is 1500-1800 m.a.s.l and experience bi-modal rainfall with peak rains from September to December and from March to May. The project is distributed in this area where there nurseries and tree farms.

3.4 Research Strategy

The study involved both the quantitative and qualitative approaches. In the quantitative research study, the objective is to classify features, count them, and construct statistical models in an attempt to explain what is observed. On the other hand, qualitative research approach was used to supplement the quantitative one. This is due to its capability of probe and explain those relationships and to explain contextual differences in the quality of those relationships (Lugumira, 2013)

3.5 Type of Data

This study employed both Primary data and secondary data. Primary data were obtained from the field direct to the respondents who are the Tree planters participating in the implementation of GEPAT using questionnaire, Interviews, discussions and their meetings when their discussing their challenges and success in implementation. Primary data was also collected in the field by measuring parameters necessary for estimation of carbon inventory. While secondary data were obtained from the different journals, repots and books. Both types of data were used because primary data gives the empirical information which is the original data and secondary data helps in making some comparison hence supplement primary data.

3.6 Source of Data

Data was obtained from the Tree farmers and their farms who participate in tree planting in the implementation of GEPAT project from three wards of Kituntu, Kanoni and Igugwa in Karagwe districts, also from Tanzania Meteorology Agency. These sources of data were selected because they had potential information pertain to the study problem.

3.7 Unity of Analysis

The unit of analysis was the major entity that was analyzed in the study. It was the 'what' or 'who' that was being studied. Units of analysis are essentially the things examined in order to create summary descriptions of them and explain differences among them. The unity of analysis in this study was the tree farmers. The Tree farms were selected because are the ones who obtain the incentives for implementation of the project.

3.8 Parameters of Interest

This occurs in determining the sample design, which depends from what one is looking at. In this study the parameters of interest were the Tree farmers' demographic characteristics; Farm related issues and Carbon inventory. These parameters are selected because they were important in assessing factors causing variations in individual performance in contribution of mitigating climate change regardless of the incentives provided to them.

3.9 Sample Design

Kothari (2006) defines sample as a collection of some parts of the population on the basis of which judgment is made. The sample design for this study included the following:

3.9.1 Study Population

This refers to the population to which the researcher intents to generalize his/her findings (Nkpa, 1997). The population of the present study was the Tree farmers at Kituntu, Kanoni and Igurwa wards in Karagwe districts who are the members of GEPAT

project, government agencies, leaders and the founders of the project. This population was selected because they were found to be key stakeholders in Environmental sector.

3.9.2 Sampling Methods

Under this study, both probability sampling and non-probability sampling were adopted. Whereby probability sampling helped to obtain the number of respondents who are the Tree farmers implementing the project, Plots and trees for carbon inventory estimation through simple random sampling. Non-probability sampling was purposive sampling since the study focused only to the tree farmers of GEPAT project.

3.9.3 Sample Size and Sampling Technique

Sampling frame was in three steps

i. Nursery raisers who grow trees and supply to the farmers were sampled
ii. Farmers who take tree seedlings from nursery raisers and grow them into their own tree farms were also sampled. Unlike natural forests, the trees are planted in land parcels owned by the farmers themselves. They are small plots which needs to be measure for the carbon stock individual member contribute in terms of carbon sink
iii. Tree sampling involved the sampling techniques used by foresters (Malimbwi, 2014) who measured huge forests, in this case was adopted for estimation of carbon stock volume the farmer contribute through tree planting.

The study involved tree farms that belong to the farmers who participate in the implementation of GEPAT project. Up to 2017 when the pilot study was conducted, GEPAT had about 1,000 members spread in Kyerwa and Karagwe district. Since I liked to measure individual efforts only three wards of Kituntu , Kanoni and Igurwa where there are 500 farmers in total were involved . To get the sample size out of these 500 farmers the formula developed by Yamane (1967) whereby level of precision of 10% was used. Based on these data the actual sample size was obtained as follows: $n=N/\{1+N(e)^2\}$. Whereby n= sample size; N= is the population size; and e= acceptable sampling error with confidence level of 10% hence,

$$n= 500/ \{1 + 500(10/100)^2\}$$

n= 99.80 = 100 respondent

3.9.4 Purposive Sampling

Techniques: Sampling tree planters is purposive because those farmers who plant trees were involved in the study. Also, nursery raisers who prepare seedlings were involved. Up to 2017 GEPAT had about 107 nurseries manned by 107 nursery raisers.

3.9.5 Random Sampling Techniques

Random sampling techniques were used in sampling plots of the farms during the real exercise of carbon stock project evaluation measurement it started with random sampling of the plots. Since my interest was to measure exactly what amount of carbon has been absorbed by trees, forestry techniques were adopted. Though different authors (Malimbwi, Katila, Maksara, Chamuya and Shamshama), three sub-sampling techniques were adapted. The study called these tree plots sampling as a subsample because it is a sample which is sampled after sampling the farms of the farmers.

3.9.5.1 Permanent Sample Plot (PSP)

This is a technique used by foresters to set a plot which will keep being measured to monitor carbon stock in trees which are found in conserved area. For this case, the technique was used to measure the efforts of individual member involved in tree planting, The project is ongoing and therefore (PSPs) were periodically premeasured sample plots to monitor carbon. They provided data of changes in land use, forest stocking, volume and carbon. The locations of PSPs were continuously be measured using high-precision Geographical Positioning Systems (GPS). To help its traceability of planted area, the following were measured:

- **Sample tree:** A live tree selected for measurements of additional parameters.
- **Tally tree:** Live or dead standing tree in the concentric circular plot.
- **Tree:** A tree is at least 1.35 m perennial wooded plant with distinct stem capable of reaching 5 meters height *in situ*. Cactuses and palms were regarded as trees in

the data collecting phase, but distinguished in the data analysis phase. Bamboos, bananas and shrubs were not recorded as trees.

- **Tree height**: Tree height is measured as the distance from the ground level up to the highest point of the tree. If the seeding point is higher than the ground level (e.g. in case where a tree growing on the top of a stone), the tree height is measured from the seeding point. See more explanations and special cases in the section *Tree height measurements.*
- **Plot radius, centre and boundary:** as described in Figure 3.1

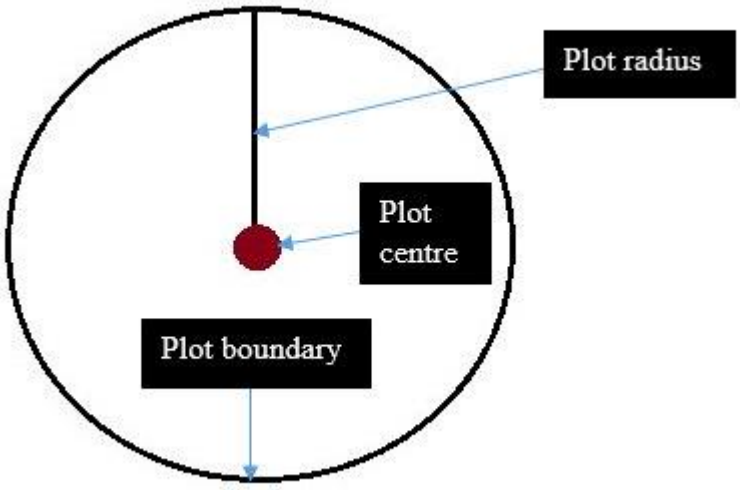


Figure 3.1 Parameters used in measuring plot sizes of sampling areas

3.10 Data Collection

3.10.1 Social Economic Issues

Data on social economic issues was collected by means of a questionnaire (Appendix 1). These include gender related issues, economic issues, farming systems, food availability and education levels. The response variables were coded appropriately.

3.10.2 Farm Activities Causing Variation in Carbon Inventory

Tree species planted by farmers were identified by using physical descriptors. The number of trees per species was estimated relative to its area in large plots. For smaller plots farmers knew the number of trees planted and this was recorded. The questionnaire also included questions probing on farm use activities such as intercropping, pesticide use, preferred fertilizers and irrigation system.

Using a Garmin Etrex GPS device, the area of small plots was measured. Some plot areas were already documented by land surveys of the Ministry of land hence were recorded.

3.10.3 Estimation of Sequestered Carbon Stock

A few trees were randomly sampled to represent the whole plot and the following parameters were measured

i. **Diameter at breast height**: This was determined using a caliper 1.37m from the base of the trunk (ground level).

ii. **Tree height**: The tree height was measured using the tangent method for the first ten trees. Heights of the remaining trees were estimated using a linear equation derived from the initial measurements

The parameters were used to determine the stand density, volume and biomass of the per trees specie. These are the required parameters in determining carbon sequestered.

3.10.4 Evaluation of Weather Pattern Changes

The levels of precipitation, humidity and temperature across five years were collected from the Tanzania Meteorological Agency website and articles published in peer reviewed journals.

3.11 Data Analysis

3.11.1 Social Economic Issues

The questionnaire was decoded using IBMs' SPSS version 25. Descriptive statistics were used to elucidate central tendency of homestead parameters. The means and percentages provided necessary quantification measurements for comparison.

Relevant charts (Pie charts and population pyramids) were sketched using Microsoft excel 2016.

3.11.2 Socio Economic Modelling

A linear regression model was used to test the hypotheses that social economic parameters influence tree planting habits of homesteads. The analysis was done using the software Minitab Version 17. The dependent variable was tree acreage per homestead. The independent variables included homestead income per month, education level, distance from water source, frequency of consultation of extension officers and food security.

Homestead education level was estimated by using an education index calculated as

$$\mathbf{E.I = \Sigma N_x/100}$$

Whereby:

E.I = House hold Education index

Nx = Education weight = $(N_P*1) +(N_O*2) +(N_A*3) +(N_B*4) +(N_M*5) +(N_{PhD}*6)$

N_P = Number of homestead members with primary education

N_O = Number of homestead members with O level education

N_A = Number of homestead members with A level education

N_B= Number of homestead members with a Bachelor's degree

N_M= Number of homestead members with a Master's degree

N_{PhD}= Number of homestead members with a PhD

The distance from water sources was estimated in kilometers from the homestead. Food security level was measured by finding the product of number of meals per day and number of food types in diet with each having a score of 1(fruits, vegetables, cereal products and legumes). The level of significance was measured at $P < 0.05$

The multiple linear regression model was split into simple linear regression models for each single independent variable that proved to be significant against the dependent variable.

3.11.3 Farm Activities Causing Variation in Carbon Inventory

The number of trees per species in farming plots was determined by descriptive statistics in SPSS. A box plot was used to display the results depicting maximum number of trees, minimum, the mean and the outliers that would shift the dynamics of the central tendency parameters.

Amount of land used for farming activities other than forestation was elucidated from response from the questionnaire and computation of land space remaining after forestation and empty land.

The volume of tree species was computed as following

i. For *Eucalyptus grandis*

$$V = 0.000065 \times DBH^{1.633} \times H^{1.137}$$

ii. For *Pinus patula*

$$V = 0.00002117 \times DBH^{1.8644} \times H^{1.3246}$$

iii. For other trees

$V = BA \times H \times 0.5$

Whereby:

- V = Volume
- DBH = Diameter at Breast Height
- H = Height
- BA = Basal Area

The basal area was computed using the formula below

Basal area = $\pi (DBH)^2 \div 4$ Where $\pi = 3.14$

The stand density was determined by calculating the number of trees per hectre.

3.11.4 Estimation of Sequestered Carbon Stock

For *Eucalyptus grandis,* the biomass was estimated using the model by Schubert *et al* 1988:

$$\text{Biomass} = 0.069413 \times DBH^{2.1472} \times H^{0.3129}$$

Whereby:

D = Diameter at breast height

H = Mean tree height

For model validation, the data of DBH collected was plotted against the regression model to determine goodness of fit of the model using the R^2 value.

The total biomass was determined by multiplying the biomass per tree and the number of *Eucalyptus grandis* trees planted in the project area

A similar approach was used to estimate biomass of *Pinus patula.* The model used was that of Kilawe *et al* 2001 as entailed below:

$$\text{Biomass} = 0.006006 \times DBH^{2.172}$$

The amount of carbon sequestered in the trees was estimated by multiplying the biomass with 0.47 (47%).

The carbon dioxide equivalent will be determined as follows:

CO_2 = Carbon (tonnes/ha) × 3.67

CO_2 (metric tonnes) = CO_2 (tonnes/ha) × 0.9072

3.11.5 Evaluation of Weather Pattern Changes

Temporal progression charts were drawn using Microsoft excel to determine trend. The slope for each chart was determined by computing the area under the graph so as to determine rate of trend. Means were compared using a T test to determine significance of changes of weather parameters between time of GEPAT project initiation and current weather data.

3.12 Validity and Reliability of the Data

3.12.1 Validity

Validity as used in quantities research to mean absence of subjectivity has been found to be almost impossible in qualitative research (Auerbach, 2003). Accuracy or trustworthiness of instrument, data and findings (Bernard, 1995) is complicated by the meaning making process. This makes justifiable subjectivity inevitable during data analysis and interpretation. Nevertheless, Bryan (Undated) triangulation method or combined method was used with the assumption that, each paradigm has got its inherent weakness and strength and integrating different methods from each paradigm helped to fill or rectify the gaps. The use of triangulation in this study enhanced the validity for the data.

3.12.2 Reliability

Reliability refers to the certainty of instrument to yield similar results over time which is difficulty criteria to attain in research. Reliability like validity depends on how

transparent the narrative is (Schensul, 1999). Therefore the researcher relied on making logical inferences from data, being precise in describing phenomenon as well as minimizing research bias or subjectivity.

3.13 Summary of the Chapter

Kothari (2000) defined the research methodology as “a plan of attack” that best meets the needs of the defined problem. In this chapter the methodology has particularly described: the study area, research approach, study design, study population, determining of the sample size, data collection technique, data processing and analysis, and finally reliability and validity of data.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the research which were obtained from the study. Generally the study intended to evaluate climate mitigation projects for sustainable development. Taking a Case of GEPAT project which is implemented at Karagwe and Kyerwa districts in Kagera region, considering Kituntu , Kanoni and Igurwa wards which are found at karagwe district. 299 respondents were taken as a sample size using different tools such as questionnaires, interview and focus group discussion.

In order to attain sound conclusions and recommendations, the study was guided by four specific objectives which included, identifying socio-economic factors influencing forestation activities within the projects sphere of influence, to elucidate farm related issues causing variation in contribution to carbon inventory, to estimate the carbon stock sequestered by the forestation initiatives of the project and to examine the weather patterns before and after the project implementation as a justification of climatic change mitigated by Project in the area, ceteris peribus. In order to assist the readers, the findings of the study are presented in both descriptive and brief methods using bar graphs, figures and tables where the researcher thought it was necessary to convey the data collected so as to make clear interpretation to readers as well as to the researcher during the process of conveying the findings.

4.2 Presentation of Findings

This study is the responsive evaluation whereby data collection was centered on the issues from the people who are directly involved in the project, documents from the project and observing how the project to be evaluated is actually working. The findings from this study have been used to test the theory of change (explained in chapter 2) which was used in this study. Inputs for the implementation were collected from the project documents while the pre conditions, which are the social economic factors, are presented here after being analyzed. Early outcomes which are farm related issues,

intermediate outcome which is carbon inventory are also presented here which in turn leads to the long term outcome that is mitigation of climate change.

4.2.1 Social Economic Factors Influencing Trees Planting by Farmers in the GEPAT Project

Most farmers grow trees for the purpose of selling processed wood planks (timber).The mango orchards are mainly for personal consumption rather than business**.** The students t-test depicts a significant difference between trees grown for economic purposes (*Eucalyptus*) and those grown for consumption (*Mangifera indica*) ($t = 3.8$, $P < 0.001$). The leaders of the homesteads are mainly men (Figure 4.1) even though the population is made up mostly of women.

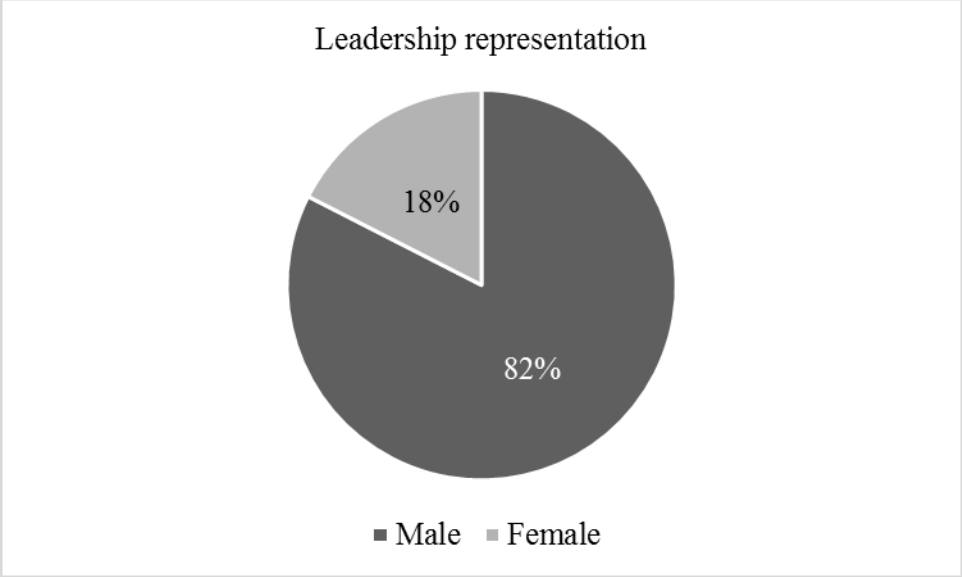


Figure 4.1 Percentage Homestead Leadership Representation in Surveyed Area

This corresponds to the number of women in the labor force where 51.27 % of farm worker are women of the age group 21 to 40 years indicating sufficient youth involvement (Figure 4.2). The elderly don not form a part of the workforce. Elders aged over 80 years do not significantly engage in tree farming.

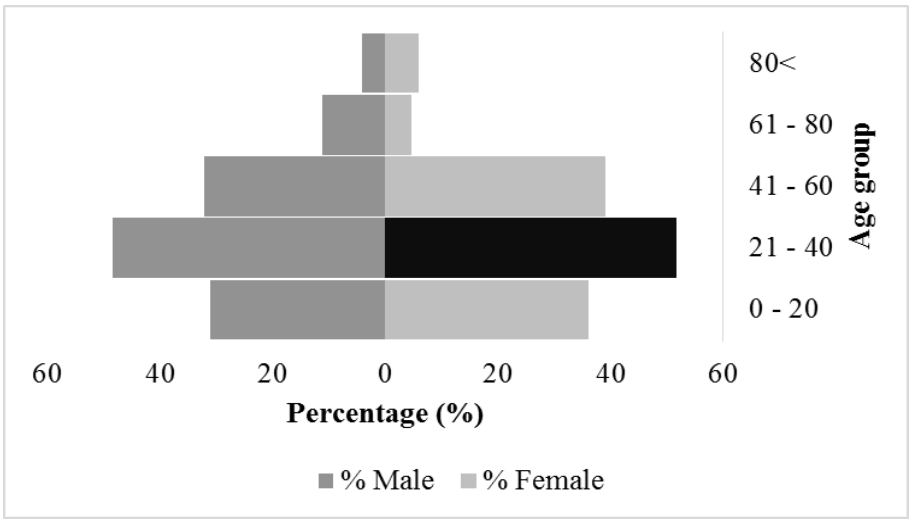


Figure 4.2 Population Pyramid of Labor Force Working in Tree Farms Based on Age-Groups and Gender

Members from all homesteads went through formal educational systems with most of them ending up in the O level stage. Around 7 female homestead members reached the PhD level **(**Figure 4.3**)**

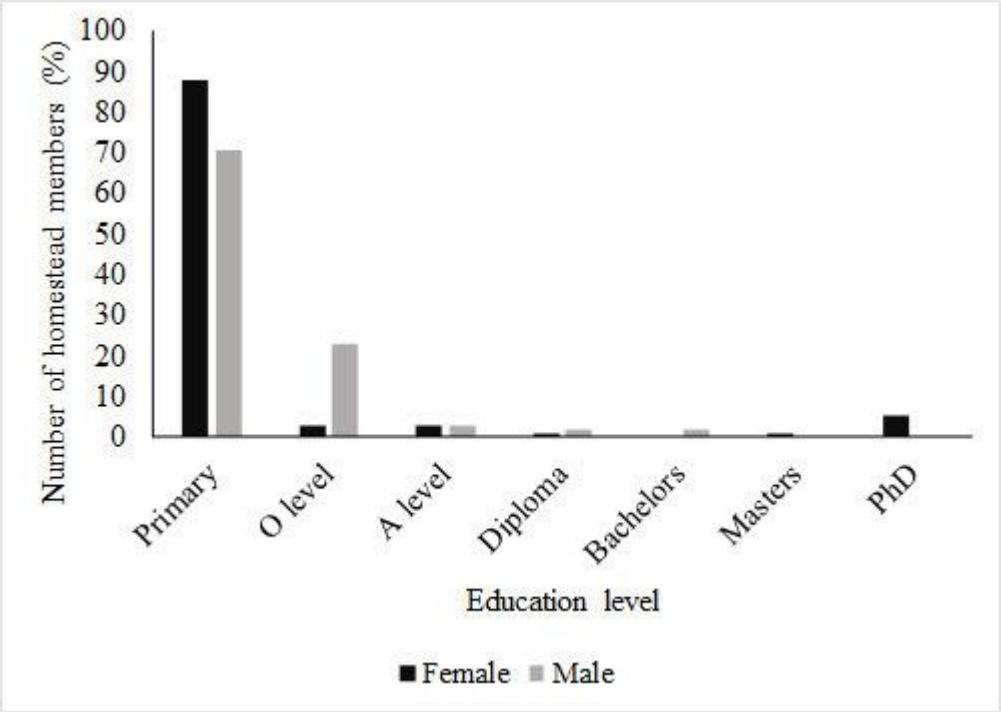


Figure 4.3 Distribution of Homestead Members Across Levels of Education Based on Gender

However, despite their participation, married women don't own any land. All the land is owned by the men.

Extension services play an important role in tree planting activities. Every homestead farmer makes use of extension services for advice on tree planting.

Food security isn't stable yet as 40% of the homestead advocate scarcity. (Figure 4.4)

The 6 % that have seen enough share of food represent households with secondary sources of income and larger plots of forests.

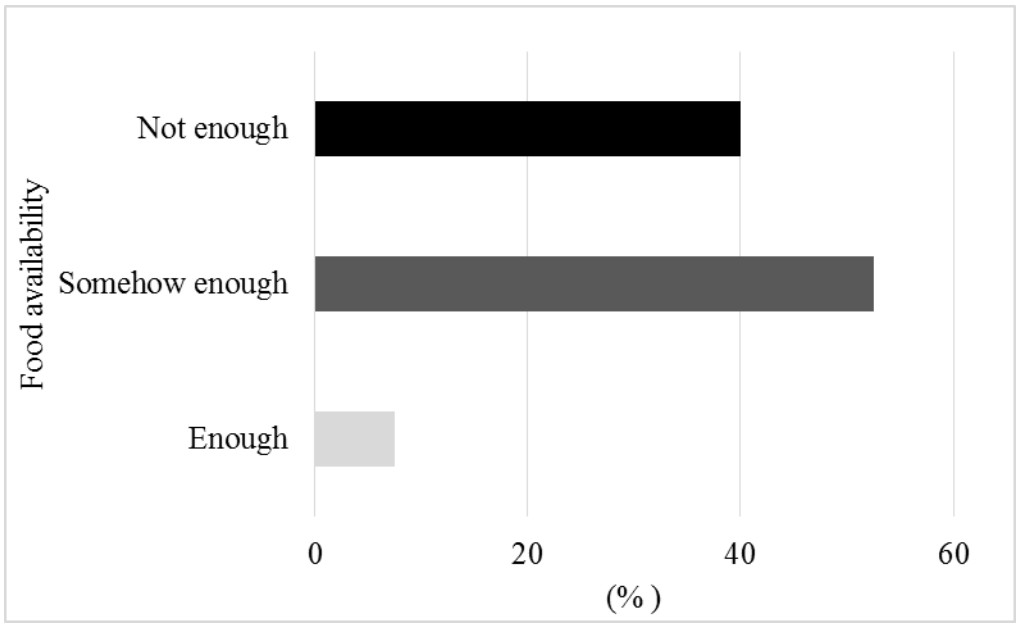


Figure 4.4 Food Availability in Homesteads Involved in the GEPAT Project

4.2.2 Farm Activities Causing Variation in Carbon Inventory

The most common types of trees grown in the surveyed area under the GEPAT project are *Eucalyptus grandis* and *Pinus patula*. Around five homesteads grow over 1000 Eucalyptus trees, an industrial level operation. (Figure 4.5)

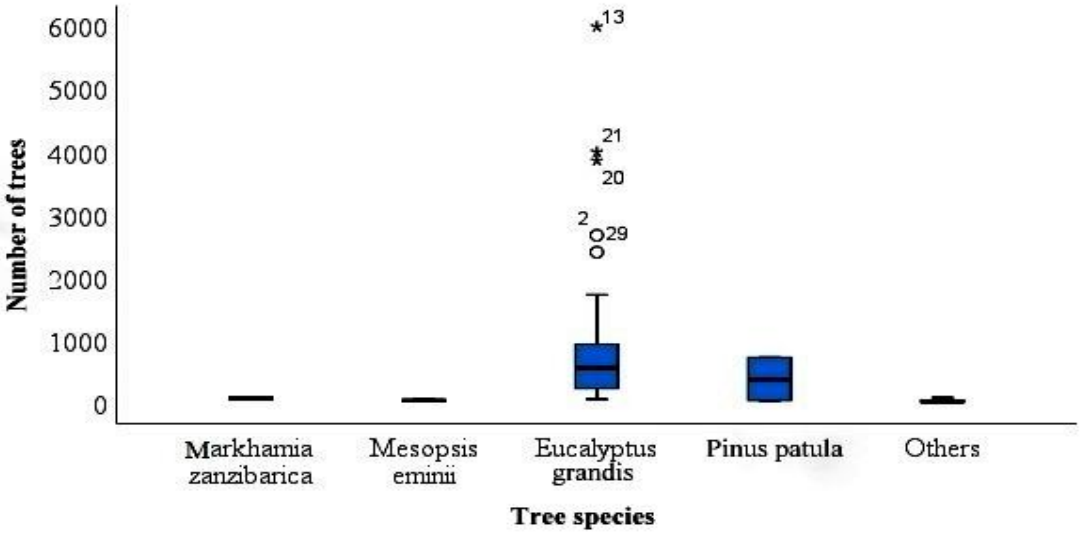


Figure 4.5 Types of Trees grown in Tree Planting Homesteads in the GEPAT Project

A total of 213.5 ha are owned by the homesteads in the surveyed which are a part of the GEPAT project**.** Most of it (48.4%) is used for tree farming while a good portion is used for crops and the rest remains unfarmed (Figure 4.6). There are no irrigation practices in the farming systems.

A few outliers represent large scale producers of the *Eucalyptus grandis.* The highest producer has 6000 trees of *Eucalyptus grandis* in his farm ferchning him a good income in sales to the pulp industry. The other trees represented in the chart mostly grown at a smaller scale include *Cyperus papyrus* and *Arundinaria alpine.*

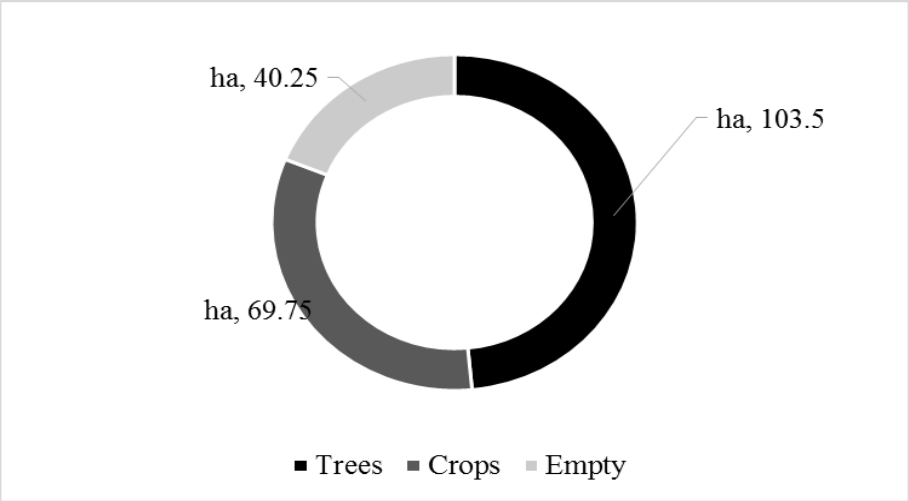


Figure 4.6 Land Use Proportions in GEPAT Project Implementation Areas

4.2.3 Results of the Regression Analysis (Test of hypothesis)

In reference to parameters measured in this study, the regressed model is as shown below:

$$Y = \mu + \beta_0 X_0 + \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3 + \beta_4 X_4$$

Table 4.1 Minitab Output of the Multiple Linear Regression

	Number of observations	130		
	R^2 (%)	97.11		
	Adjusted R^2 (%)	96.14		
	Parameters (X)	**Coefficient (β)**	**F value**	**P value**
0	Food security	0.0074	2.91	0.832
1	Extension services	0.212	22.7	< 0.01*
2	Water source distance	-0.2030	48.13	0.016*
3	Education level	-0.159	0.47	0.313
4	Homestead income	0.000005	10.56	0.007*
	Constant (μ)	3.53	100.65	< 0.01*

*Variable effect significant at P<0.05

Hence, based on the results, the resulting model is

$$\mathbf{Y = 3.53 + 0.074X_0 + 0.212X_1 - 0.203X_2 - 0.519X_3 + 0.000005X_4}$$

Whereby:

Y = Tree acreage per homestead

X_0 = Food security

X_1 = Extension services

X_2 = Distance from water source

X_3 = Education level

X_4 = Homestead income

The R^2 value of the above model indicates that 96.14% of the variation of tree acreage per homestead is accounted for by the independent variables. Amongst the listed independent variables, consulting extension services ($P<0.01$), distance from water source ($P<0.01$) and house hold income ($P<0.05$) significantly contribute to the variation of tree acreage per homestead.

4.2.2.1 Liner Regression Models of Independent Variables with Significant Effects on the Variation in Tree Acreage per Homestead

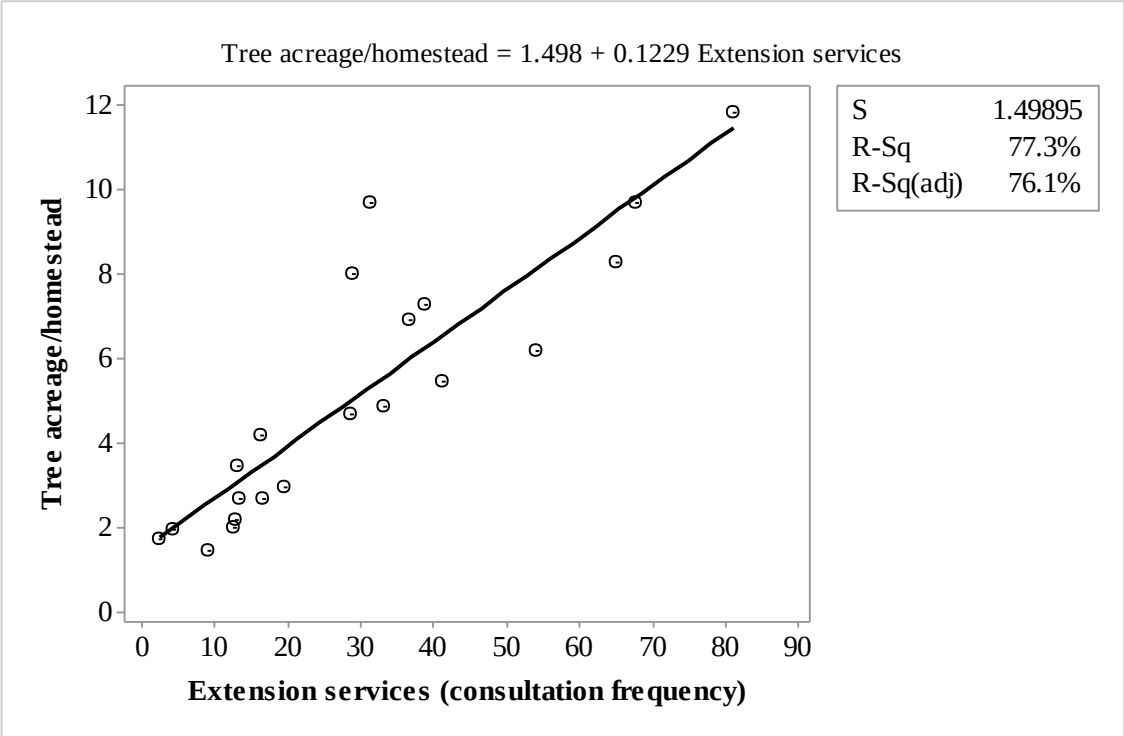


Figure 4.7 Linear regression model depicting changes in tree acreage as a response to frequent consultation of extension agents with respect to appropriate agronomic practices in tree planting

The model (Figure 4.7) indicates that for every increase in frequency of consultation of extension agents, we can expect an average increase in tree acreage by 0.1229 acres. Extension agents are part of the local government system but under the Ministry of Agriculture. They are set up to help famers get the most out of their fields. They achieve this by teaching good agronomic practices, help fight pests and diseases and seek local buyers for farmers produce. In regards to forestation activities they have a played a significant role in increasing tree acreage in the study area of implementation of the GEPAT project.

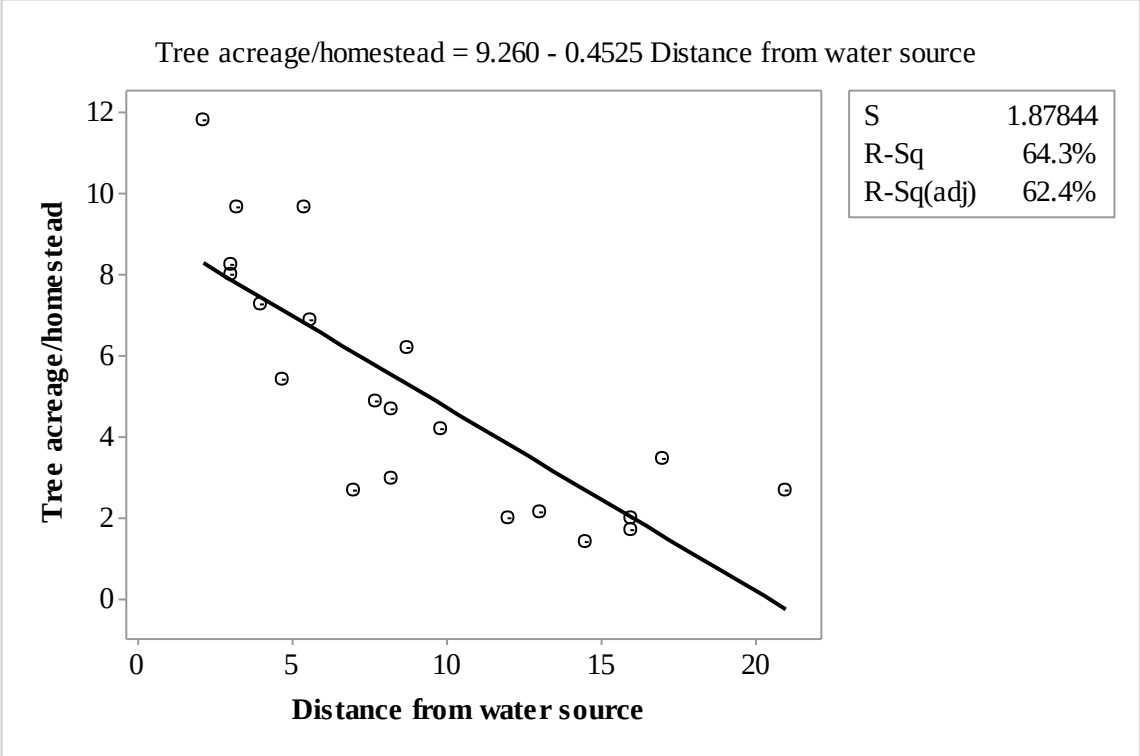


Figure 4.8 Linear regression model chart portraying tree planting habits of homesteads in relation to distance to water sources

Most of the tree species planted in the GEPAT project areas that were the focus of this study requires abundant water for irrigation. The physiology of most trees under water stress such as *Pinus patula* usually responds by wilting of leaves and slower development. Many seedlings die due to lack of water. The regression model (Figure 4.8) indicates that for every kilometer further away from the water source, there is an average 0.4525 acres less of trees planted in the GEPAT project areas of implementation.

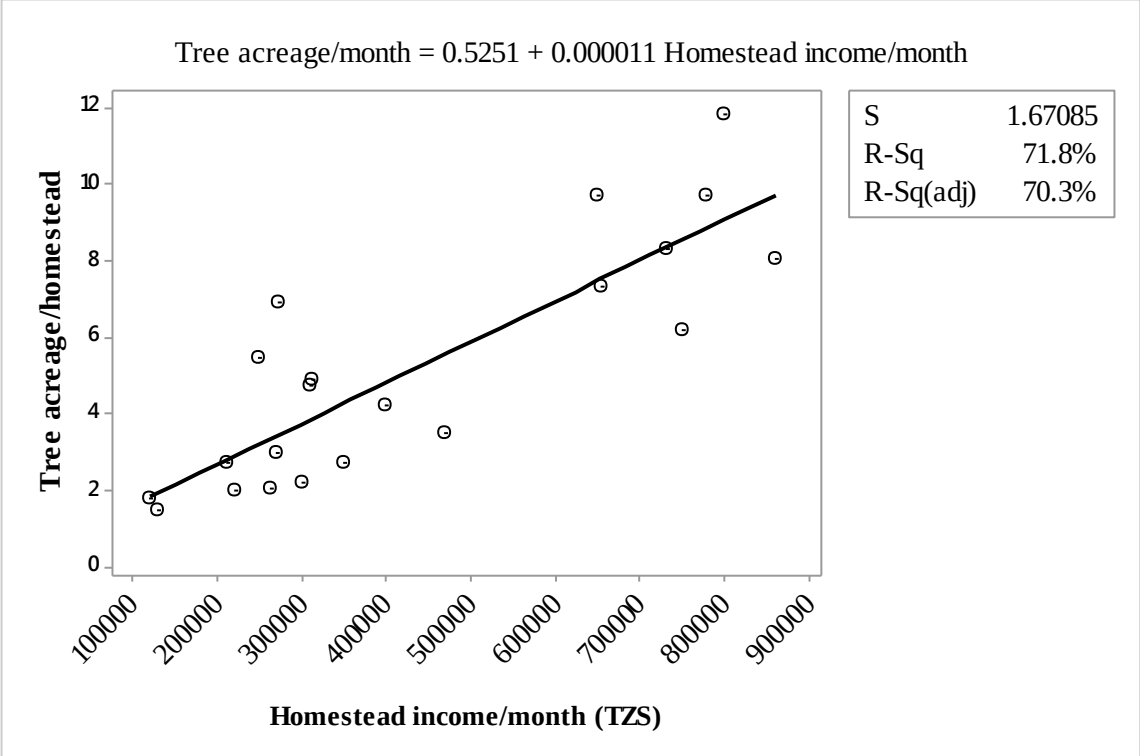


Figure 4.9 Linear regression of monthly homestead income against tree acreage per homestead

The linear regression model in figure 4.9 relates the monthly homestead income with tree acreage per homestead whereby for every increase in 1TZS, there is a 0.000011 increase in tree acreage. The more the income, the more the ability of a homestead to purchase agricultural inputs necessary for seedling development (seeds, fertilizers) and hiring extra labor. There are two distinct clusters of households based on their monthly income as seen in the model figure 4.9

4.2.2.2 Summary of Measured Tree Parameters in the Project Area

Table 4.2 Field mean survey data summary for Eucalyptus grandis trees in the project area

	Mean ± Std dev	Maximum	Minimum
Height (m)	12.4 ± 4.05	16.3	7.3
DBH (cm)	7.85 ± 2.3	9.5	6.2
Stand density (trees/ha)	25.52 ± 12.1	36.5	13.2
Volume (m3/ha)	0.84 ± 0.4	1.6	0.77

Table 4.3 Field mean survey data summary for Pinus patula trees in the project area

	Mean ± Std dev	Maximum	Minimum
Height (m)	8.8 ± 2.4	12.5	6.8
DBH (cm)	10.957 ± 5.82	19.8	6
Stand density	7.7 ± 3.2	12.9	3.1
Volume (m3/ha)	0.25 ± 0.1	0.37	0.14

Table 4.4 Field survey data summary for other trees in the project area

	Mean ± Std dev	Maximum	Minimum
Height (m)	18.367 ± 10.01	24.3	6.8
DBH (cm)	19.2 ± 6.83	24.5	9
Stand density	0.94 ± 0.3	0.97	0.58
Volume (m3/ha)	0.0083 ± 0.001	0.01	0.0064

4.2.3 Estimation of the Carbon Inventory Reduced by Homesteads Through Forestation Initiatives of the GEPAT Project

a. Carbon sequestered by *Eucalyptus grandis* in the study area

The relationship between the diameter at breast height (DBH) and the biomass of *Eucalyptus grandis* measured in the study area proved to fit the regression model by Schubert *et al* 1988 for estimation of biomass

(Figure 4.10). The result validated the use of the model as appropriate for this study.

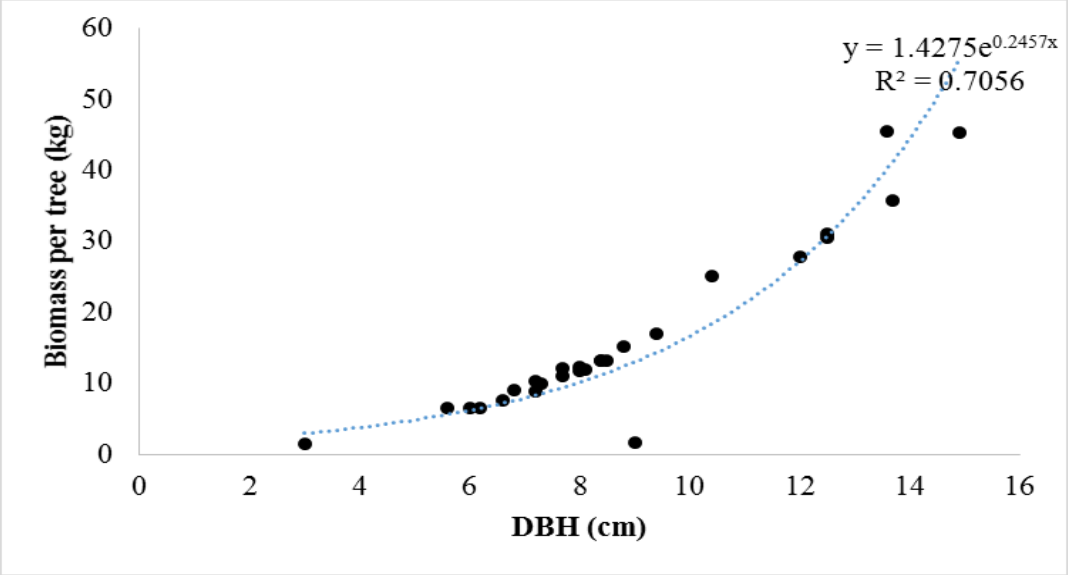


Figure 4.10 Regression model fitted with data collected from tree farms funded by the GEPAT project for estimation of biomass of *Eucalyptus grandis*

The estimated biomass of *Eucalyptus grandis* in the project area was found to be 8,313 kg. A total 47 % of biomass of *Eucalyptus grandis* represents the carbon stock (IPCC 2006).

Hence, carbon stock present in *Eucalyptus grandis* trees in the study area is 3,907 kgC (3.9 tonnes C).

The equivalent amount of CO_2 removed from the atmosphere is 3.54 metric tonnes.

b. Carbon sequestered by *Pinus patula* in the study area

Regression model by Kilawe *et al* 2001 fit the data collected in this study by 92.7% (Figure 4.11).

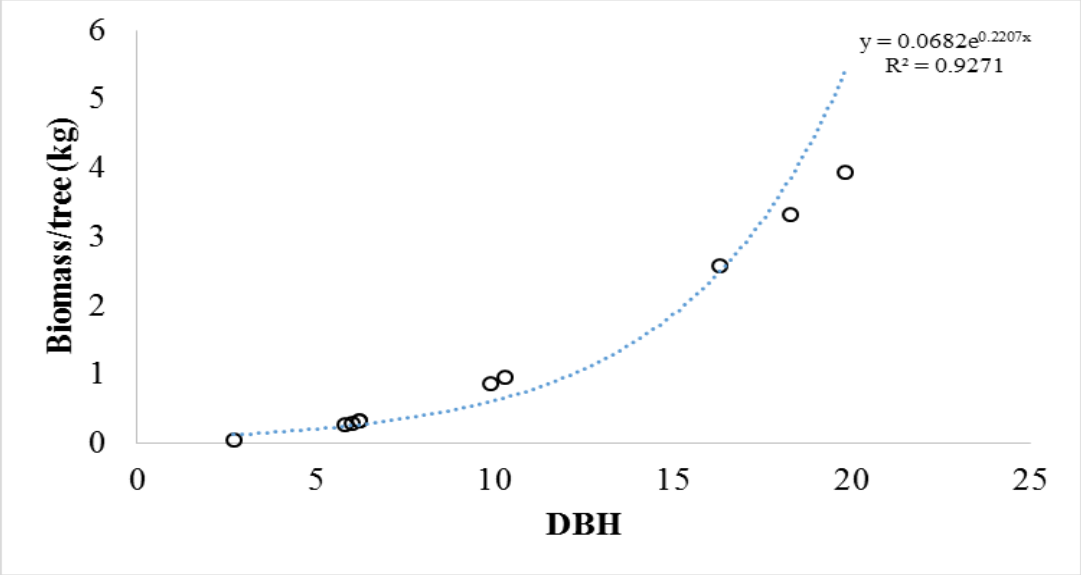


Figure 4.11 Regression fit of data collected in GEPAT tree farms for estimation of biomass of Pinus patula

The estimated biomass of *Pinus patula* in the project area was found to be 874 kg. Half of the biomass (50%) (Guedes 2017) of *Pinus patula* account for carbon stock which in respect to this study is 437.1 kgC (0.437 tonnes C)

The equvalent amounf of CO_2 sequestered is 0.39 metric tonnes.

The two species of trees account for 98% of trees planted in the project area hence the total sum of CO_2 sequestered is 4.8 metric tones.

4.2.4 Weather Patterns During Project Implementation

There is a steady decrease in maximum temperature in the study area for the past two years (Figure 4.12) from 29.08 °C to 24.7 °C.

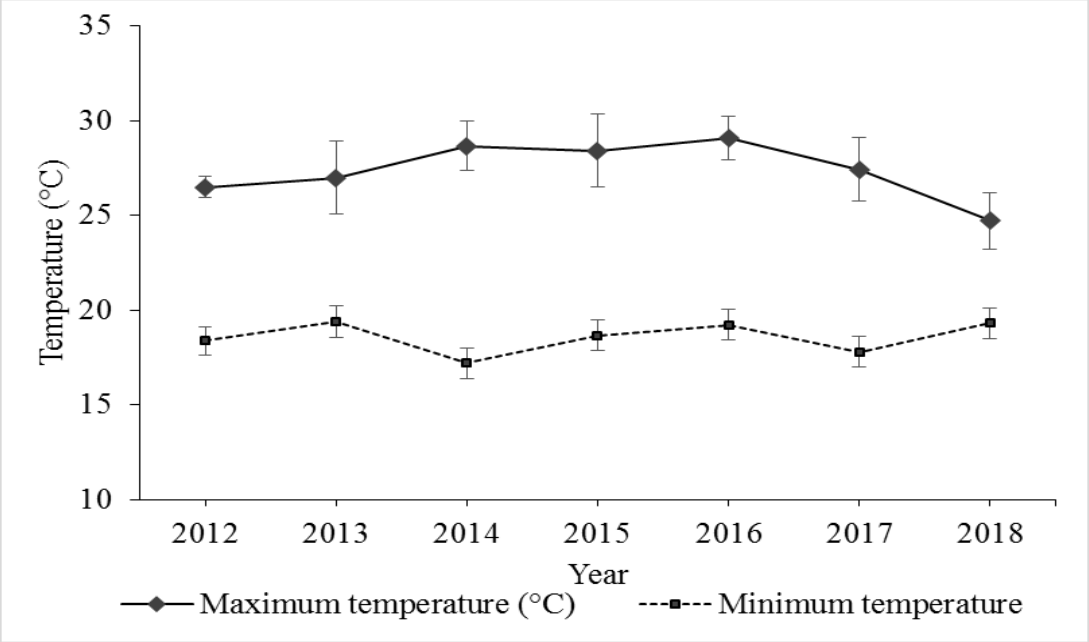


Figure 4.12 Temperature fluctuations for five years within the GEPAT project areas

Source: TMA, (2012-2018)

The rainfall pattern has fluctuated from bimodal in 2012 to trimodal for the next two years. In 2016 the area experienced a unimodal rainfall pattern. The rainfall pattern in 2017 was also trimodal (Figure 4.13).

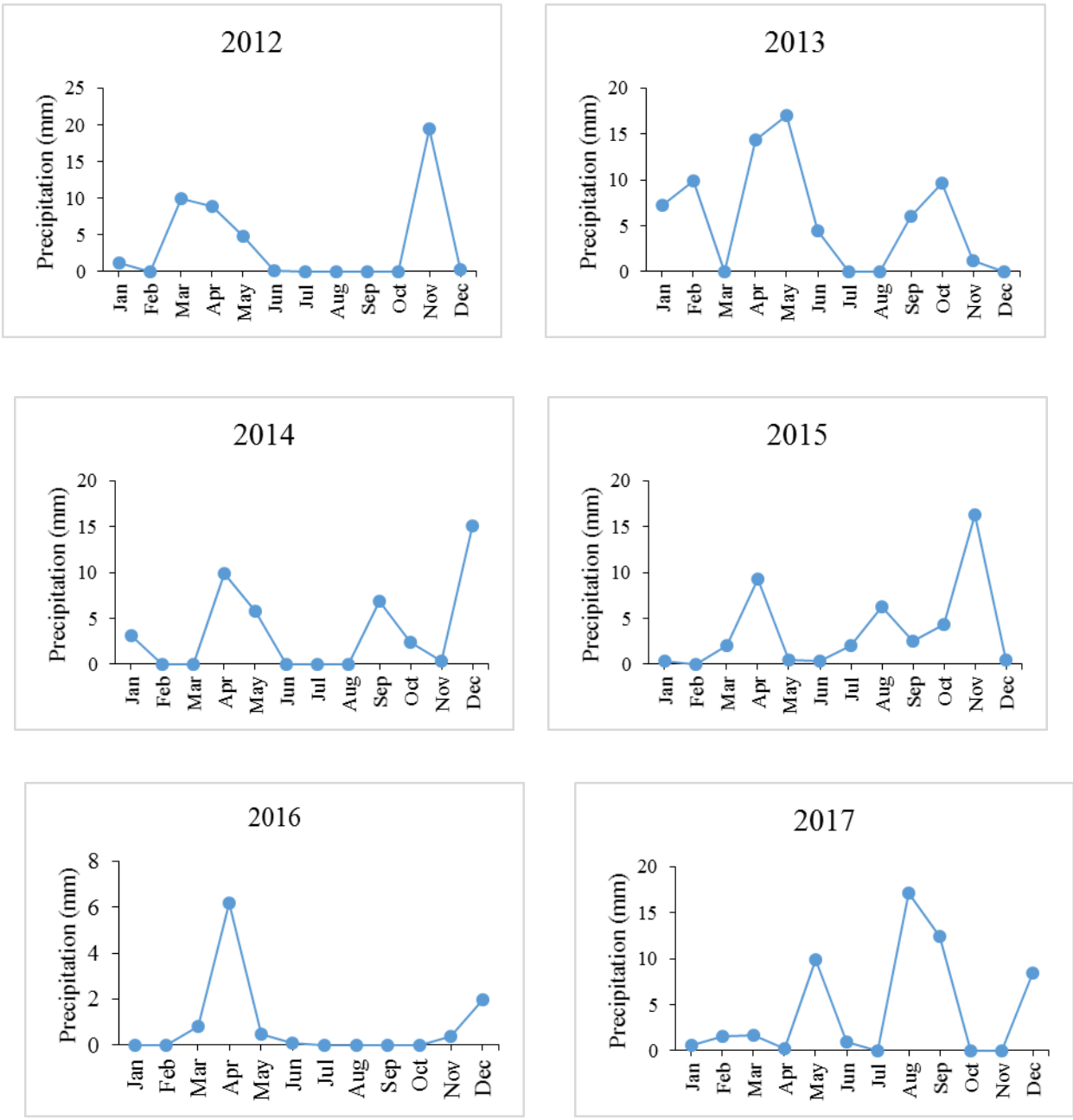


Figure 4.13 Charts depicting mean precipitation per month throughout the year from 2012 to 2017 in the project area

Source: TMA, (2012-2017)

4.3 Chapter Summary

The chapter presented the data, methods of analysis and relevant discussions with the aim of elucidating the reality of the situation as it applies to social economic status in implementation areas of carbon sink projects aimed at mitigating climate change. A number of conclusions were attained. Amongst them is that education sensitizes tree planting activities in the area of study. Food and nutrition security triggers the willingness of the homestead in tree planting. This goes hand in hand with the homesteads monthly income. Household income plays a major role in motivating tree planting. A good number of youth and women participate in tree planting. This is a main step towards curbing gender issues that arise in climate change mitigation. Their participation in tree planting has the positive effects.

The distance from tree farms owned by a homestead to the location of water sources are indirectly proportionally related, the further the water source the less the tree acreage.

The carbon which has been removed is the cause of mitigation of the climate in the area under study which is the long term goal of the project. Variations of the carbon contribution by individual farmers is due to the size of the farms, management of the farms which promote the growth of the trees having large DBH and heights which vary directly with the amount of carbon sequestrated. Also the weather patterns of five years show the success of the project under study.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides the summary of the findings, conclusion and recommendations of the study. In this case, the study answered the research hypothesis formulated by the researcher due to the specific objectives. The chapter therefore, gives more recommendations for improving the areas related to the study of which social economic projects for mitigating climate are or will be implemented. The conclusions are arranged according to each specific objective and there are suggested areas for further studies**.**

5.2 Summary

The aim of this area is to review some of the major themes of the study. The aim of the study was to evaluate social economic carbon sink projects on mitigating climate change taking a Case of GEPAT project implemented at Karagwe and Kyerwa districts in Kagera region considering three wards of Kituntu, Kanoni and Igurwa in Karagwe districts.

The portion of land allocated for forestation activities by farmers demonstrates willingness to participate fully in the GEPAT project. The families have dedicated time and efforts in planting tree species that have in turn been able to reduce carbon dioxide in their communities and been a source of income, however a significant arable land portion remains empty (40.25 ha). It has potential to achieve more with respect to climate change mitigation in the event of a scale up. The food security issues in the study area could be solved by making efficient use of empty arable land to grow food security crops such as cassava and maize this could further increase efforts in tree planting since farmers could be assured with food security and increase in income. The study revealed that tree acreage per homestead is significantly affected by the homesteads' income ($P = 0.07$)

Education played a positive role in forestation as it was clear that farmers are knowledgeable enough to understand the ramifications of neglecting the project. However, there is room for improvement in regards to gender balance in the education sector and further learning for the whole society. Policy makers need to revisit curriculums and include climate change as an important element of learning for long term impacts (UNESCO 2012).

The involvement of youth is an area which GEPAT has been exceptionally successful. The majority of the labor force was female youth. It is an important achievement since the youth are the ones to inherit the impacts of climate change. The involvement of youth in climate change mitigation is crucial and more emphasis should be put in defining their role and increasing their awareness (Pandve *et al.,* 2009). The GEPAT project could consider partnering with youth networks in the country that advocate for a cleaner planet and increase their engagement on a practical basis.

Land ownership remains a risk to long term sustainability of GEPATs efforts to curb the potential deforestation of Karagwe. There exists a gender biased land tenure imposed on women in the study area. The difference in social roles between men and women cause a disconnect in how climate change is being perceived between the two groups (GCCA 2016). However with land being owned by mostly men, the decisions on land use for forestry remain at the mercy of one sided experiences which may be in turn be detrimental to the project's impact.

The tree species *Eucalytpus grandis* has been extensively studied by environmental scientists over the course of years. It's one of the most widely cultivated trees in tropical and subtropical areas (Eduardo *et al.,* 2004). *Eucalyptus grandis* is known for its high potential in carbon sequestration (Kiyingi *et al* 2016) and its dominance in the study area was a positive outlook for success. The *Pinus patula* trees have many economic benefits such as gum and resin extraction, furniture production, paper and pulp manufacturing. Studies by Oeba *et al.,* (2016) show that *Pinus patula* has a sequestration rate of 145.6 ± 44.4 MgC ha-1 for trees with the age of six years. This is in conformity to the results in

this study (10 years) and shows great sequestration potential of the trees. The choice of trees was influenced by the GEPAT project coordinators and their technical judgment was keen and sound.

The number of *Markhamia zanzibarica* and other tree species significantly lower and due to economic constraints they were not included in the analysis to estimate their role in the carbon inventory within the project area. Little information on carbon sequestration rates of *Markhamia zanzibarica* exist and more studies are required. However, this is an indication that the GEPAT initiative has contributed a bit more to reducing CO_2 levels in the study area than what is being reported.

Weather patterns showed a decrease in maximum temperature levels from 28°C to 25°C in a space of three years, another sign of successful climate change mitigation by GEPAT. However, rainfall patterns have yet to stabilize. Kagera region in general experiences a bimodal rainfall pattern with short vuli rains from October-December and long masika rains from March-May. However in 2016 there was little rainfall. Inspite of the drought, in September 2016, Kagera region experienced an earthquake and the following year, vuli rains shifted and began in July.

5.3 Conclusion

The study has a number of conclusions with respect to its objective mainly to evaluate social economic carbon sinks project on mitigating climate change, in the study area.

On socio-economic factors influencing forestation activities within the projects sphere of influence, it was concluded that, most of the farmers grow trees for commercial purposes of selling timber and building poles rather than fruits trees, education sensitize the tree planting in the area of study. Food security triggers the willingness of the homestead in tree planting. Women and youth participation in tree planting has the positive effect.

On farm related issues causing variation in contribution to carbon inventory it was concluded that, Use of extension officers promotes the growth of trees, also the farmers mainly grow *Eucalyptus grandis* and *Pinus patula* species in the study area.

On estimation of the carbon stock sequestered by the forestation initiatives of the project was concluded that, carbon has been sequestrated through tree planting in the project. The carbon been removed is the cause of mitigation of the climate in the area under study which is the long term goal of the project. Variations of the carbon contribution by individual farmers is due to the size of the farms, management of the farms which promote the growth of the trees having large DBH and heights which vary directly with the amount of carbon sequestrated.

On weather patterns before and after the project implementation as a justification of climatic change mitigated by Project in the area, ceteris peribus it was concluded that, from the answers of the respondents on how they experience the climate before the project and during the time of implementation, the climate has been improving in rainfall and temperature. Also the data from Tanzania Meteorology Agency support this phenomenon.

Generally, the GEPAT project was successful in mitigating climate change in the study area. The farmers are knowledgeable and have improved resilience to climatic issues. There is still work to do in respect to gender issues affecting climate change mitigation.

5.4 Recommendations

From the findings of this study, the following are the recommendations

- Government should promote projects like GEPAT in other areas of the country so as to combat climate change which has been has detrimental effects in the country such as food and nutrition insecurity
- Projects for mitigation of climate should include initiatives to solve gender bias land tenure issues as this has detrimental effects on climate change mitigation initiatives. It may include awareness creation seminars and media campaigns.

- Farmers need to make efficient use of arable land to improve the food security of their societies this will increase the effort on tree planting. Climate mitigation projects can expand their objectives to include Climate Smart Agriculture.
- An analysis of stakeholder involvement should be conducted to determine impact of the project towards policy advocacy. This is necessary in ensuring sustainability of the projects' achievements.
- There is a need of increasing number of tree species in the project area so as to increase and conserve biodiversity. Deep rooted trees with water retaining capacities survive in harsh condition that may be results of climate change.
- As a means to mitigate carbon dioxide emissions into the carbon inventory of the project area that is caused by cropping activities, the GEPAT initiative need to adopt farmer field school training of integrated pest management (IPM). Through such a program farmers can learn how to use an array of technologies in controlling pests such as biocontrols, push and pull techniques using botanicals, biopesticides, mulching, solarization etc. This reduces dependency on synthetic pesticides which contain chloro fluoro carbons (CFCs) and contribute to the depletion of the ozone layer, consequently adding to the global warming predicament.
- Future evaluation of the GEPAT project need to include indicators such as spatial distribution of forestation acreage (tree species mapping) and economic impact across value chain (prices of seeds, fertilizers, distance to ago dealer shops, costs associated with pest management) so as to identify gaps that can be remedied to improve farmers lives within the project area.

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APPENDIX

QUESTIONNAIRE

EVALUATION OF CLIMATE MITIGATION PROJECTS IN PROMOTING SUSTAINABLE DEVELOPMENT

Questionnaire Number **.....**

Name of the interviewer **.....**(Optional)

Village **.....**

Telephone Number **.....**

I am Adam John Minzi, a Masters student from Mzumbe University in Morogoro. I am here to collect data for my thesis that entails at finding out how social economic carbon sink projects are efficient in mitigating the climate change. Generally, I am expecting to consult 100 households of tree famers and gather information from the respective household representative. The findings of this study will be translated into recommendations that would assist Environmental Policy makers in determining how to improve these projects so as they can be efficient and convince donors who fund these projects. Therefore your inputs are considered very valuable to this research. The information you give is confidential, and will not be used by any other person in any other way except for the desired purpose and your name or household will not be mentioned anywhere. Thank you so much for time in responding to the questions.

INTRODUCTION

- Date ……..
- Time.....
- Name of ward ……
- Name of village ……..
- Name of homestead (kitongoji).....
- Name of Shina leader.....

PART A: **SOCIAL STATUS OF THE HOMESTEAD**

(a) **Characteristics of homestead**;

1. **Gender of the head** (1) F... (2) M....
2. **Females in the family**
   i. Members of the family (i) Children..... (ii) Parents..... (ii) Extended family members..... (iii) Employees.....
3. **Age group**

a. Female family members

(i) 0-20 years ……

(ii) 21-40 years …

(iii) 41-60 years....

(iv) 61-80 years....

(v) 80 years and above

b. Female employees

b) 0-20 years ……

c) 21-40 years …

d) 41-60 years....

e) 61-80 years....

f) 80 years and above…..

4. Education (Female)

- **Type of education**

(i) Informal education .....

(ii) Formal education ……

- **Level of education**

i. Primary.....
ii. Olevel .....
iii. A level .....
iv. Tertiary.....
v. Undergraduate.....
vi. Masters.....
vii. PhD .....

2. **Males in the family**

i. Members of the family (i) Children..... (ii) Parents..... (ii) Extended family members..... (iii) Employees.....

3. **Age group**

a. Male family members

i. 0-20 years ……
ii. 21-40 years …
iii. 41-60 years....
iv. 61-80 years....
v. 80 years and above

a. Male employees

i. 0-20 years ……

ii. 21-40 years …

iii. 41-60 years....

iv. 61-80 years....

v. 80 years and above…..

a. **Education (Male)**

- **Type of education**
  - i. Informal education .....
  - ii. Formal education ……
- **Level of education**
  - i. Primary.....
  - ii. Olevel .....
  - iii. A level .....
  - iv. Tertiary.....
  - v. Undergraduate.....
  - vi. Masters.....
  - vii. PhD .....

(a) Marital status (i) married..... (ii) Unmarried..... (1) Single..... (2) Divorced..... (3) Cohabitation..... (4) Widow.... (5) Widower.....

PART B: EMPLOYMENT OF THE HEAD OF THE FAMILY

1. **Occupation** (a) Farmer**.....** (b) Employed..... (c) Entrepreneur..... (d) Other (specify) …….....
2. If the answer in 1 above is farmer what kind of cash crop he/she grows per year (a) Beans..... (b) Coffee..... (c) Banana..... (d) Maize..... (e) Other crops.....

3. If the answer in 1 above is employed then what is your income per year (Tsh).....
4. If the answer in 1 above is Entrepreneur then what is your income per year (Tsh).....
5. If the answer in 1 above is others then what is your income per year (Tsh).....
   .....
   .....
   .....
6. Do you own land? (a) Yes.... (b) No.....
7. If YES how many hectares do you own……..……?
8. From the answer in 7above, how many hectares do you use for; (a) Tree planting..... (b) Other crops.....
9. Put a tick to show the relevance of the food security in your family:
   a. Not enough to feed the family.....
   b. Somehow enough to feed the family.....
   c. Enough to feed the family.....

PART C: FARM RELATED ISSUES

14. How many hectares have you planted trees …….
15. Have you mixed trees and other crops in the same farm: (a) Yes..... (b) No.....
16. What is the distant from your tree farm to water source you use for watering transplanted seedlings (a) Very close..... (b) Close..... (c) Far..... (d) Very far
17. What is the distant from your tree farm to the nursery which supplies you tree: (a) Very close..... (b) Close..... (c) Far..... (d) Very far
    (a) Do you have extension officers in your village: (a)Yes.....(b) No.....(c) I don't know.....
18. If the answer above is yes do you use them as advisors in planting your tree: (a) Yes..... (b) No.....
19. What is the location of your farm: (a) In the valley..... (b) On the hill-side or mountain.....
10. Had you any experience in tree planting before starting your own tree farm: (a) Yes..... (b) No.....
11. If yes how did you get this experience: (a) From formal institution..... (b) From other growers..... (c) From meetings and seminars
12. Are you a member of any community organization which deals with tree planting: (a) Yes.... (b) No.....
13. If yes name that organization …….., and how long have you been a member……
14. Which varieties of tree do you like to plant: (a) Timber producing trees..... (b) Medicinal trees..... (c)Fruits trees..... (d)Wind breakers.....

PART D; CHARACTERISTICS OF TREE SPECIES

20. How many varieties (species) of trees have you planted in your farm…….

21. Mention the species

    (a) …… … No of trees……

    (b) …… No of trees …...

    (c) …….. No of trees ……

    (d) ……. No of trees ……

    (e) …… No of trees ……

    (f) ……No of trees ……

22. Total number of trees…….

23. What is the average height of each species?

    (a) …… … H……

    (b) …… H……

    (c) …….. H…….

    (d) ……. H…….

    (e) …… H…….

    (f) ……H……

24. What is the average Diameter at breast height of each species?

    (a) …… … DBH……..

    (b) …… DBH……

    (c) …….. DBH…….

    (d) ……. DBH…….

    (e) …… DBH……..

    (f) …… DBH……

PART B: SOCIAL STATUS OF THE NURSERY RAISER WHO PROVIDED THE SEEDLINGS

- Name of ward ……
- Name of village ……..
- Name of homestead (kitongoji).....
- Name of Shina leader.....
- Name of nursery raiser ……..
- Name of Head of the homestead …….