DETERMINANTS OF HOUSEHOLD FOREST COVER IN RURAL ARID AND SEMI ARID LANDS OF KYOME/THAANA WARD, KITUI COUNTY

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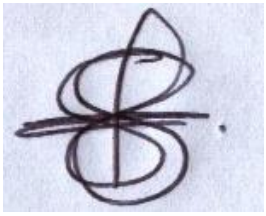
DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

Joseph Kasau Stephen **Date: June 12, 2021**

This thesis has been submitted for examination with our approval as university supervisors.



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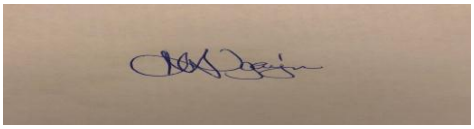
Dr. Fridah W. Mugo



Signature _____ Date – 17-07-2021

Dr. Margaret Ng'ayu

DEDICATION

This study is dedicated to my family for their continuous support, encouragement, prayers and patience.

ACKNOWLEDGEMENT

To my supervisors Dr. Fridah Mugo and Dr. Margaret Ng'ayu I would like to register my heartfelt appreciation for taking time off their busy timetable to lead me to draft this research thesis. It is with modesty that I record my appreciation for assistance I have received from my lectures; Prof. Karanja Mwangi, Prof. Jeremaih Ayonga, Dr. Rose Musyoka, and Dr. Elizabeth Wamuchiru. I also acknowledge the tremendous support I received from fellow students. I thank University of Nairobi particularly the Department of Urban and Regional planning for the support and guidance. I thank my family once again for their patience, encouragement and prayers while I was writing this thesis report.

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ABBREVIATIONS AND ACRONYMS

ADC - Agriculture development cooperation

ASAL - Arid and semi – arid lands

CFM -CFM Community Forest Management

CIDP - County Integrated development Plans

D&D -Deforestation and forest degradation

EKC – Environmental Kuznets curve

FOA - Food and agriculture association

GDP - Growth domestic product

KEFRI - Kenya forest Research Institute

LPGs – Liquid petroleum Gas

MTS – Modified Taungya system

NTFP - Non – timber forest products

SDG – Sustainable development goals

TIP – Transition implementation Plans

UN – United Nations

UNDP – United Nations Development programme.

ABSTRACT

Forests are major sources of livelihoods for millions of people and contribute to many countries' national economic growth and environmental health. Kenya has just about 8.3 percent forest cover. Currently, the country's timber supply is unable to satisfy demand, and last year (2020) there was a national deficit of 7 million tons of timber. Factors determining the proportion of land allocated by households for forest cover are not clearly known. This research sought to determine the average area of land under forest cover at household level, factors that contribute to variations in areas of land devoted to forest cover, hindrances that stand on the way of increasing and sustaining household forest land cover and propose planning interventions that could increase household forest land cover in the study area to sustainable levels. The study employed a descriptive research design. The target population for this study was all the 6,350 households living within 308 square kilometers of Kyome-Thaana Ward. A sample of 100 respondents was calculated using the Cochran formula. The study used multi stage sampling techniques. Face to face interviews with household heads or adult representatives were conducted using a semi-structured questionnaire. Observations were also done. The study used both quantitative and qualitative techniques of data analysis. Inferential statistics included correlation, chi-square tests and t-tests. The average land under forest cover at household level in the study area was 5 acres. The size of land owned by the household was found to be the main factor that influence decision by the household head to have either small or large size of their land under forest cover. There was a significant association ($p=0.038$) between mode of land acquisition and land devoted to forest cover. Correlation analysis shows that land owned has strong positive correlation ($r=0.947$, $p=0.000$) with land devoted to forest cover. Correlation analysis also showed that land owned by father had a strong positive correlation ($r=0.543$, $p=0.000$) with land devoted to forest cover. There was a significant association ($p=0.007$) between livestock keeping and the land devoted to forest cover. Population growth that leads to conversion of forest land to crop land and settlements were the greatest hindrance to increasing forest cover in the study area. Changes in climate and the environment adversely affected livelihoods as household food security is in all circumstances affected. This study recommends deliberate investment in forestry, at least 10 percent of each household land to be under forest cover in the study area. Adoption of alternative sources of energy and fuel efficient cooking technologies is also highly recommended within the study area to minimize deforestation.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Forests provide livelihood to millions of people and contribute to the economic prosperity of many countries around the world. Despite their critical role in livelihood and climate control, forest resources around the world are under immense threat, resulting in deforestation and destruction as a result of rising human and livestock populations, as well as widespread rural poverty. For example, it is estimated that 129 million hectares of forest land have been lost globally since 1990 (World Bank, 2015). Land destruction has a number of biological, social, and economic impacts, including the disappearance of biotic communities, and results in a loss of biodiversity, increased soil degradation, increased global warming, and a loss of income for forest dwellers.

Forests and trees on agricultural landscapes are well-known for providing products and services to rural communities that are important for their survival (Cedamon et al., 2019). Forests provide inputs to rural households' livelihood and farming processes almost everywhere, and they also provide a means of income for many. Access to forest or tree services may also assist rural households in diversifying their sources of income and lowering their risk exposure. Forest-based operations provide about 30 million informal workers in developed countries, accounting for up to one-third of all rural non-farm work (FAO, 2015). Widespread reforms in forest governance favor more stable land tenure and improved local rights to forest resources. These have the ability to enhance access, long-term resource sustainability, and production intensification. Internationally, it is assessed that between 1.095 billion and 1.745 billion individuals rely upon woodlands for their jobs in contrasting degrees, with around 200 million native people groups as a rule dependent on timberlands. Moreover, 350 million individuals who live close to thick timberlands rely upon them for food and occupations. Natural administrations are relied upon to give 20–25 percent of country individuals' pay in created nations, and they fill in as security nets during seasons of dry spell or occasional food deficiencies (Langat et al., 2015).

Forests occupy 31% of the world's ground surface. About half of the woodland remains largely unchanged, with primary forest accounting for more than a third of the total. The greater part of the world's trees are packed in just five nations which incorporate Russia, Brazil, Canada, the United States of America, and China, and (66%) are found in just ten nations (Food and Agriculture

Organization (FAO, 2020). According to FAO (2020), Africa is forested 22.7 percent of the time, or around 674,419,000 hectares. Forest Cover Change: Africa lost an average of 3,740,950 hectares per year between 1990 and 2010, or 0.50 percent per year. East Africa's forest area accounts for 21% of Africa's total forest area and 4% of the world's total vegetation area. East Africa's natural forests cover 134 million hectares. According to the FAO, Kenya is forested to the tune of 6.1 percent, or 3,467,000 ha. Primary woodland, the most biodiverse and carbon-dense type of forest, accounts for 18.9% (654,000 hectares) of the total. Kenya has 197,000 hectares of planted woodland.

Despite the importance of forests to people's livelihoods, deforestation is increasing at an unprecedented pace around the world, particularly in the tropics, raising concerns about possible impacts on biodiversity, ecosystem services, and human health (Acharya, Naz, Galway & Jones, 2020). Approximately 420 million hectares of land are no more thanks to deforestation since 1990. According to the Global Land Resources Assessment (2020), net forest depletion has slowed considerably, from an annual estimate of 7.8 million hectares from 1990 to 2000 to 4.7 million hectares from 2010 to 2020. Africa has seen the fastest average rate of net forest area depletion of any continent over the last decade (2010 to 2020). Since 1990, the rate of loss on the continent has been slowly rising. Somewhere in the range of 2000 and 2005, in excess of 4 million hectares of normal timberland were lost yearly in agricultural nations, particularly in Africa (Worku et al., 2018).

Mozambique, Tanzania, Uganda, and Kenya occupy 70 percent, 55 percent, 9 percent, and 6.99 percent of the total land area in eastern Africa, respectively, while Ethiopia covers 12.5 percent (World Bank, 2015). The primary drivers of deforestation in these countries are not from within the forest market, but rather from the agriculture and energy industries. Africa, the world's second-largest continent by area, has just 624 million hectares of forest cover (Keenan et al, 2015). (Oishimaya, Sen., 2017), mentioned some alarming data from the FAO, stating that primary forests in Africa are being cleared at a rate of 4 million hectares each year. About 10% of Africa's forest cover has been destroyed in the last 12 years (from 2001 to 2013). According to the findings of a study conducted in Ethiopia, forest lands have decreased from 3.8 percent in 1973 to 0.2 percent in 2015 (Agidew & Singh, 2017).

Deforestation caused by humans, habitat destruction, and erosion are also major threats to biodiversity and ecosystem services. Just 31% of the world's forestland is still intact today (FAO, 2018). For this reasons, the years between 2021 and 2031 were christened the UN decade on ecosystem restoration. Forest conservation has become a global concern as a result of a variety of projects around the world. Worldwide arrangements including Bonn Challenge, International Forest Policy and New York Declaration intend to recuperate up to 350 million hectares of deforested and jeopardized scenes by 2030. These lofty goals face many democratic, socioeconomic, financial, and legal obstacles. Land conversion to agriculture is closely linked to deforestation (Gibbs et al, 2010). Given that private land holdings own 11% of the world's existing forests and the majority of farm land, land-use policies within private land holdings play a critical role in forest management, environmental resources, and biodiversity (FAO, 2018).

Kenya reportedly has an 8.3 percent forest land cover (World Bank, 2015). Notwithstanding the low cover, the nation vigorously depends on its backwoods abundance to drive monetary advancement by giving truly necessary woodland items and administrations. In Kenya, for instance, biomass represents 68% of essential energy utilization and in excess of 90% of fuel for rustic families (Government of Kenya, 2015). Currently, the country's timber cover is unable to satisfy demand, and the country faces an estimated deficit of 7 million tonnes of wood per year (Githiomi, J. K., & Oduor, 2012). To protect the country's forest cover, efforts must be made on both the supply and demand sides. On the supply side, tree planting and forest farming promotion are expected, while on the demand side, implementation of alternative cooking technologies such as LPG could reduce forest pressure and have a positive effect on forest cover.

Kenya has a gross land area of 576,076 square kilometers. Just 20% of this land has high to medium potential for arable cultivation, with sufficient and consistent rainfall (Agro-ecological Zones I-III). The remaining 80% (Agro-ecological Zones IV-VII) is either arid or semi-arid land (ASAL) with infrequent rainfall. The majority of farm holdings in Kenya (98%) are limited (average 1.2 hectares) and mostly in high-potential areas, accounting for 46 percent of total farmed land area. (Kimemia, 1998). Broad fields, averaging 77.8 hectares (more than 50 percent greater than 200.0 hectares), account for just 0.1 percent of farm holdings but cover 39 percent of total land area. The average farm size in the Kenya is around 2.5 hectares. Owing to the ongoing sub-division of both small and large-scale holdings, often into uneconomic units, the number of holdings is rapidly

growing. Any of the larger units are still not being farmed effectively. This has resulted in low land productivity, resulting in malnutrition, famine, and increased poverty.

Kitui County covers a complete space of 30,496.4 km2, of which 6,369 km2 is utilized by the Tsavo East National Park and which is not appropriate for horticulture, 14,137.2 km2 is arable farming area, and 6,364.4 km2 is unsatisfactory for agribusiness. Country districts are home to more than 85% of the County's populace. The normal populace thickness is 44 individuals for each square kilometer, which is low. The normal land holding size in the province is 0.12 kilometres squared (12 hectares for every individual). Most of the homesteads in the examination region are smallholder cultivates that consolidate yield and animals creation. The normal size of a limited scale ranch in the district is projected to be 4.38 hectares, while enormous scope ranches are assessed to be 50 hectares (Mutua, 2018). Small-scale farms can be found in heavily populated areas such as Kitui, Kyangwithya East, Kyangwithya West, Matinyani, Migwani, Mulango, Mutonguni, Mwingi and Nzambani, upper. As of 2014, the gazette land cover was 37,750 hectares, with a percentage forest cover of 7%. The aim of gazetting is to protect forest habitats, the climate, culture, science, or some other unique and natural type. Natural species such as Turmeric tamarind and others grow in such forests in Kitui.

1.2 Statement of the Problem

The livelihood of people in rural Kenya is reliant on the resources available in the region. Forests offer both an incentive for growth and an obstacle in meeting conservation targets in terms of rural livelihoods (Timko et al., 2010). When the world's population grows, so does the need for public services and the strain on natural resources. This has a negative impact on the growth of multi-purpose and indigenous tree plantations, as well as ago-forestry practices, creating a vicious cycle with regards to food security. Kenya's forest cover (7.2 percent) falls short of the recommended global norm of 10%. Kenya has set a goal of raising and sustaining the country's tree cover to at least 10% by 2022 (Ministry of Environment and Forestry, 2020). Kitui County, which lies under ASALs for example, has forest area of 215,340 hectares which represents 7.08 % and aims to achieve 10% forest cover by 2030 hence a deficit of 92,289 hectares (County Government of Kitui, 2018).

Destruction of forests in Kitui County, as well as the resulting depletion of biodiversity, is another major environmental problem. Deforestation has been exacerbated in the county due to population increase, agricultural expansion, over-reliance on wood fuels, and low levels of afforestation. Ecosystems and food protection can suffer as a result of forest loss. The majority of the people in Kitui County rely on wood for cooking. Population development and resulting rises in demand for agricultural and residential property would likely intensify deforestation and amplify the impact of climate change in the county, with approximately 97 percent of households using firewood or charcoal for cooking and heating (County Government of Kitui, 2018).

Kenya desires to attain a 10% forest cover by 2030. With minimal public land in regions like Kitui County where the land tenure system is freehold, it would mean such a goal can only be achieved within private land holdings. Information on the factors that determine the proportion of land set aside for forest land use at the household level is scanty. There is need to have such information in order for the country to use it to formulate ways of achieving its dream of 10% by 2030. There is also a need to examine factors that determine the current percentage of land devoted to forest cover at the household level, hindrances that stand on the way of increasing and sustaining forest land cover and planning interventions that can address the challenges in such areas.

1.3 Research Questions

i. What is the average area of land under forest cover at household level in Kyome/Thaana Ward Kitui County?
i. What factors contribute to variations in areas of land devoted to forest cover at household level in the study area?
ii. What hindrances stand on the way of increasing and sustaining household forest cover in the study area?
iii. What planning interventions could incr**e**ase and sustain household forest cover in the study area?

1.4 Research Objectives

i. To determine the average area of land under forest cover at household level in Kyome /Thaana Ward, Kitui County.

ii. To establish factors that contribute to variations in areas of land devoted to forest cover at household level in the study area.
iii. To assess the hindrances that stand on the way of increasing and sustaining forest cover in the study area.
iv. To propose planning interventions that could increase household forest land cover in the study area.

1.5 Research Hypothesis

H_1: Households with larger land sizes have significantly higher land area under forest cover than those with smaller land sizes.

H_0: Households with larger land sizes have equal or lower land area under forest cover than those with smaller land sizes.

H_2: Households with higher incomes have significantly higher land area under forest cover than households with low income.

H_{02}: Households with higher incomes have equal or lower land area under forest cover compared to households with low income.

1.6 Scope of the study

The study will focus on Kyome/Thaana Ward, Mwingi West Sub- County, Kitui County. It will look at the Existing land sizes per household and areas devoted to forest cover in each household. It will also seek to establish the variations in areas devoted to forest cover and factors contributing to these variations. Finally it will establish the hindrances to increased forest cover and possible planning interventions to deal with those hindrances.

1.7 Justification of the Study

Forest destruction and rapid transfer of forestland to new land uses are threatening Kenya's ability to continue providing forest goods and services. Continued deforestation necessitates collective

attempts by policymakers and scholars to delay or halt the depletion of forest cover (Langat & Cheboiwo, 2010). The results of this study are important in formulating future environmental policies to ensure that people benefit from forest products and as well conserve forest. Forests are becoming highly valuable to the world's human population. In addition, the study findings will help Kitui county, and the County at large to formulate strategies for achieving 10 per cent forest cover by year 2030.

1.8 Definitions of terms

Arid land Land portrayed by low yearly precipitation of under 250 mm, by vanishing surpassing precipitation and a scanty vegetation (Maliva & Missimer, 2012).

Deforestation The deficiency of backwoods cover; land that is forever changed over from woodland to rural land, greens, steers field, or other land use (Geist & Lambin, 2001).

Desertification Land corruption in regularly dry territories coming about because of different variables, including climatic varieties and human exercises (Veron et al., 2016).

Forest cover Land cover comprising of backwoods which incorporates both the plants of a timberland along with the results of their rot (Agidew & Singh, 2017).

Forest degradation A decrease in the limit of a backwoods to create biological system administrations like carbon stockpiling and wood items because of anthropogenic and ecological changes (Ghazoul et al., 2015).

Forest Trees taller than 5 meters and with an overhang front of over 10%, or trees equipped for arriving at these edges in situ, ashore covering more than 0.5 hectares. It prohibits land that is generally utilized for agribusiness or monetary turn of events (FAO, 2015).

Woodland Land not delegated Forest, spreading over more than 0.5 hectares; with trees higher than 5 m and a shade front of 5-10%, or trees ready to arrive at these limits in situ; or with a consolidated front of bushes, shrubberies, and trees above 10%. It does exclude land that is prevalently under horticultural or metropolitan land use (Rackham, 2008).

Tree cover tree patches outside recorded forest areas exclusive of forest cover and less than the minimum mappable area of one hectare. (FAO, 2015).

1.9 Organisation of the Report

This report is organized into six chapters. The first chapter presents the background and introduction of this study. Chapter two presents the review of literature that culminates in a conceptual framework. Chapter three relates the methodology adopted in undertaking this study. Chapter four presents the area's physiographic and socio-economic characteristics, while chapter five presents the study's analysis and findings. Finally, chapter six summarizes the findings and presents the conclusion arrived at in this study. In the last chapter, recommendations made under this study are also presented.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section contains analyses of the study's current theoretical and methodological literature. The aim is to recognize established information gaps that the current research would attempt to close.

2.2 Average Area of Land under Forest Cover at household level in Global, regional and local context

Worldwide backwoods region has diminished by 3.1 percent over the most recent 25 years, from 4.1 billion ha to just shy of 4 billion hectares (Keenan et al., 2015). Between 1990 and 2015, the pace of global forest region transition slowed by more than half (Table 2.1). This shift is the result of lower land change rates in certain nations and expanded backwoods territory development in others. Throughout the most recent decade, net woodland region change appears to have balanced out. Given that yearly wood evacuations in 2011 were around 200 million cubic metres higher than in 1990, and human populaces developed by about 37% during this period, this is a critical turn of events.

Table 2.1 The Rate of Global Forest Area Change between 1990 And 2015

Year	Forest Cover (000ha)	Annual Change (000ha)
1990	4,128,266	
2000	4,055,602	-7,267
2005	4,032,743	-4,573
2010	4,015, 673	-3,414
2015	3, 999,134	-3,308

Source: (Keenan et al, 2015).

Consistently, Africa loses in excess of 4 million hectares of land, which is twofold the worldwide normal (Alister, D., 2018). Also (Seth, 2018) reported that degradation of the trees, widespread tree cutting for fuel and other uses makes up the majority of the biomass loss (55 percent) along the massive ecosystem across Angola, Zambia, Tanzania and Mozambique, known as the Miombo woodlands. This clearly demonstrates that the market for wood in Africa could triple by 2050,

putting a strain on the continent's declining timber supplies well ahead of schedule. This is summarized in Figure 2.1 below.

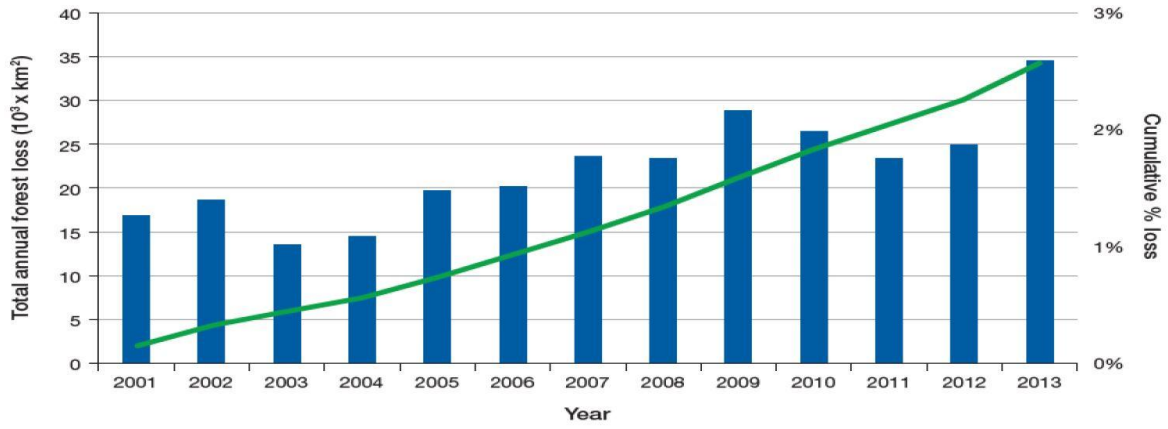


Figure 2.1 Africa's Forest Cover Loss Trends

Source: (Oishimaya, Sen., 2017)

Two-thirds of the world's 3 billion rural people live in around 475 million small farm families, most of whom work on land plots of less than 2 hectares (Nagayets, O., 2005). Many are disadvantaged, have little access to markets and utilities, and are food insecure. Their options are few, but they farm their land and feed a significant portion of the world's population. They engage in a variety of economic activities in addition to farming, such as forestry and forest-related economic activities, as well as trade. The majority of the labor on these small farms is provided by family members. Nearly 98 percent of Chinese farmers work on farms less than 2 hectares, accounting for nearly half of the world's small farms. Around 80% of farmers in India are few. Farms of less than 2 hectares account for approximately 90% of the overall number of farms in Ethiopia and Egypt. Local farmers account for half of all farmers in Mexico, and smallholders account for 20% of all farmers in Brazil (Nagayets, O., 2005).

According to Agidew and Singh (2017), forest lands in Kenya have decreased from 3.8 percent in 1973 to 0.2 percent in 2015. Between 1973 and 2015, 552 hectares of forest land were cleared. This represents 95 percent of the land cover in 1973. Similarly, shrub lands have decreased from 28.4% in 1973 to 24.9 percent in 2015. Crop lands and agricultural villages, on the other hand,

rose from 38.6% in 1973 to 44.1 percent in 1986 and 54.4 percent in 2015. Between 1986 and 2015, the most crop fields and rural settlements were added (81 percent). Grasslands, shrublands, marginal lands, and woodland lands can be harmed as a result of this conversion.

In light of the public gauge from the 2010 timberland cover results, Kenya's woods cover was projected to be 7.2 percent in 2015 (Keenan et al, 2015). The woodland cover is not exactly the suggested worldwide least necessity of 10%. Kenya lost 311,000 ha of forestland between 1990 and 2015, according to a study of land-use reform. Conversion to villages, crop cultivation, and infrastructure improvements are the main causes of forest cover depletion. The expansion of croplands at the detriment of forestland is also explained by the growing rural population and strong reliance on rain-fed agriculture. This is summarized in Figure 2.2

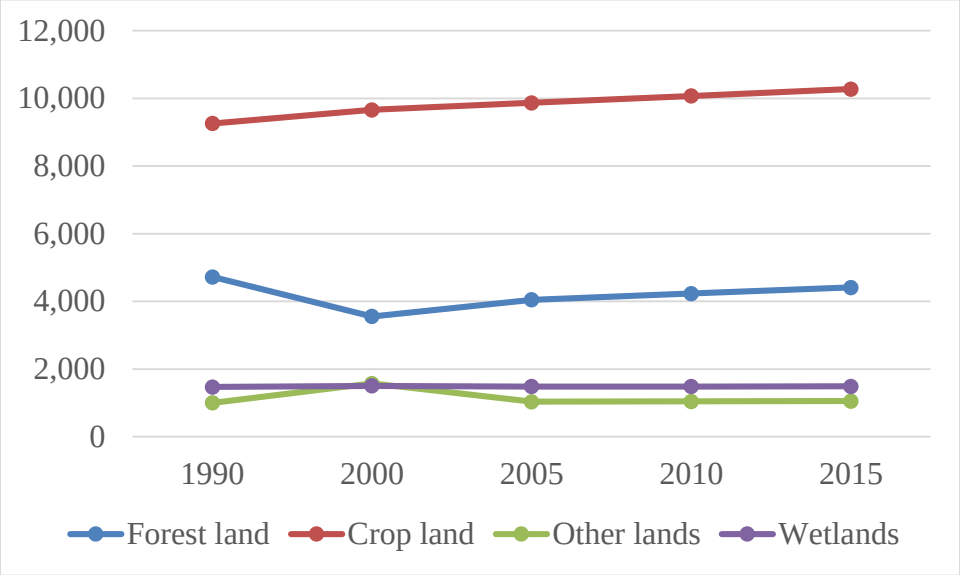


Figure 2.2 Land-Use Area Changes in Kenya

Source: (FAO, 2015)

Despite the country's low land cover, it heavily relies on its forest wealth to drive economic development by providing much-needed forest products and services. In Kenya, for example, biomass accounts for 68 percent of primary energy consumption and more than 90 percent of fuel for rural households (Government of Kenya, 2015). In Kenya, the normal homestead size in provincial zones is about 2.5 hectares. The quantity of possessions is expanding quickly because

of the proceeded with sub-division of both little and enormous scope property, in some cases to uneconomic units (National Land Commission and Institution of Surveyors of Kenya, 2016). Most households in Kenya allocate their land use to crops (both cash and food). Between 52% and 74% of the land holding is allocated for agricultural crops and less than 21% (14.2%–21%) was allocated to forest cover (planted or natural regeneration) Langat. et. Al (2016)

2.3 Factors Contributing to Variations in Land Devoted to Forest Cover

Provincial families in most tropical districts of the world with human settlements, particularly in country zones, depend vigorously on backwoods and forestland for endurance (Adetoye et al, 2017). Borokini et al. (2012) found that most of families in woods networks are ranchers and lumber laborers who rely entirely upon the backwoods and its administrations for their means. More regrettable, rustic families in backwoods networks have undeniable degrees of lack of education and uncertainty, which adds to the commonness of impractical woods land use exercises among them.

Sandewall et al. (2015) found parallels between growth in China, Vietnam, and Ethiopia over 30 years and development in Sweden over 150 years. Initially, all four countries faced hunger, fast population growth, and intensive agriculture, which resulted in deforestation. All four countries are now in different stages of forest transformation, with tree planting playing a role. This is aided by technological, structural, and socio-economic growth, as well as improved agricultural yields, which have freed up land for tree planting. There is a current movement in Sweden to improve institutional property rights to forest land for households through national policy mechanisms, as there has been in the past.

The forest conversion of Pakistan's ancestral Kalasha was researched by Zeb et al. (2019). According to survey data, cropland extension (77 percent), livestock grazing (18 percent), and orchards were the top three reasons for forest conversion (5 percent). Families with more individuals and less actual resources is bound to clear forested land for farming development, as per the analysts. Land leeway was more uncommon in groups of more individuals working off-homestead and individuals from Joint Forest Management councils. Fuel wood represented the majority of a helpless family's absolute pay, despite the fact that it represented the least of a

family's complete pay with off-ranch pay. Preparing, race, and land possession were not discovered to be significantly associated with woodland freedom. They arrived at the resolution that off-ranch pay age administrations focused on the least fortunate families would be the best approach intercession for lessening deforestation and land transformation.

Endale et al. (2016) conducted research in the semi-arid East Shewa Zone of Oromia, Ethiopia, to classify the species composition, diversity, form, and spatial distribution patterns of trees. There were 77 tree species described, divided into 32 families, with the Fabaceae being the most numerous. In every one of the four set up land utilizes, trees were dispersed in an unexpected way (properties, line plantings, in crop lands and woodlots). With Shannon variety files of 3.1 and 1.8, line plantings had the best tree variety and woodlots had the most reduced. Most of the species (70%) were native, while the leftover 30% were extraordinary. The complete number of tree species per bundle was 4.7, with treeless packages going from zero to a day and a half incredible ranch condition. The tallness and width at bosom stature of the 6066 individuals (2 meters and up) estimated went from 2 to 25 meters and 1 to 86 centimeters, separately. The three predominant species in the framework were Acacia tortilis, Eucalyptus camaldulensis, and Acacia Senegal. Land-holding scale had considerable positive associations with tree species wealth and basal region, yet not with species lavishness, as per relationship research.

Information on factors that contribute to variations in areas of land devoted to forest cover at household level in rural Kenya is scanty. Adetoye et al. (2018) in the examination 'determinants of timberland land use choices among country ranch families in south‐western Nigeria,' recognized a portion of these elements incorporate; level of training of family heads, destitution, family size, and proficiency level, measure of land possessed and family pay among others as shown in Table 2.2 below.

Table 2.2 Factors Contribute To Variations In Areas Of Land Devoted To Forest Cover At Household Level.

FACTOR	DESCRIPTION
Age of Household head	Farmers' ability to change their farming practices is influenced by their age, which has been discovered to be a significant factor.
Sex of household head	Sexual orientation was found to assume a huge part in the execution of current farming practices. Male ranchers are bound to follow present day cultivating rehearses/innovation, as indicated by the report.
Household size	A household is made up of all the people who live in the same housing unit on a regular basis. A single family, a single person living alone, two or more families sharing living quarters, or some other group of similar or unrelated people sharing living quarters may be among the inhabitants.
Level of education of household head	Farmers can easily grasp the principles of environmental protection thanks to education.
Size of Land owned by the household	Ranchers' choices to follow agroforestry exercises were discovered to be affected by ranch scale. A rancher with a major plot of land is bound to move from unadulterated horticulture to agroforestry.
Household income	As indicated by the report, non-ranch pay is probably going to have a positive effect, since expanding away from agribusiness will empower ranchers to build their pay, permitting them to go through more cash in on-ranch creation.
Land ownership status	Land ownership was modeled as one of the factors affecting farm enterprise among farmers in the report.
Land tenure security	Land protection was discovered to have the potential to influence the type of operation carried out on forest land. A farm family with secure land might be able to practice agroforestry.
Preference for tree(s) on household land	Some farmers recognized the value of trees on farm plots, such as soil safety, wind breakers, and other benefits, and therefore favoured trees on farmland. Farmers who like trees are more likely to use agroforestry techniques.
Farming method used	Households that engaged in horticulture, especially the planting of fruit trees such as bananas, mangos, and avocados, were more likely to have greater areas of land covered in woodland.

Hettig, Lay, and Sipangule (2016) analyzed land-use adjustment at the farm-household level in 70 recent empirical and theoretical studies. The study used a meta-analysis to draw on a conceptual basis of land-use transition generators. The decrease of non-utilized timberlands or forested regions into agrarian land is the most generally contemplated situation, representing about 33% of all situations considered. Studies into the exchange of non-utilized forest or forested regions to farming record for the second most noteworthy segment. Most investigations analyze land-use progress utilizing information from families and additionally towns, and they frequently center on little overviews of 100-200 perceptions. There is an unmistakable geological centralization of studies on Central and South America, just as a few African nations, with only a couple concentrates on Asian nations. This is startling, given that proof focuses to high paces of deforestation in Southeast Asia because of ranger service and manor agribusiness. They find that an assortment of tests have inner legitimacy issues because of endogeneity (synchronization and converse causality), just as missing variable inclination, which are not adequately talked about. Notwithstanding these imperfections, research recommends that microeconomic turn of events, like expansions in wages and capital gifts, is an incredible driver for human-actuated land-use change. The broad observational writing shows the intricacies of miniature level land-use change measures, particularly the interaction between family level attributes, factor economic situations, and land-use change. Establishments and practices impact these variables. Many fostered nations' market-arranged changes during the 1980s and 1990s appear to have assumed a huge part in changing area use, albeit the impacts of later mediations, like PES or REDD+, are as yet being considered.

Babigumira et al. (2014) looked at what factors affect rural households' decisions to clear forestland. Over the previous 12 months, 27% of sampled households converted forest to farmland, clearing an average of 1.21 ha. Male-headed families with a great deal of male work that lived in recently settled regions with a ton of timberland cover cleared further, however there were a ton of topographical contrasts. The least fortunate and market-segregated families were bound to clear woodland than those with medium to enormous resource proprietorship and a higher market direction, giving occasion to feel qualms about basic approach accounts of neediness driven backwoods leeway. In their exploration, Agidew and Singh (2017) took a gander at the impacts of changing area use and land cover on country family food instability in the Teleyayen sub-

watershed, which covers 152 km2. As indicated by the discoveries, woods lands diminished from 3.8 percent in 1973 to 0.2 percent in 2015. Populace pressure, just as the expansion of ranch fields by impromptu and inappropriate land the executive's exercises, are causing the revealed land use and land cover changes to fulfill the food requests of the undeniably expanding populace.

Worku et al. (2018) looked at tree planting at the household level, domestic energy use, and the implications for environmental protection. The territory's principle wellsprings of homegrown energy were fuelwood and compost, which were burned-through on normal 2280 and 1533 kg/year, individually, and absolute biofuel admission was 268.06 t/year. Individuals were enlivened to have secretly planted trees due to the decrease in common woodlands and expanded interest for lumber. Regardless of the way that tree planting was advanced dependent on ground real factors, it was variable among various financial qualities of ranchers. Therefore, reassuring private-area tree planting can be viewed as a methods for diminishing expenses and filling the fuelwood market deficiency. Likewise, the chance cost of utilizing fertilizer as a dirt conditioner. The utilization of eco-friendly ovens and other sustainable power sources ought to be advanced.

2.4 Hindrances that Stand On the Way of Increasing Forest Cover

While forests are known for their social, economic and environmental relevance, their ability to provide these essential services has been compromised by deforestation, habitat destruction and fragmentation of forests. The main reasons for tree cover reduction include weak governance of forestry, teamwork and cooperation in public, community and private forest management, growing growth and overreliance on forests in particular for charcoal for the production of wood energy. The difference between wood supply and demand has an estimated 13 million m3; insufficient land and forest protection, particularly in forest and community forests, forestry and grasslands forest and overgrazing in forest reserves, national parks, game reserves, community and private forests, is supposed to promote conservation and forestry investment. Conversion of forest land to agriculture, villages and construction of infrastructure due to failure to enforce spatial plans of national and CGs. waste in the use of wood, especially in the processing of wood and wood; The related effects and climate change. The decline of water rationing, biodiversity destruction populations, water and pasture disputes and an increasing depletion of soil and water are significant manifestations of deforestation and land degradation in river and dams. More than 80% of rural

Kenya's households depend on wood or coal for heat. The coal sector, with about 700,000 employees and projected funding between 2.3 and 2,5 million dependents, is a leading contributing force in job growth. (MEMR, 2012). In addition to the over reliance on timber fuel, synonymous with deforestation and forest destruction, the country needs to invest heavily in renewable energy sources for cooking and lighting.

The rural populations of Kenya are clustered in so-called agro-ecological areas 'high' and 'medium-positive' where the precipitation levels are sufficient for farming. There are also predictable areas where closed canopy forests and water towers lie. Population growth in the same agricultural and ecological areas in the last 4 decades has been unprecedented, and Kenya has had one of the fastest population growth rates in the world since the 70s and even early 80s. The high population rate of growth interacted in the form of agricultural growth, which in Kenya is seen as a major driver of the loss of forestry cover. The key elements for the clearance of agriculture were summarized following earlier national consultations; related to country insecurity and rapid population growth, inefficient use (including timber logging, coal production, land grazing) and past forest administration and administrative failure, as seen in the table 2.3 below (Government of Kenya, 2010)

Table 2.3 Drivers of Deforestation and Forest Degradation

DRIVER CATEGORY	DIRECT DRIVERS	INDIRECT DRIVERS
Governance drivers	Poor timber land management (this has now been addressed through the Forest Act 2005)	i. Poor administration, with ineffective agencies, graft, illicit mining, poor law enforcement. ii. Weak forest management society engagement iii. Inadequate woodland wealth sharing iv. Local governments do not respect their forests v. Common property systems - lack of resource/farm control vi. Unclear tenure and land access (e.g. Local Authority forests)
Policy drivers	i. Grassing in forest reserve causes erosion during drought ii. The Taungya ban has hampered reforestation iii. Poor Taungya Framework Management	i. Agricultural policies that urge farmers to grow more export cash crops ii. Focusing on gazetted forests has limited emphasis on drylands and other habitat types, including rivers and coasts. iii. Ban on harvesting in forests
Economic drivers	i. Poverty ii. Carbon fuel dependence / unsustainable processing of charcoal / urban sector iii. Conversion to a large-scale economic processing of organic fuel or other farming cultures of trustland and woodland iv. Clearing populations (competitive land uses), including rural extension v. Coastal woodland conversion to other applications	i. Agricultural prices are high. ii. Subsidies/Incentives—Fertilizer, agricultural tractor tax deduction iii. Too poor price fixing of timber

Technological drivers	i. Failure to know and use sufficient technologies in tree cultivation and nursery development ii. Lack of public awareness about deforestation impacts. iii. Lack of facts and awareness around tree planting iv. Enhanced equipment for saw milling v. Fires for forest clearance, insufficient fire management capability	Lack of timber protection in the science industry
Natural/Environmental drivers	a) Climate change and associated impacts	i. Low precipitation ii. Wildlife's dry forest devastation

(Government of Kenya, 2010)

The literature on communal forests in Mexico, Nepal and the Philippines have been discussed in depth by Baynes et al. (2015). Experiences in Asia, Latin America and Africa have also been gained. Five major interconnected variables were established, which are also crucial for the progress of group forestry literature. We use the idea of 'bonding social capital,' i.e. group capacity to work together for a shared purpose and 'cross-bridging social capital' - their desire to connect with external countries - to combine the many ways community forestry initiatives will boost the status of these variables. Their research shows that failure to recognize both the complexity and involvement of the different forces will result in a project failure.

Nugroho et al, (2018) conducted a investigation of the case in the Kandilo sub watershed utilizing blended techniques in with translations of pictures, spatial demonstrating and sociocultural exploration for the motivations behind understanding the present and future example for the extension of conventional land use and deforestation. As per their investigation of a 20-year pattern of conventional land-use action in Adat woods, the information showed the lower the pace of deforestation, the more extreme the slant of the country and the further the town is. The examination showed that traditional land utilize administrative traditions enactment assumed a critical part in overseeing deforestation and land misfortune. They presumed that the coordination of land appropriation, better horticulture and standard law consistence are fruitful activities to increment ordinary creation while simultaneously forestalling deforestation and land consumption.

The successful Community Forest Management (CFM) in reducing deforestation in Madagascar from 2000 to 2015 has been researched by Rasolofoson et al. (2015). The authors used mathematical matching to monitor variables that confuse effect calculations. The writers have also compared the impact of CFM with whether or not forest products are being commercially used. In comparison with no CFM, the authors did not discern an effect, on average, even though they limited the study to only those cases in which evidence indicates successful implementation of CFM on the field. Similarly, an impact of CFM may not be detected if industrial use of natural resources were permitted. In comparison with no CFM or CFM allowing industrial applications, however, they have found a deforestation reduction in CFM. The results show that the CFM and the commercial use of forest resources are not guarantees of protection and that it is necessary to distinguish between CFM types.

A survey by Kuamri et al. (2019) has found that shifting crop, rotational felling, other biotic stresses, forest lands diversion for construction activities etc. are key reasons attributed to forest cover reduction. The continued unlawful cutting of trees has affected the country's microclimate conditions, hydrological cycle, consistency of soil, biodiversity and so on, leaving it more exposed to incidents.

Ali and Khan (2018) were interested in investigating the causes of deforestation in the rural communities of District Swat, Pakistan as well as their impacts on various influences. The use of timber for the cooking and building of houses was identified as major causes of deforestation. The results showed further that the group is responsible for deforestation because the means available for overcoming wood mafia, overgraze, expanded commercial use and migration to woodlands for subsistence basses are not used. The results also clarified that climate change was highly impacted in the form of erratic precipitation patterns, snowfall, flooding, soil erosion, decrease in animal feed volume and unfavorable wildlife environments in the study region. The results of the report explained.

In Khyber Puthtunkhwa, Pakistan, Tariqu and Aziz (2015) tried to highlight the reality, major reasons and effects of deforestation and forest destruction. The study reveals that Khyber Pukhtunkhwa's substantial deforestation took place for household requirements, such as cooking, equipment, heating, income etc. The position of black marketers and stakeholders in these forests is another growing factor. Meanwhile the forest department's inefficient administration and negligence is one of the big contributors of deforestation. Furthermore, the non-scientific pasture is an essential part of deforestation. Another attractive aspect in the destruction of these forests was unemployment and hunger. In Pakistan, it is drought, weather transitions, slipping, depletion of the soils, soil erosion and desertification that have the most negative effects.

Duguma et al. (2019) employ behavioural studies that capture the background, attitude and everyday experience of smallholder farmers' decisionmaking. The findings show that factors that have driven farmers to participate in D&D, such as sociodemographics, supply constraints, and politics and governance problems, have been mostly contextual, with some impacts of routine activities such as fuelwood extraction and building. These factors may be generally combined as appropriate, market-driven and governance-driven factors. D&D is mostly due to the needs and

governance problems of the forests studied. The scale and effect of the D&D is greatly exacerbated by factors beyond the forest landscape, although most factors are intrinsic to the sense of smallholders.

Mohamed (2014) evaluated the impact of deforestation on forest fringe communities' (farmers') subsistence trends in Asunafo North District, Ghana. The research has shown that farmers in the field of study are mostly involved in food production, which is mostly subsistence in nature. It was found that farmers are the primary land preparation system for mixed crops with slash and burn. The study showed that deforestation influenced crop production in delayed seasonal planting, infestation of plagues, disease, crop yield levels, and decreases in farmers' income levels.

A research on Ontukigo and Ngare Ndare CFAs participatory in Ontulili and Ngare Ndare forest conservation in northern Central Kenya was conducted by Musyoki et al. (2015). Home size, age, animal ownership, size of land, access to timber products, PFM knowledge under the new Forest Act and access to training in forest management aspects were important factors associated with the household choice to become a CFA members. Members of CFA have shown that household proportions are far greater than non-CFA members. The average age for the CFA and the members of the non-CFA was 46 and 41 years, respectively. Therefore the household decision to enter the CFA has a better generation among household leaders than the youngest households.

A research on the importance of forest resources in the livelihoods of local communities was conducted by Langat et al. (2015). The households contributing 33 per cent of the overall household income received substantial forest income. Fuelwood contributed 50% to the income of household forests through grain (27%), building material (18%) and timber fodder and stoned materials. Absolute forest income and relative forest earnings (percent), through research locations and across ethnic groups, were not substantially different. But absolute forest income and relative (percent) forest income differed significantly among wealth groups. Poor households depended more on the wealth of the forests. The rich households nevertheless produced higher forest incomes in absolute terms.

Koech (2018) tried to identify domestic factors influencing forest management policies in South Nandi Forest, Kenya. The study revealed that most local people are not working and that they will

finally invade the forest for things that will produce some revenue. Most people earn less than U.S. $ 100, which is insufficient to look after their loved ones. Daily expenses are not sufficient to meet their needs, which may make them invade the trees. The forest is an excellent supply of firewood, since it is the source of fuel that most people in the area use so that techniques can prevent forest logging. Most of the locals have inadequate ground, which is why they are tempted to invade the forest for products such as lumber, fuel and farming. This makes it impossible to save forests. Grassing local people ends up threatening the tree cover and the forest's native trees. The study showed that most do not have experience in the protection of forests, making it impossible to protect the environment. The findings show that there are a very limited number of local people who have been educated about how to regulate and prepare treetary clearing, forest fire management, reforestation and reforestation control, forestry clearance checks, forest conservation and proper use of forest goods and forests for agricultural purposes.

A research by Kaniaru (2013) on the impact of tea growing in the Chinga region of Nyeri County Aberdares on forest depletion. Other habitat destruction causes such as forest fires, deforestation and the wind were neglected. Evolution the most important results were: Tea production areas have a negative connection with the forest cover in the Chinga region (Plate 1, Plate and Plate 2) and an increased tea acreage resulted in more land being cleared up in order to cultivate tea. This continued to lead to the loss of more forest trees. Increased wood fuel use has resulted in considerable woodland destruction. This goes against a previous feeling of a negative relationship. The study examined whether increased expansion of tea and tree cover depletion is related to wood fuel use, and whether the use of wood fuel has affected the forest cover. The study found that the production of tea has a direct impact on forest cover; the study has found that tea acreage has increased and forest cover has decreased. In the future, we cannot have forests in the farmlands at this pace of expansion of tea. Wood fuel extraction has adversely affected the woodland cover.

2.5 Planning Interventions Could Increase Household Forest Cover

Forest restoration has become a global priority, spurred by numerous initiatives around the world. The New York Declaration on Forests and the Bonn Challenge (Climate focus, 2015), for example, are international commitments seeking to restore up to 350 million hectares of deforested and degraded ecosystems by 2030. These ambitious targets face many political, socio-economic,

environmental and legal challenges. Deforestation is strongly associated to the conversion of forest to agriculture (Gibbs et al, 2010). Given that eleven percent of the World's remaining forests and most agricultural land are privately owned (FAO, 2018), land-use decisions within private land holdings play a key role in conservation of forests, ecosystem services and biodiversity. Well planned restoration within private land holdings is important to remove barriers and gain landholder's acceptance. It may as well avoid negative outcomes, such as competition for land or displacing deforestation to other regions (Latawiec et al , 2015). Landholders may be encouraged to set aside productive lands for restoration if it is a more economically interesting activity. That may include, for example, the sustainable exploitation of non-timber products, rather than conventional crops (Melo at al, 2013), or financial support through certification and incentive schemes

(Ministry of Environment and Forestry, 2019) Through national strategy for achieving and maintaining over 10% tree cover by 2022, recommends the following interventions which could help increase household forest cover in the study area: Implementing the Agriculture (Farm Forestry) Rules, 2009 is one of recommended interventions. This intervention will target planting of appropriate trees and fruits in the 10.5 million hectares of agricultural land using appropriate technologies. This will be achieved through; Support establishment of 350,000 hectares of trees on farm forestry; Adopt and promote high value fruit tree species such as avocado, mangoes and Macadamia for increasing tree cover. Restoration of degraded landscapes in the Arid and Semi-Arid Lands (ASALs). ASALs face severe land degradation arising from unsustainable charcoal burning, overgrazing and erratic weather patterns. This strategy will rehabilitate 543,000 hectares over the next four years through the following; impose a moratorium on unplanned settlements in the Arid and Semi-Arid areas and implementation of appropriate livestock grazing systems that promote tree growing

The Li et al. (2013) research analyzed the impact from the two conservation policies in 108 towns in two major giant pana habitat areas – the Qinling zone in the province of Shaanxi and Sichuan Giant Panda Sanctuary in the province of Sichuan – on forest cover transition between 2001 and 2008, in a quantitative manner. The product was very reliable in the sample area (total accuracy was around 87 percent using 425 field-collected ground truth points), thus ideal for analysis of forest transition. Results found that 94% of city ships in both regions showed either reductions, or

no changes in forest cover, during the timeline assessed. In both regions 101 out of 108 were seen. After taking into account various socio-economic and biophysical characteristics, a linear regression model indicates that after seven years of introduction, GTGP had a favorable impact on the annual transition rate for forest cover. The findings further show that increased forest cover changes have a substantial positive impact, with unfavorable impacts on the proportion of agricultural population, original forest cover in 2001 as well as the relationship between heights and slopes..

Agarwala et al. (2017) have checked whether the intervention of biogas in depleted forests in Chikkaballapur district in southern India involves higher forest biomass and forestry regeneration. The authors observed that forest grounds near villages which are subject to biogas (treatment) intervention had higher forest biomass than comparable grounds in villages which have no biogas by using a matching propensity score (control). They noticed somewhat higher bounty of sapling and variety in treatment than control plots, despite the fact that no significant contrasts in seedling plenitude and variety exist in treatment timberlands. These findings show the ability for renewable sources of energy to help facilitate the restoration of degenerated forests by reducing fuelwood reliance. Forest development, however, is not standardized in treatments and is constrained by soil nutrients and oriented to lighter, fire-resistant plants that can survive in poor soil conditions.

Tabor et al. (2017) examined the ties among over 600 investments in conservation and growth in the Madagascar Ankeniheny-Zahamena Corridor using linear regressions panels for fixed effects, occurring in the years 2007 to 2014 and the conservation results (deforestation rates and fire detection). Annual improvements in the tree cover and satellite remote sensing fires have been derived. In 2010 and 2011, they showed a statistically important association between some investment and decreased rates of deforestation – years of increased deforestation elsewhere in the study field. Investments in the period of political stability and lack of government since a 2009 Madagascar coup have been shown to reduce deforestation rates. They also found a statistically significant connection between some investments and decreasing fire detections in the field of research, indicating that investment had an effect on reducing forest burning in agriculture. We observed that more spent dollars contributed to higher conservation results (i.e. less fire or less deforestations), especially when funding was maintained for one or two years. The results show that protection and sustainability expenditure will minimize erosion and the impact of fires but

also highlight several difficulties and difficulty in evaluating partnerships in a diverse environment and a fluid political context between investment and conservation.

Catterall (2020) study dealt primarily with the relative study of forest-based landscape methods for the restoration of vegetation through former farmland. It proposed an ecological paradigm to explain and compare the possible effects of various realistic actions and to identify the ramifications for decision-making on restoration. There are an increasing number of regeneration procedures rather than high cost expensive planting of trees. They seek to expedite the regeneration of vegetation by the elimination of factors otherwise inhibitory at various stages of forest restructuring. Possible solutions include the addition of seeds to seed distributors, the installation of systems to selectively cover or remove various plant elements (trees or soil) and management of fire, cattle grass or wildlife in regenerative ecosystems.

Langat D.K. et al. (2016) in his study which examined the role of forest resources to local livelihoods in Mau Ecosystems found that poor rural households in Kenya have high dependency on forest resources. According to his study findings, 33 percent of rural households within Mau Ecosystem earn their annual income by sale and consumption of forest products. The study recommended promotion of intensification of tree growing on farms, through support of agro-forestry or farm forestry, and creating income opportunities independent of forest extraction.

Ronnie. B, et al. (2014) study dealt with forest clearing in rural livelihoods in developing countries found that forest clearing in developing countries is as a result of poverty within rural households and in access to other income generating enterprises and livelihoods. The study recommends income diversification through exploitation of other income generating activities like farm forestry, cash crop growing and adoption of small – scale retail businesses. It also recommended law enforcement and development of new policies to prevent forest clearing in rural households.

2.6 Theoretical Framework

This study related three theories i.e. forest transition theory, environmental Kuznets curve theory and Land rent theory for deforestation.

2.6.1 Forest Transition Theory

The patterns of forestry cover are also captured in time, theoretically considered the principle of forest transformation. This hypothesis has been presented (Mather, A. S., 2007). He originally developed the concept on the basis a simple sequence of degradation and restoration of natural resources, or of Whitaker (1940), Friedrich (1904) and Whitaker's model of decline and improvement (1940). This model proposes that the loss of natural resources is necessary at an early point in order to satisfy human needs. Increased demand and natural resources prices will encourage people to protect their natural resources and preserve them.

Forestry transformation theory focuses mainly on shifting forest cover temporarily or changing forest cover trends over time (Lambin, E. F., & Meyfroidt, P, 2010). The transition occurs as the decreasing tendency towards forest cover is reversed to a rising tendency. Further explains the sequential forest transit as provided in Figure 2.2 (Angelsen, A., 2009). After the point where the canopy of woodland is high and when the deforestation rate is poor, the growth is attributed to forest shortages. Ultimately, a growing income from forests may encourage change through the incentive for forestry or reforestation.

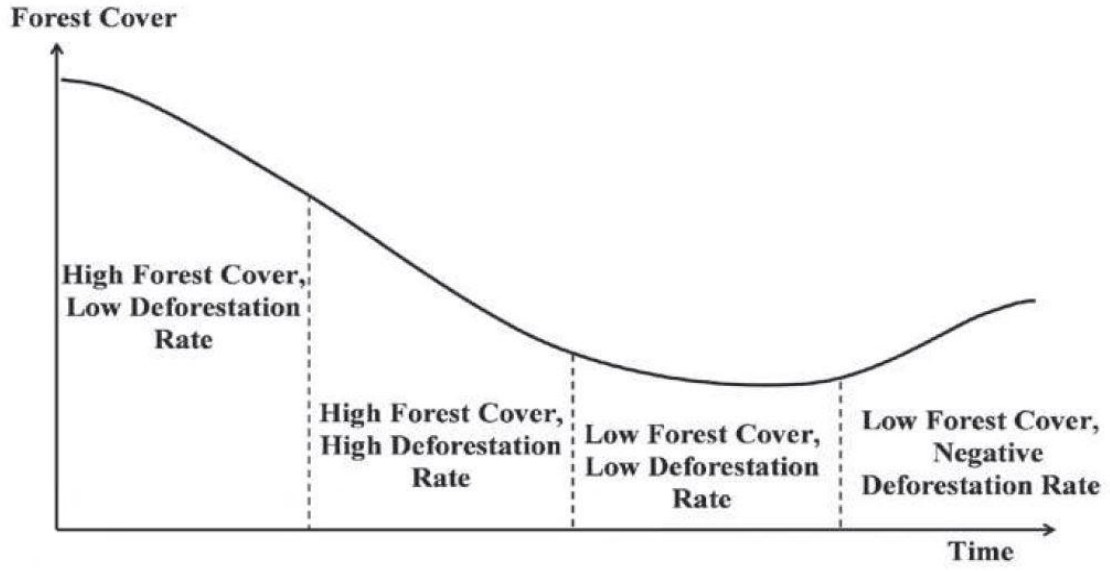


Figure 2.3 Stages of Forest Transition

Source: Adopted from (Angelsen, 2009)

The transition from high tree cover to the lowest point of the forest is usually regarded as taking place in a single period of transition, then rising forest cover. This curve-forming model in U-shirts is essentially made up of two tendencies or periods: forest decline and forest regeneration (Grainger, A., 1995). (Perz, S. G., 2007). The decrease in forest cover for most countries is an unavoidable result of their processes in growth. A consistently expanding populace and food interest at a beginning phase of its development would squeeze backwoods land in view of the extension of rural land. At that point, as nations keep on developing, expanded interest for woods labor and products would support the reforestation interaction.

The drivers of land-use changes are isolated into two sorts: Lambin and Meyfroidt (2008) (1) Land-use changes connected to negative contribution from a lessening in the stock of fundamental labor and products to the biological system; (2) land-use advances due to financial change and development which are autonomous of and seek after their own elements. They portray how these different drivers consolidate and lead to five pathways for backwoods change (recognizing that the pathways may cover by and by). This is the street of woodland shortage. The hypothesis of forest transformation is motivated by conditions beyond the forestry under this mechanism. Like woodland amenities, natural and esthetic principles. This business incentive will be addressed by the forest sector by reforestation.

The direction of state forestry strategy. In modifying the land use cover, government plays a key part. As the government has the majority of forests, it has clear political power for promoting forest cover and/or promoting it. Any forest cover promotion policies can be connected with the promotion of tourism and the greening of the region. For the country's political will the forest conservation strategy should also consider a different direction as the government plays an active role in stirring up the forest transformation should be accredited in many countries. The road to economic growth is where non-farm employment is created by economic growth, work is pulled out of the land and forest reversal occurs. Forest restoration areas in marginal agriculture are neglected. Farmers in key agricultural areas should follow more sustainable farming strategies because marginal land farming is becoming increasingly unprofitable. This mechanism is driven by job shortages rather than forest shortages.

The heading of globalization another instrument for changing the front of woodland in time is the worldwide assembly of public economy and markets. The bearing of neo-liberal monetary change, work out relocation, neighborhood indications of preservation philosophy and developing the travel industry are four significant components that have been set up. Globalization makes conceivable the fare to world business sectors with country spaces of their woodland assets. Destitute individuals moving from country to metropolitan zones leaving more minor land for ranger service (Mather, 2007). In return, the market for esthetic and environmental resources offered in forests in rural areas is raised from urban-rural migration of wealthy people. Global integration allows the spread of sustainability activities and innovations worldwide through foreign organisations. In peripheral, little homestead locales overwhelmed by smallholder farming, a tree-based, earth-use increase course happens. The extension of agroforestry, natural product forests, woodlots, fences and optional progressions, frequently advanced with important species, in deserted fields or fallows can bring about a significant expansion in the tree cover.

2.6.2 Land Rent Theory for Deforestation

The solution to renting lands for deforestation is strongly rooted in von Thunen's 1826 land-value system. The central premise of this spatial economic land use philosophy is that a piece of land can be used to achieve the maximum rent potential (Chomitz, K. M., & Gray, D. A, 1996). In this rivalry for land usage, distance and transportation costs play an important role. In short, the rivalry among land uses is calculated by assuming benefit maximization incentive, which land utilization produces the highest land rental/value. For example, in Figure 4, the forest is best suited for Zone C, ceteris paribus among three competing land uses. Some researchers developed the theoretical rationale for this hypothesis for the forestry sector (Walker, R., 2004). Nevertheless a study by (Von Amsberg1994) who already considers von Thunen's forest science role model should be noted. The way to clarifying changes in land uses and land cover is changes in land lease of various employments. Especially where land use can provide the most benefit in relation to other potential land use for the forest can be conserved. On the other hand, reforestation in a given land could be promoted if reforestation would compete with other land uses. For forest land use is to start to be used at a point where the land rent from the forests is higher than the land rental from agriculture, as defined in Figure 2.4..

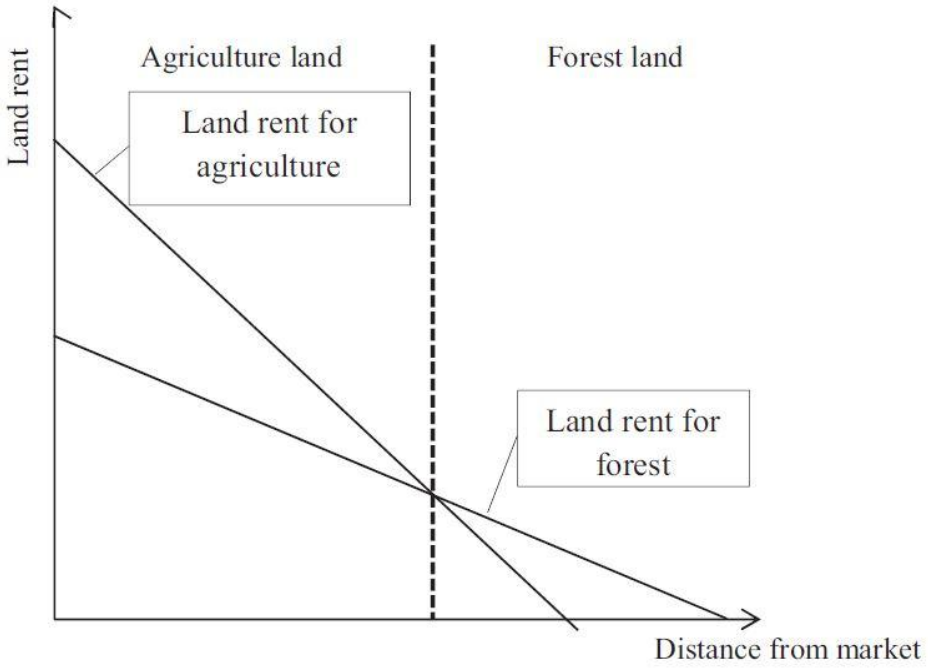


Figure 2.4 Model of Land Rent for Deforestation

Source: simplified from (Von Amsberg, 1994)

By and large, land lease could allude to rents, benefits, or utility. It is viewed from a diverse point of view. For example, land rent for agricultural use or forest use may be changed by the rivalry between agricultural and forest land uses (Walker, 2004). Shifts in farmland rents may be due to shifts in agricultural production rates, input farm prices, agro-ecological status, agricultural equipment, labor wages or transport costs. Due to changes to prices of forest products, forest technologies or the implementation of economic incentives, renting of forest land can be changed (Angelsen, 2007)

2.6.3 Sustainable Livelihood Theory

The Sustainable Livelihoods Approach (SLA) is a technique for examining and changing the existences of individuals encountering destitution and impediment. It is a participatory methodology zeroed in on the enthusiasm for the limit and resources that all people should work to better their lives. Chambers and Conway (1992) states that a livelihood includes ability, properties and activities for a livelihood. Means is maintainable in light of the fact that it can adapt

and bounce back from pressing factors and stuns, and hold or improve its abilities and properties now and later on, without losing the premise of regular assets. SLA is based on the possibility that the methodology ought to be founded on a comprehension of which occupations are based (Morse, & McNamara, 2013).

The literature has listed five kinds of assets or wealth that we all have to make a living, not just poor people. Human capital is the expertise, experience, desire to work and good health that allow people together to follow various strategies for living and meet their livelihood targets.(DFID, 2000). Social capital is described as the social tools that people use in search of subsistence results, such as networks and connections, which improve public confidence and the capacity of people to collaborate or to become members of more formalized communities and their laws, standards, and sanctions structures. They are based on social capital. Natural capital refers to the natural resource reserves that are used to extract resources from and commodities that can be useful for livelihoods (e.g. soil, water, forestry, air quality, erosion control, biodiversity level and exchange rate, etc.).

Actual assets incorporates fundamental framework and assembling materials important to support livelihoods like reasonable vehicle, safe house and structures, adequate water and sterilization offices, perfect and available energy and information. Monetary capital alludes to the monetary instruments that individuals use to achieve their work objectives which incorporates fundamental money or equivalent accessibility that permits individuals to execute different occupation techniques (Serrat, 2017).

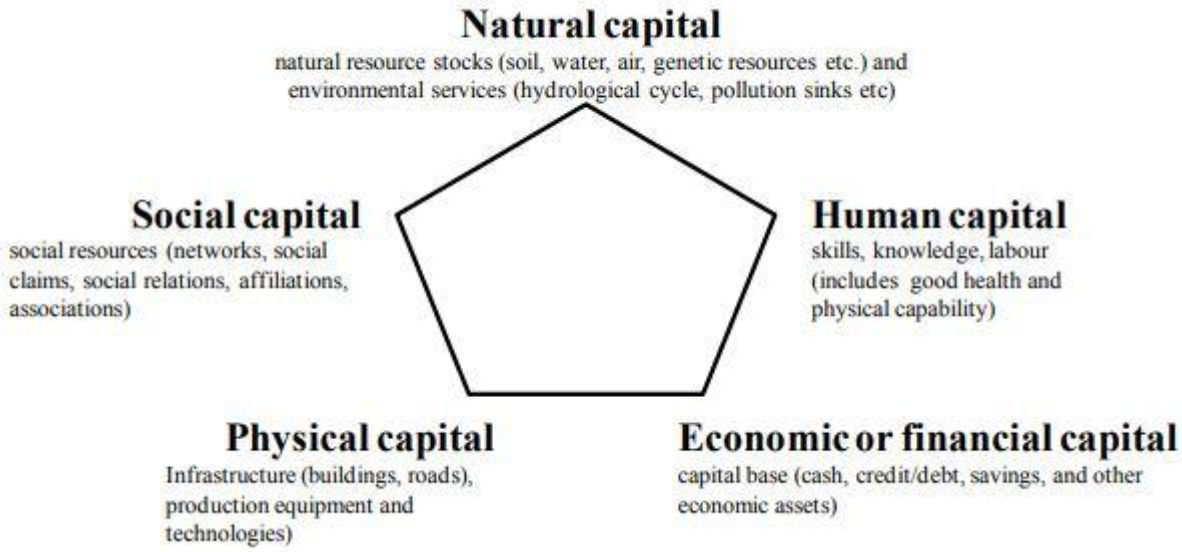


Figure 2.5 The Five Capitals of Sustainable Livelihood

As indicated by the SLA, woods assets are normal resources that add to family pay, food handling, weakness and better government assistance (DFID, 1999; Warner, 2000). Water, wood, biodiversity and identification constitute essential sources in the woodland. The main source of livelihood, nutrition and work are forest resources at the center of their social, political and economic existence (Matsvange, Sagonda & Kaundikiza, 2016). The value of community forests is expressed in their cultural, social, educational and economic properties, which draw urban dwellers closer to nature and their local heritage.

Africa is the second-biggest square of forest on the planet, however this timberland is unfortunately endlessly, and is moving rapidly. African forests are reduced by more than 4 millionyt hectares each year, double the global average. The growth of land-grab and depopulation cycles have opened the way for climate change, technical advancement, higher consumer pricing and neoliberal deregulation (Harvey, 2003, 2004). Interventions that can effectively address (Bong et al., 2016). Africa is the second-biggest square of forest on the planet, however this woodland is unfortunately endlessly, and is moving rapidly. This research therefore aims at determining domestic forest cover in rural arid and semi-arid lands.

2.7 Policy and Legislative Provisions on Household Forest Cover

2.7.1 Sustainable Development Goals

One of the leading organisations that are working to achieve the SDGs by the year 2030 is the United Nations Development Program (UNDP). We aid nations to achieve the objectives in nearly 170 countries and territories. These goals include;

(i) Goal number 13: Make a dire move to battle environmental change and its effects

The dramatic consequences of the climate change are more evident in any country in the world, some than others. The estimated damages of hundreds of billions of dollars from hurricanes, tsunamis, and tropical cyclones on average. By encouraging more impoverished areas like land-locked countries and island countries to become more resilient, we will reduce the loss of life and wealth. The worldwide mean temperature ascend to two degrees celsius over pre-mechanical levels is as yet conceivable with political and specialized mediations and along these lines forestall the most noticeably awful outcomes of environmental change.

(ii) Goal number 15: Ensure, reestablish and advance practical utilization of earthbound biological systems, economically oversee backwoods, battle desertification, and stop and opposite land corruption and end biodiversity misfortune.

Forests covering 30 percent of Earth's surface contribute to maintaining clean air and water and balancing the atmosphere with the Earth. Not to mention the millions of animal species are home to them. Yet there is difficulty for the ground and life on it. It's 30 to 35 times sooner than arable land has traditionally disappeared. Wilderness is expanding. The races of animals are running out. This patterns may be reversed. Fortunately, the Sustainable Development Goals are aimed at preserving and restoring land use habitats such as wildlife, trees, drylands and mountains by 2030..

2.7.2 Laws and Policies in Kenya

(i) The Constitution of Kenya 2010

The Constitution expresses that the nation will raise and hold at any rate 10% of the gross space of the domain. Article 69(1)(b) highlights the need to 'staff on at least 10% of the territory of Kenya for tree cover'".

(ii) The Kenya Vision 2030

The Vision makes the world a social foundation and stresses the need to secure regular assets to advance financial turn of events. For backwoods the point is to raise secured territories to 10% by 2030 and oversee common timberland assets reasonably to ensure the climate and upgrade monetary development.

(iii) Medium Term Plan III (2018-2022)

The public authority has submitted under the Medium Term III the assurance of normal woods in water towers and consistent land recovery to increment and keep up the progression of water and environmental uprightness.

(iv) Forest Conservation and Management Act 2016

Segment 6(3) features the need to foster projects for accomplishment and upkeep of tree front of at any rate 10% of the land space of Kenya. Section 37(1) provides that each County Government shall, as part of its authority, create and preserve Arborescences, Green Zones or recreation parks. In this regard, every County will make arrangement for the making of green zones inside its locale at a pace of in any event 5% of the all out territory for any lodging property anticipated turn of event.

(v) Environmental Management and Coordination CAP 387 and (Amendment) Act, 2015

The Act accommodates the protection of trees and woods related natural effect evaluations. Article 9(2)(r) of the Act commands NEMA to foster proposals with other lead organizations and to suggest ventures for tree inclusion of at any rate 10% of Kenya's property territory. Area 44 of the Act requires NEMA to draft rules, conventions, rules, and activities for the feasible administration of ridges, slopes, and wetlands, in counsel with proper other lead offices, and to implement them around here.

(vi) Agriculture (Farm Forestry) Rules 2009

This principles would cover in any event 10% of the all out rural land and ensure and moderate the natural scene in the battle against environmental change and a worldwide temperature alteration, with the goal of advancing and holding the backwoods cover. Segment 6 of Part II of the Rules manages 10% tree inclusion preservation.

(vii) Agricultural Sector Development Strategy 2010–2020

Promotes commercial tree-growing as a corporation, even for oil, of any farmer, cooperative, organization or organization.

(viii) Charcoal Regulations 2009, Forest Act

Provides advice for manufacturers, carriers, and retailers involved in the charcoal industry on legal specifications. Encourages farmers to form associations and to formulate harvest and forest strategies. Recommends the use and conservation with endangered species of effective technology for processing. Requires licenses for the movement and sale of charcoal from the competent authorities.

(ix) Draft Forest Policy 2015

Promotes sustainable production of charcoal. Promote approaches to community-based forest management in dryland for sustainable timber and non-wood production.

2.8 Synthesis of literature Review

Previous studies were able to show forest cover trends, various interactions between rural livelihoods and forest resources and some of drivers of deforestation from global, regional, national and local context. Review of literature shows many strategies proposed by scholars and policy makers to increase household forest cover, theoretical, legal and policy frameworks for forest land use in Kenyan context. However, information on average land size set aside for forest land use at household level in the study area, and factors that determine the portion of land set aside for forestry at household level at the study area was not able to be found through review of

literature. Therefore, it is important to go to the field and collect data, analyse and draw conclusions which will be used to fill the established gaps.

2.9 Conceptual framework

Review of Literature has established that at a household level in Kyome/Thaana Ward, some of the forest land uses include, woodlots, forest plantations, and planted tree species within the homestead, Fruit orchards, hedgerows and trees within farm boundaries, graze lands among others. Some of the socio- economic characteristics that influence household forest cover established include age of household head, gender of household head, and education level of the household head, household income level, and land size owned by the household and household preference to plant trees and conserve forests. In addition, there are natural and environmental factors which affect forest cover like, amount of rainfall, drought, topography, type of soils and temperature. All these constitute independent variables. Some of the intervening variables which will lead to the depended variable in this case sustainable household forest cover in the study area include; legal and policy interventions like favorable forest policies, favorable agriculture policies, favorable market systems and availability of incentives and planning interventions which include agroforestry programmes, educations and research, afforestation programmes, sensitization campaign, provision of seedlings, application of energy efficient technology and mobilization of resources.

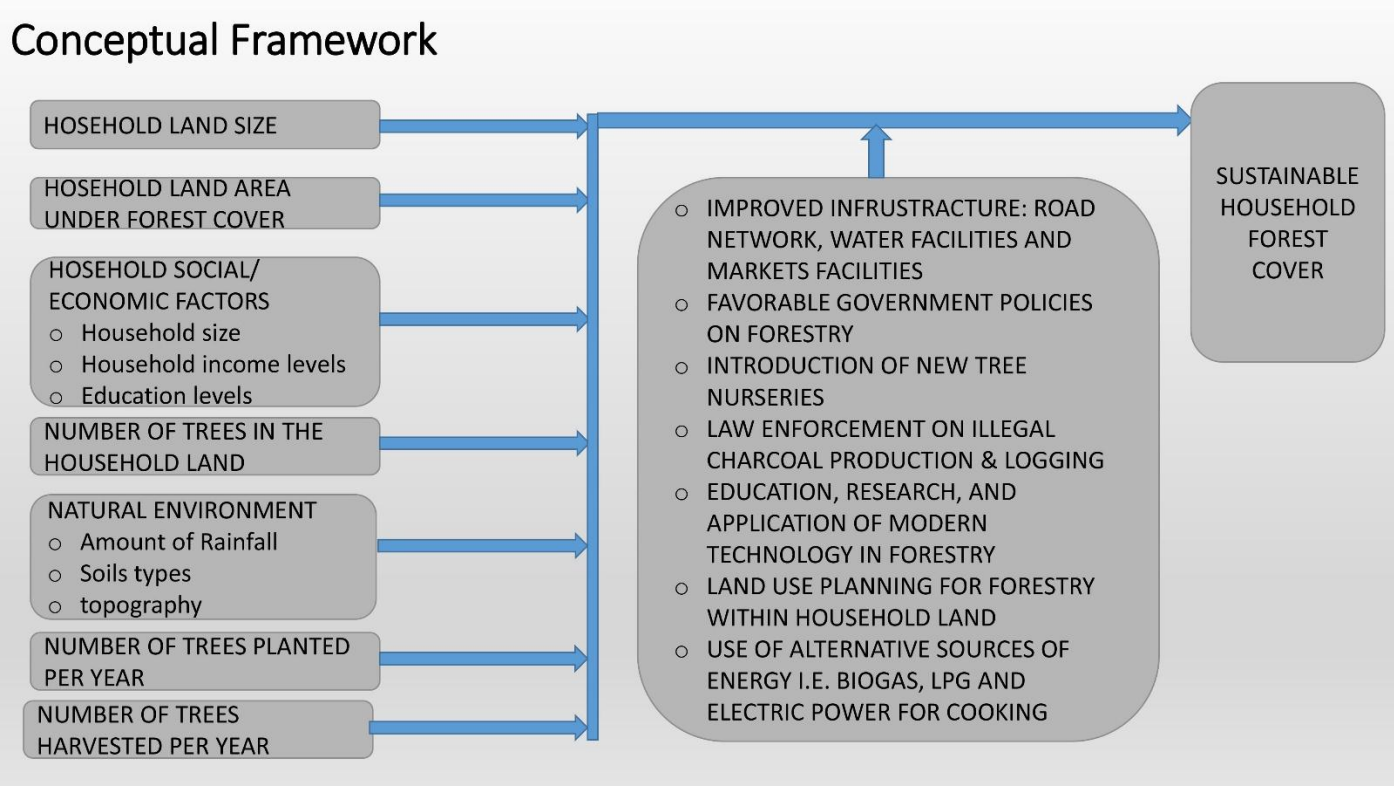


Figure 2.6 Conceptual Framework

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the following: research design, target population, sample size and sampling procedure. It also covers data collection methods, research instruments and data analysis methods.

3.2 Research Design

Kombo and Tromp (2006) guarantee that an research design can be seen as a game plan of terms for information assortment in a manner pointed toward offsetting importance with the goal of exploration. A descriptive design of analysis was used in the analysis. This method aims to gather data without altering testing variables or interviewees in order to identify the determinants of forest ground cover in rural areas that are the case of Kyome/Thaana Ward in Kitui County. The variables are often determined without overt intervention by the associated variants of independent and dependent variables.

3.3 Target Population

The target demographic corresponds to the actual sample group (Mugenda & Mugenda, 2003). Explains that a society is a collection of people or things with the same type of properties. The target population for this study was 27,055 people, and 6,350 households living within 308 square kilometers of Kyome-Thaana Ward.

Table 3.1 Target Population

Number	Sub-Location	Total Population	Number Of Households
1	Kyome	2,274	573
2	Yenzuva	2,724	593
3	Thaana	1,535	328
4	Kiusyani	1,725	365
5	Kasevi	2,458	591
6	Thokoa	2,664	652
7	Musuani	2,571	606
8	Winzyei	1,942	438
9	Kavaini	1,844	455

10	Kanyaa	2,343	573
11	Kasanga	3,285	781
12	Kitulani	1,690	395
Total		27, 055	6,350

3.4 Sampling Plan

A sample is a smaller number of items or components used to draw results about the population as a whole. It is aimed at estimating uncertain population characteristics. The analysis thus represents the systemic mechanism by which a selection of people for a sample are chosen to represent the wider group (Mugenda & Mugenda, 2003). The way toward testing considers different issues and will rely upon among different viewpoints, the association type, reason, intricacy, time imperatives and past research around there.

Kyome/Thaana Ward consists of 12 sub-locations. Stratified sampling method was used to select 4 sub – locations to represent the 12 based on population.

(i) Stratum A- Population > 2000 people (6 sub-locations) -2 sub-locations sampled
(ii) Stratum B- Population < 2000 people (6 sub-locations) - 2 sub-locations sampled

Table 3.2 Sampling Plan

Sub-Location	**Population**	**Number Of Households**	**Number Of Households Sampled**
Thokoa	2,664	652	31
Kasevi	2,458	591	28
Yenzuva	1,844	455	21
Winzyei	1,942	438	20
Total	8908	2136	100

3.4.1 Sample Size Determination

Cochran formula was used for sample size detrmination

$$(i) \quad n = \frac{Z^2pq}{d^2}$$

Where:

n = The sample when the study population is in excess of over ten thousand

z = Abscissa of the typical bend that cuts off a space σ at the tails

p = The extent of the objective populace assessed to have the trademark being estimated (93%)

q=l-p (7%)

d = the level of confidence set (5%)

$$n = \frac{(1.96^2)\ (0.93)\ (0.07)}{(0.05)^2} = 100$$

Be that as it may, since the investigation region had a populace of 6,350 families which is under 10,000, a subsequent equation was utilized.

$$(ii.)\ nf = \frac{n}{1+\frac{n}{N}}$$

nf = The sample when the study population is in excess of less than ten thousand

n = The sample when the study population is in excess of over ten thousand

N = The gauge of the populace size

Thus the sample size was $n = \frac{100}{1 + \frac{100}{6{,}350}}$

$=100$

3.4.2 Sampling Techniques

The study population consisted of 27,055 people in 12 sub-locations of Kyome /Thaana Ward, Kitui County. Since it was impossible to study the whole population due to time and financial limitations the population was sampled. This reduced the number of households that the researcher needs to interview thus saving on time and financial costs. The study used multi stage sampling technique. This technique was chosen since it is administratively convenient and financially economical. It also gave the flexibility of combining different sampling techniques. Selection of the study area was done via 2 stages: The first stage comprised selection of Kyome/Thaana ward, Kitui County**.** Kyome/Thaana Ward, Kitui County was selected purposively because of familiarity of the researcher with it thus easing the process of data collection. The second stage involved selection of sample households from sub-locations. Kyome/Thaana Ward consists of 12 sub-locations. Stratified sampling method was used to select 4 sub – locations to represent the 12. Selection of the 4 sub – locations is based on population densities with south - eastern area having high population densities and sub- locations in that area have smaller areas in terms of square kilometers compared to those in North – western side. Based on this criteria 2 strata can be formulated. The first strata comprised Thaana, Kiusyani, Winzyeei, Yenzuva, Kavaini and Musuani sub- locations. The second strata comprised Kasevi, Thokoa, Kyome, Kitulani, Kanyaa and Kasanga sub-locations. Simple random sampling method was used in selecting 2 sub – locations in each block and also selecting 100 households from the 4 sub – locations (25 households in each sub- location) sampled from the 2 blocks.

3.5 Data Needs Matrix

Table 3.2 show the data collection plan.

Table 3.3 Data Needs Matrix

Objective	Data Needed	Method Of Data Collection	Data Instrument	Data Analysis	Data Source
1.To determine the average area of land under forest cover at household level in Kyome/Thaana Ward	-Total size of plot per household -Land area allocated to forest cover	-Interviews -Observation -Photography -Physical measuments	-Household Questionnaire -Key informant guides	-Descriptive statistics -Statistical analysis using SPSS -T- tests -Correlations	-Household members -Key informants
2. To establish Factors that contribute to variations in areas of land devoted to forest cover at household level in the study area.	-Household size - Household income levels -Household education levels -Population density and distribution	-interviews -Photography	-Household Questionnaire -key informants guides	-Descriptive statistics -Statistical analysis using SPSS	-Household members

3. To determine hindrances that stand on the way of increasing household forest cover in the study area.	-wood fuel consumption -Timber and poles harvesting levels -Availability of seedlings -Technology	-interviews -Instrument administration -Physical measurements	-Household Questionnaire -key informant guide -Weighing balance	-Descriptive statistics -Statistical analysis using SPSS e.g. correlation	-Household members -Weight measuring
4. To propose planning interventions that could increase household forest land cover in the study area.	- Household believes/ vision to increase forest cover -Policy and legislative provisions	-Interviews	-Household Questionnaire -Key informant guide	-Descriptive statistics -Statistical analysis using SPSS	-Household members, -Key informants

Source: (Researcher, 2020)

3.6 Data Collection Methods

3.6.1 Primary data

i. Questionnaire

Household questionnaire is fundamental examination instrument that was utilized to gather essential information. The survey was picked as a result of simplicity in organization to a huge example and is liberated from questioner's predisposition. It contained both organized, shut finished inquiries just as open finished inquiries.

ii. Observation

The observation method was used in addition to the household questionnaire. The researcher made a general observation on the environment to assess the state of the environment. Through perception the analyst had the option to distinguish a portion of the systems that families use to expand woods cover.

iii. Measurements

The study used various measurements to collect primary data. To determine the weight of firewood used per day, women were asked to lay out a bundle of firewood equivalent to the amount used per day. This bundle was measured using a weighing scale by the research team. The study measured the amount of firewood and charcoal used in kilograms. To determine income levels, the households was requested to estimate how much they earn per month in Kenya shillings.

iv. Interviews

The surveys were controlled utilizing eye to eye talk with strategy. Information from key sources was additionally gathered utilizing vis-à-vis talk with technique. Key informants for this study included officials in the forest department, environment department, COB’4s and Non-Governmental Organizations (NGO’s).

v. Focus group discussions

The researcher conducted four focus group discussions comprising of married couples, the young, professionals and religious leaders. Gender parity was observed in all the groups with males and females participating in the discussions in all categories and where possible on a 50 percent side. A focus group discussion guide helped the researcher guide through the sessions that lasted a maximum one hour and focused solely on land sizes and uses, their changing nature and their effects on household forest cover.

Vi Literature review

Existing literature comprising of books, journals, periodicals, research reports and scholarly articles on the subject of study were reviewed and findings documented as literature review.

3.7 Data Analysis Methods

The study used both quantitative and qualitative techniques of data analysis.

i. Percentage

This is a proportion of a particular value in relation to 100. The study used percentages to standardize values for comparison purposes. The study calculated the proportion of respondents of households in each income bracket among others.

ii. The mean

This is the arithmetic average of a set of data and is obtained by summing up all the scores and dividing by the total number of cases. It is the most frequent measure of central tendency used in the study as is with other studies conducted by various researchers.

iii. The mode

It is the most frequently occurring value in a set of observations. The mode was used to show the most frequent family size, the most frequent income bracket and other relevant variables

iv. Standard deviation and the variance

Standard deviation indicates the extent to which scores in a distribution deviate from their mean or in other words how tightly the scores are clustered around the mean.

v. Tabulation

This involves data being shown in a range of columns and rows. The use of tables condenses massive data mass, makes it easy to compare data types, and takes up less space than the story data displayed (Alabi, 2007). The study tabulated data obtained for some of the objectives of the study. Due to the simplicity that comes with use of tables, it can be difficult to see numerical relationships and patterns were used since they are clearer.

Vi Diagrammatic representation

Diagrammatic representation brings out the visual relationship in a better way. The study used pie charts, bar graphs, histograms and photographs to present data.

Vii Correlation analysis and T- test

These techniques were applied during the hypothesis testing. The study had two hypothesis which were tested at the end of data analysis section

3.9 Ethical Considerations

The object of ethics is to ensure that the study practices do not harm or adversely affect anybody. In this study reasonableness is established based on ethical considerations and criteria because of the often delicate relationships between researcher and respondent. The knowledge received during the thesis has therefore been viewed confidently and for scholarly purposes only.

CHAPTER FOUR: STUDY AREA

4.1 Introduction

Kyome/Thaana Ward is located in Mwingi West constituency which is one of the 8 constituencies that make up the County of Kitui. It is also one the four administrative wards that make-up Migwani Sub – County namely; Nguutani, Migwani, Kiomo/Kyethani and Kyome/Thaana.

Kyome/Thaana ward is divided into 12 Sub-Locations namely; Kyome , Yenzuva, Thaana, Kiusyani, Kasevi, Thokoa, Musuani, Wenzyeei, Kavaini, Kanyaa, Kasanga, Kitulani.

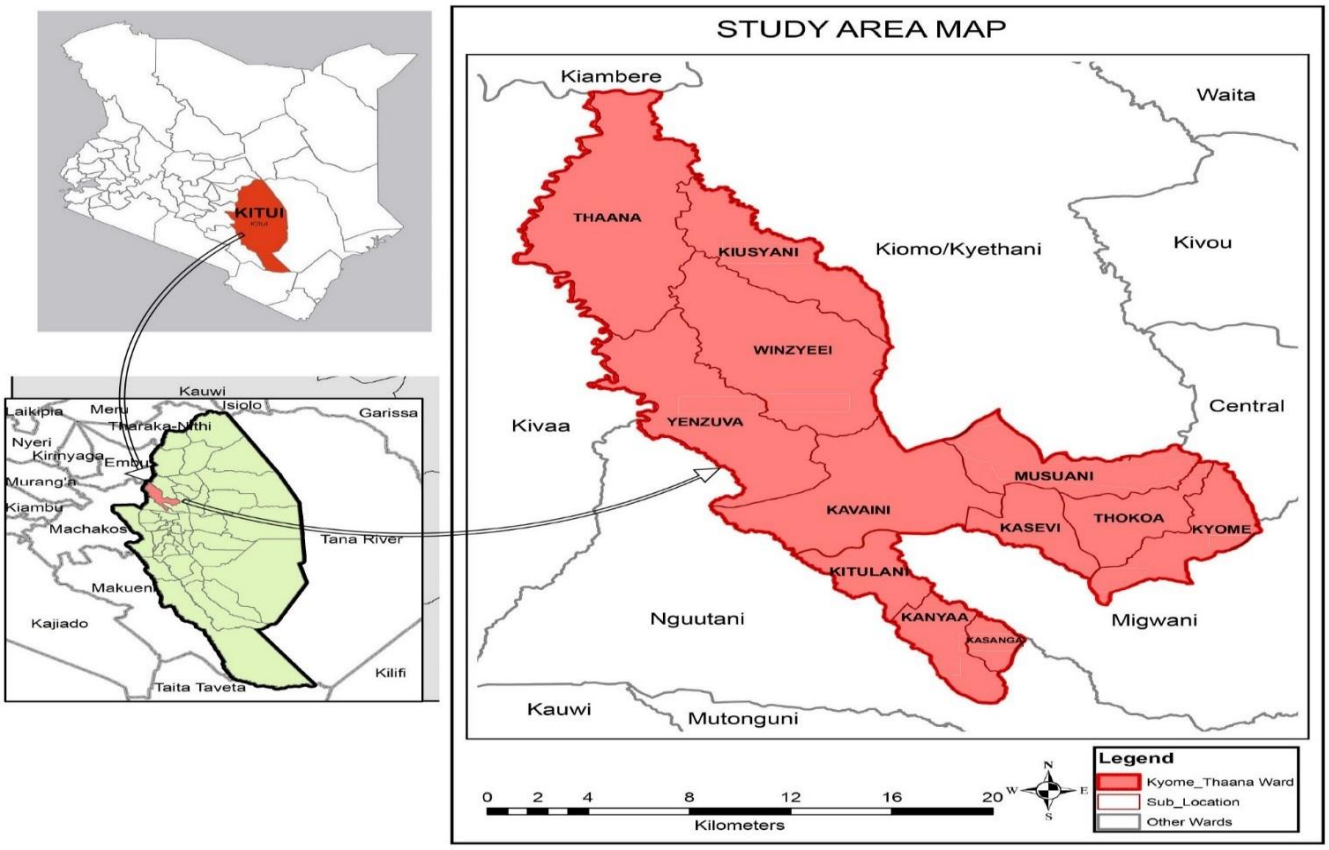


Figure 4.1 Study Area Map

4.3 Demographic Dynamics

According to the KBS (2019), Kyome/Thaana Ward has a population of 27,055 people and has dispersed human settlement patterns. In Kitui population density was 33 people per square kilometre, compared to a national per square kilometer average of 66 people. It is forecast that the population density of 37 people per square kilometres will rise by 2022 to 39 people per square kilometres. Home size is average at 5.1 people.

4.4 Climatic and Physiographic Features

Kyome/Thaana Ward is hot and dry for most part of the year with temperatures ranging between 14 - 34 ^{0} C, and rainfall between 400 - 800 mm. Mwingi is a strongly heterogeneous natural vegetation (Jaetzold et al. 2006). Uncultivated parks of soil, containing different variations of the dryland, are covered by bushlands, grasslands and shrub-lands. A mixture of Acacia-Commiphora bushlands is the primary plant association. Food for animal pastures is provided by permanent grass such as Eragrostis superva Peyr, Cencrus ciliaris and Enteropogon macrostachyus, Benth and some specias of Pensetum. Planted tree vegetation mainly on farms in terms of woodlots; farm boundaries consisting of regenerated acacia species; and a few planted species of *Melia volkensii, Terminalia* species, *Eucalyptus camaldulensis*, *Grevillea robusta* and different fruit trees. Increasingly, farm crop residues have become important sources of biomass energy.

4.5 Social- Economic and Cultural Profile

The population in the field of research depends heavily on farming and cattle management. Really, 75% of the food and profits of households come from farming (Republic of Kenya 2007). In higher altitudes, growing is more prevalent, while in lower attitudes livestock conservation is more common. Various seeds, predomino, millet, sorghum, green grams (mung bean), and cowpeas, are cultivated. While the production of food serves livelihood, some are sold to satisfy the cash requirements of a family. The sheep, however, are primarily made up of cattle, goats, donkeys and chicken. Though livestock and cattle provide milk, beef, ox-plough, hide and currency, donkeys are kept solely for transport work.

In addition, livestock has important role in society and culture as a token of prosperity and married trade (Nyariki & Abeele 2004). Goats are usually sold for domestic purposes, while bovine animals have to be sold in excess of vast amounts of money. The area of Mwingi has poor rain-fed farming ability. The locals are increasing their agropastoral income from forests and forests. Kamba women make kyondo which is a traditional basket made by weaving the sisal Strings together in a given pattern and form. The Kamba is now renowned for their fine wood carving, basketball and pottery activities. The work of sculpture shown at several artisan stores, galleries in Kenyan main towns and towns demonstrates their creative tendency.

As other parts of Kenya, both customary and national laws regulate land tenancy. The customary law establishes that the tenural rights of women are dependent on social ties between men and women and, more precisely, husbands and women. The transition from customary to state land tenure legislation involves patriarchy, since, in individual tenures, male heads of households are, more than once, the exclusive place of land retention (Kameri & Mbote 2005).

4.6 Social Infrastructure

Social Infrastructure is a sub-set of infrastructure that usually includes social services-friendly properties. Examples include schools, colleges, hospitals, jails and communal accommodation. social infrastructure property. The school density has been constantly low, with a high teacher/pupil rate of 1:35 (approx. 1 elementary school per 28 km2) (Republic of Kenya 2005). Despite steady growth in local population, many elementary and high schools do not have basic facilities, including classrooms. The CDF, popularly known as the CDF, has been seeking to reverse the situation since its inauguration in 2005 by promoting the building of extra classrooms and paying grants for children in disadvantaged homes.

4.7 Physical Infrastructure

Physical infrastructure refers to the fundamental physical facilities needed to operate and sustain an economy such as transport systems, piped waters, power grids and sewage systems and waste disposal systems. In 2020 we will upgrade the Kibwezi-Kitui-Mwingi road that cuts across the field. Most other access roads and walking trails are not all weather and also have a rainfall, especially on the pavement. The earth's paths become dusty and unmoved during heavy rain. The

road's top soils are also eroded, with rough ribs and ravines which make driving difficult and lead to high vehicle wear and loss rates. Connection to piping water, relying on dams and private boreholes, is lacking in most rural houses. Not only does dryness lead to a loss of precipitation, but water is still dried in river beds and lakes. Water in open barriers turn brown or green with the rise in evaporation and the accumulation of non-water components, thus increasing health risks. It is also said that groundwater is decreasing as a result of decreased rain refill. This undermines the capacity of households to access sufficient and clean water. Households invest significant time and resources on acquiring household water. In the dry/dry season, water is obtained up to 24 kilometers away in the regular season compared to 5 km (Kiragu, 2013). Thanks to the rural electrification scheme, all public schools have access to hydro-electricity, which means that even rural families have access to electric power. Waste disposal is done through pit latrines and burning, while waste waters are mainly used to water animals and plant trees.

CHAPTER FIVE: FINDINGS AND DISCUSSIONS

5.1 Introduction

The results of the analysis and the debate on the results according to the collected data are presented in this chapter. The results are interpreted with respect to the aims of the analysis. Twenty five respondents from households in 4 sub – locations were interviewed, and their responses analyzed.

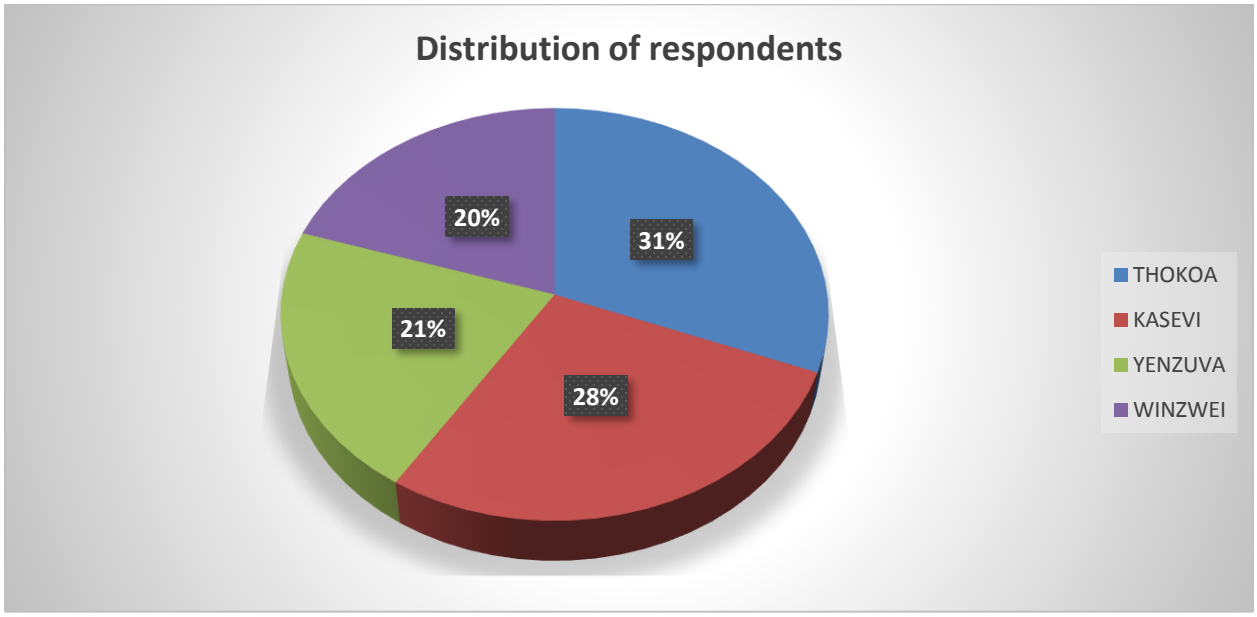


Figure 5.1 Distribution of Respondents within Sub location

Source: Field Survey, 2020

The analysis focuses on household land sizes, areas under forest cover the factors leading to variations in areas devoted to forest cover, hindrances to that stand on the way of increasing and sustaining forest cover and the planning interventions that could increase the household forest cover in the planning area.

5.2 Social Economic and Demographic Profiles

5.2.1 Age of Respondents

The greater part of the respondents, around 51% of them matured over forty years. Over 70% of the respondents were more than thirty years old while the base age was 18 years. All respondents were therefore, mature adults and would make sense of the study, provide reliable information and had capacity to own or rent land for forestry practices.

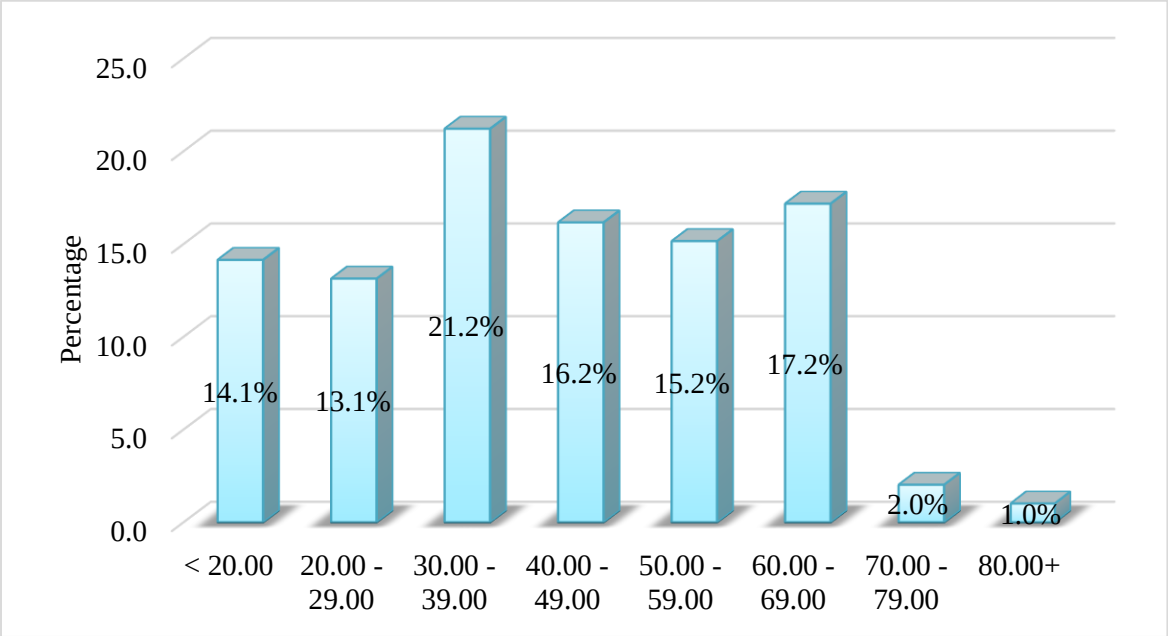


Figure 5.2 Distribution of Respondents by Age

Source: Field Survey, 2020

5.2.2 Gender of Respondents

At approximately 56 percent, females were the majority respondents compared to males who constituted 44 percent of the respondents. This was credited to the way that men were to a great extent occupied with monetary exercises from home as a method of expanding family pay. Gender parity is also in play with almost a fifty percent aside of either gender responding and thus giving the study a vital desired wider view of the subject under investigation. It was also an indication that land related decisions are equally shared among either gender in the study area.

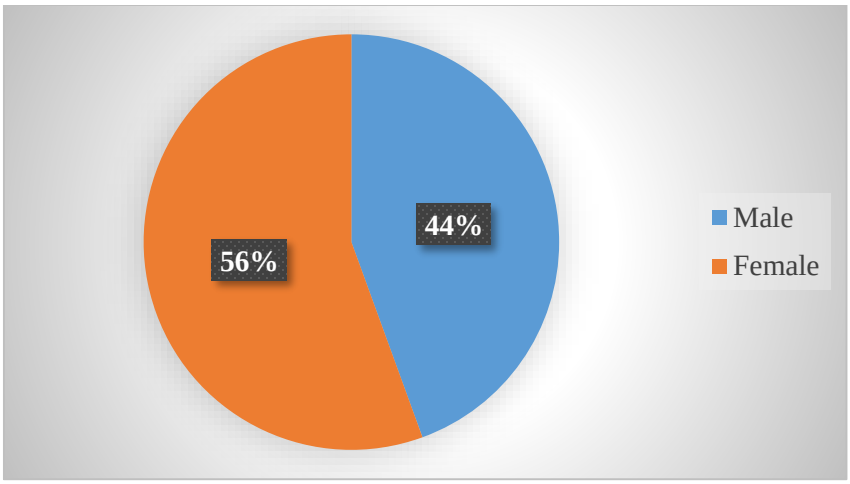


Figure 5.3 Distribution of Respondents by Gender

Source: Field Survey, 2020

5.2.3 Marital Status of Respondents

Majority of the respondents at about 58 percent were married while 11, 26, 3 and 2 percent were widowed, single, separated and divorced respectively. This implies that majority of land related decisions and forest land cover are possibly conducted in consultation with the spouse while the widows held sole responsibility as did the single and divorced ones. Single respondents comprised of men and women who had established homes away from their parents and had not gotten married at all, some with, others without children. Widowed respondents were responsible use decisions which affected mostly immediate dependents being children since their spouse had passed away.

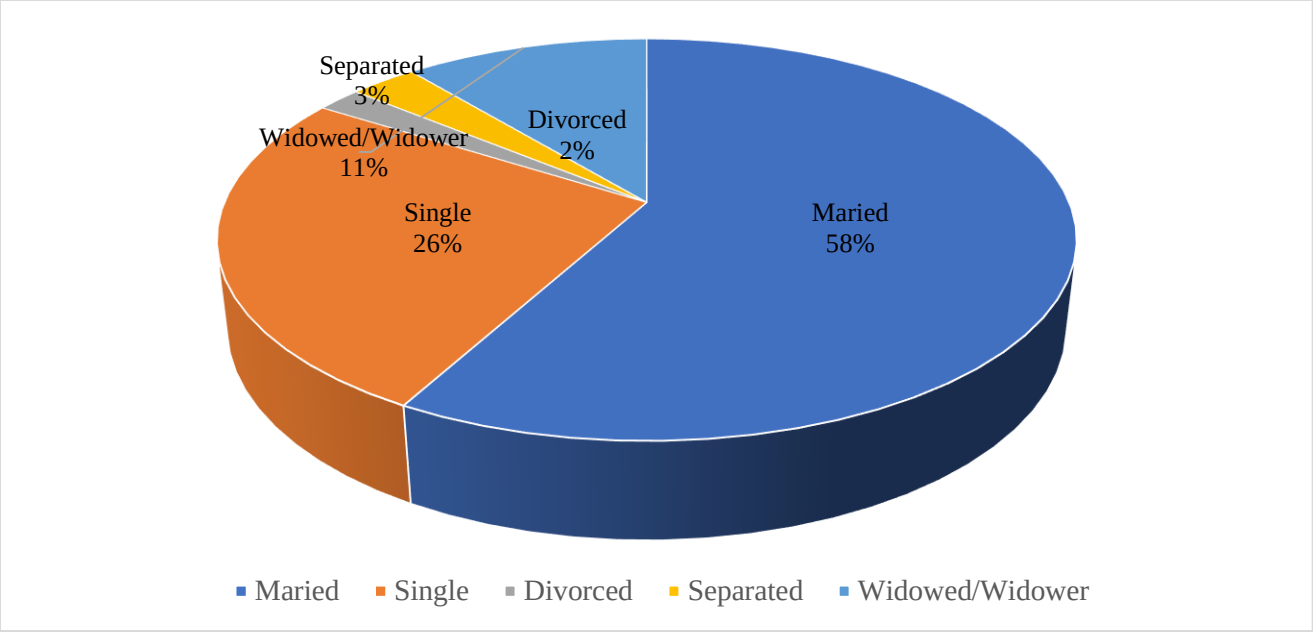


Figure 5.4 Distribution of Respondents by Marital Status

Source: Field Survey, 2020

5.2.4 Education Level of the Respondents

To get a comprehension of the degree of education of the respondents, respondents were asked their most elevated level schooling that they have accomplished. It is then understood that most of the respondents had attained a primary level of education 31.2 percent, none of respondents never attended any formal education, 23.7 percent had attained secondary education while 26 percent had gone beyond the tertiary education as shown in Figure 5.5 . Low literacy levels were attributed to lack of sufficient funds to finance education at the time the respondents were growing up. The effect was that majority of them got married at tender age while others dropped out of school to do menial jobs.

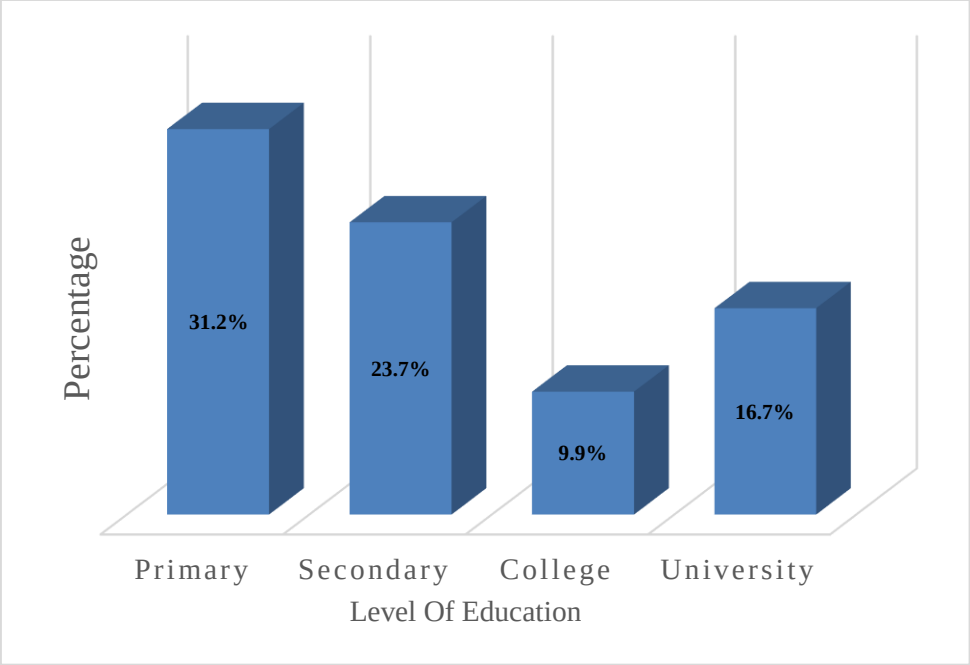


Figure 5.5 Distribution of Respondents by Level of Education

Source: Field Survey, 2020

5.2.5 Household Size

On average, a household in Kyome –Thaana Ward comprises of five members. One and eight members form minimum and maximum family size. Majority of the households, approximately 81 percent as can be deduced from Figure 5.6 have between four, five and six members.

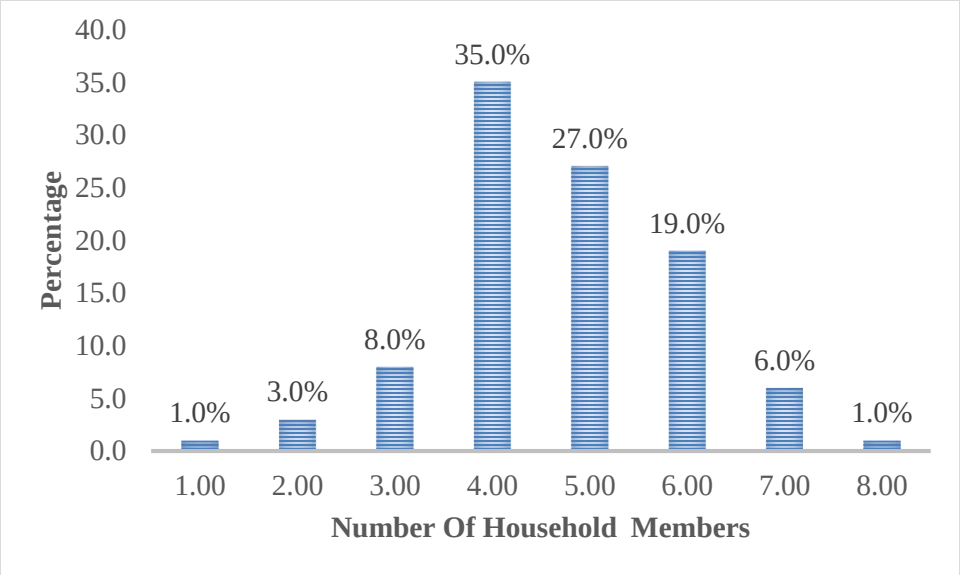


Figure 5.6 Household Size

Source: Field Survey, 2020

5.2.6 Main Household Economic Activities

Majority of the respondents constituting 59 percent of the total respondents interviewed indicated that agriculture was the main economic activity, while some 23 percent others noted that small-scale businesses was their main economic activity. Additionally, 8 percent of the respondents were casual laborers while some 6 percent were found to be civil servants and two percent were working in the private sector.

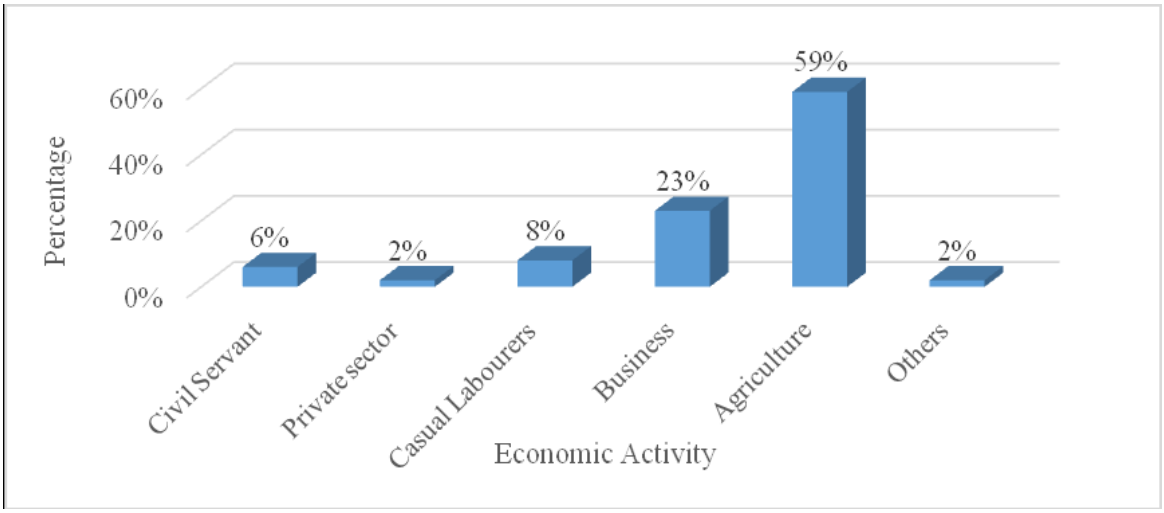


Figure 5.7 Main Household Economic Activities

Source: Field Survey, 2020

Agriculture is the population's primary economic food supply. Maize, rice, pigeon peas, cowpeas, sorghum, manioc, green grams and millet are the most important food crops.

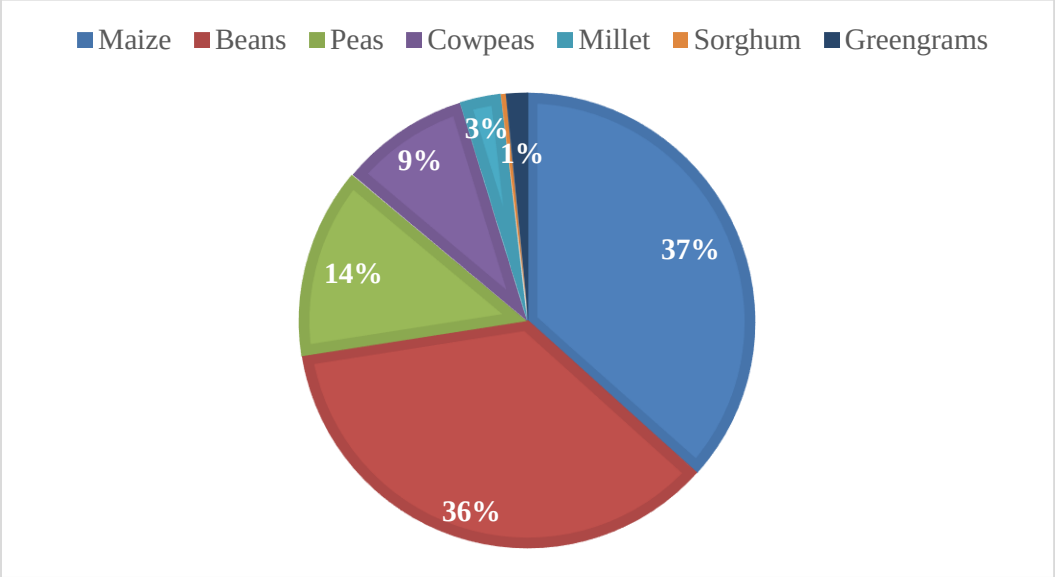


Figure 5.8 Crops Grown In the Study Area

The second biggest economic operation is livestock retention; many students can be defined as agro pastoralists in the area of research. In the main, pigs, goats, sheep, chicken and donkeys are held. Cattle and Goats are stored for sale rather than consumption during the dry season. Milk is usually low, but on the local market it may be consumed or sold. Donkeys are kept mostly in water for the transport of goods.

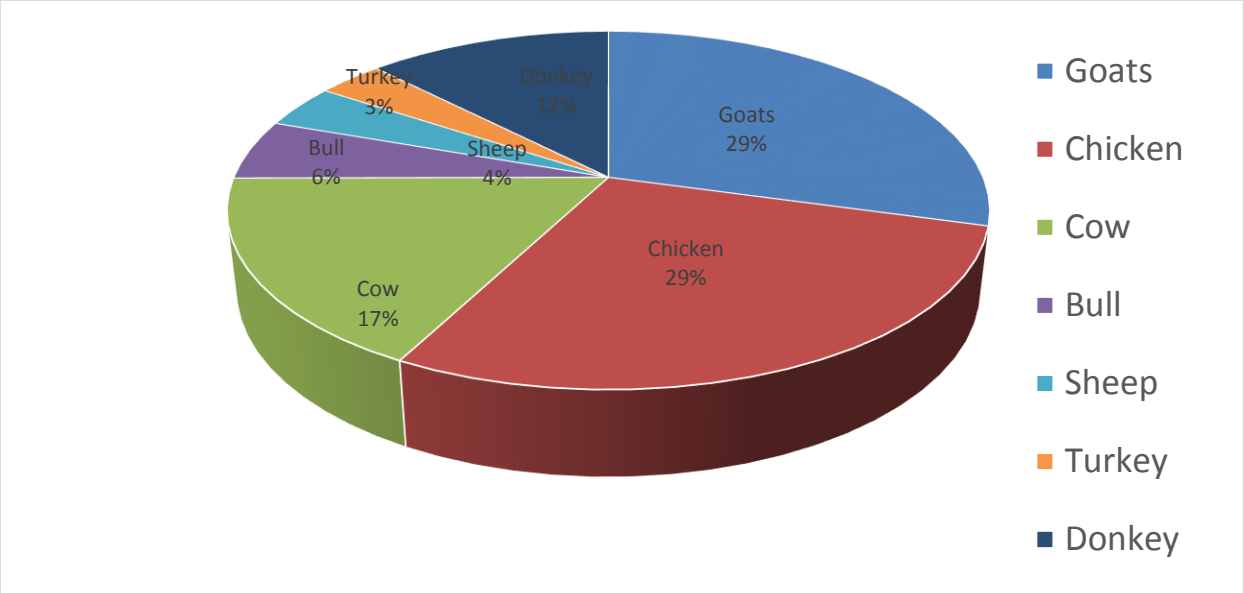


Figure 5.9 Animals Kept by Respondents

Source: Field Survey, 2020

5.2.7 Household Income Levels

Majority of respondents, 74.5% have their monthly income below ksh 25,000 while 15.2% earn between ksh25, 000 to ksh 50,000. Notably, observation showed that there is overdependence on rain fed agriculture and with majority of household heads engaging in farming as their main occupation, any negative effects to the farm size or land use or changes in climate and environment adversely affects livelihoods as household food security is in all circumstances affected.

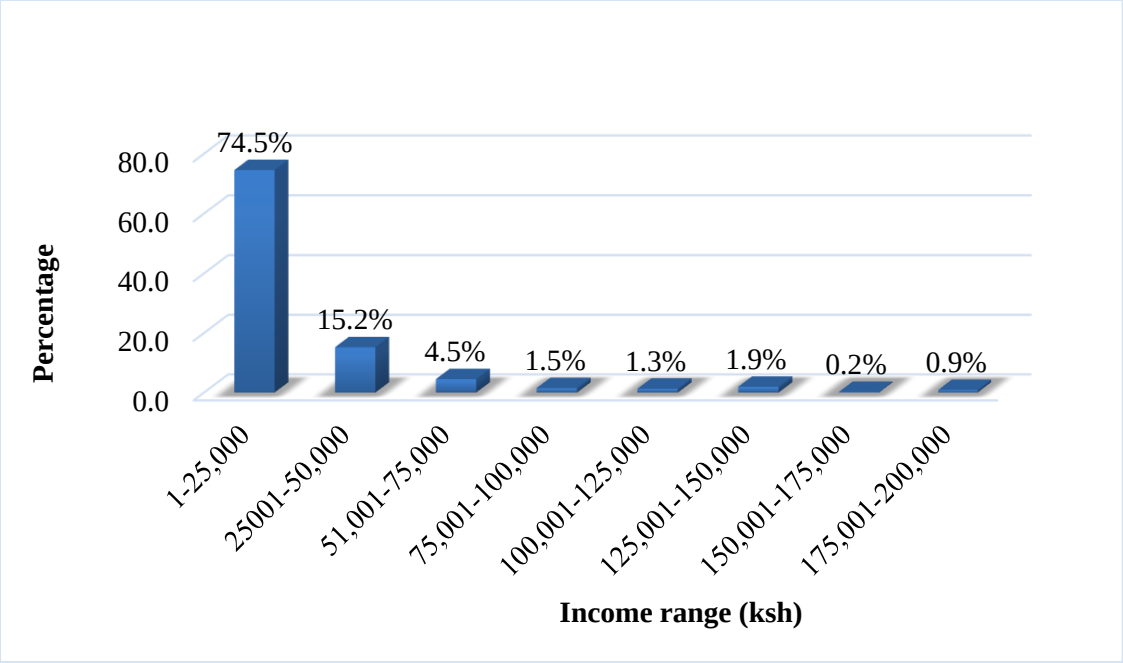


Figure 5.10 Household Income Levels

Source: Field Survey, 2020

5.3 Findings on the Average Area of Land under Forest Cover

5.3.1 Mode of Land Acquisition

Inheritance was the main way of acquiring land for 55 percent of the respondents while 44 percent others obtained land through purchase.

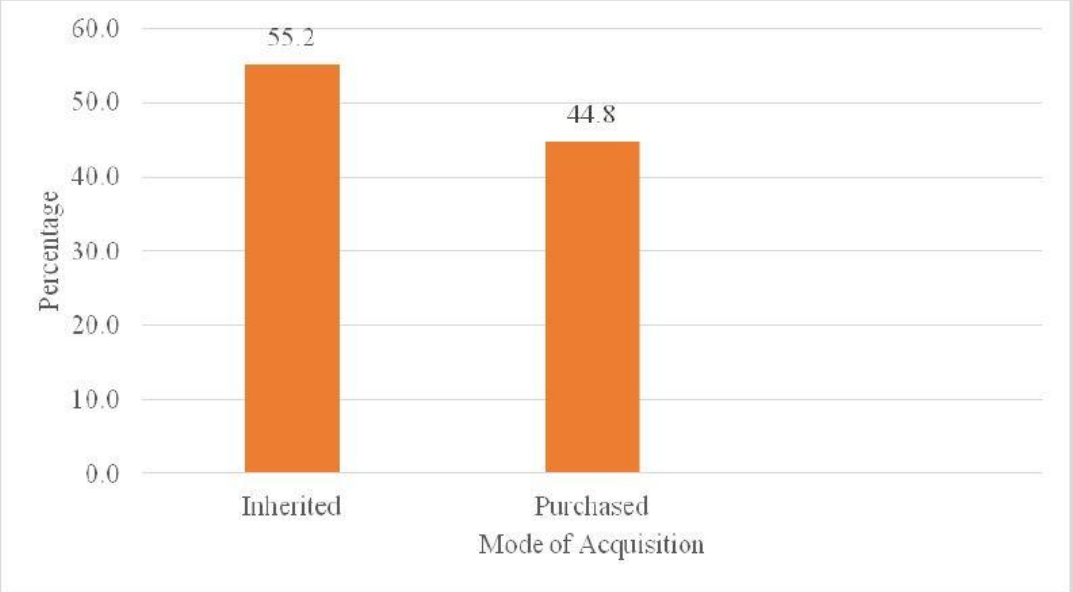


Figure 5.11 Modes of Land Acquisition

Source: Field Survey, 2020

These two methods of land acquisition had effects on household land sizes since the land had to be subdivided to accommodate heirs or buyers. With inheritance leading the mode of land acquisition for the respondents who were household heads, it brought to the fore the tradition that children have to be heirs of their parents' land indicating intergenerational transfer of land was highly practiced. Buying of land was on the rise in the area occasioned by influx of migrants, both native and non-native Kamba, from neighboring major towns.

5.3.2 Original Parent Land Size before Subdivision

Majority of the respondents (30.3 percent) said that their original parents land size was between 11-20 acres, 28.3 percent being between 31-40 acres, 17.2 percent being between 21-30 acres, 9.1percent having between 41- 50 acres, 8.1percent having between 0 - 10 acres and finally 7.1percent having between 51 and above acres as shown in the figure.

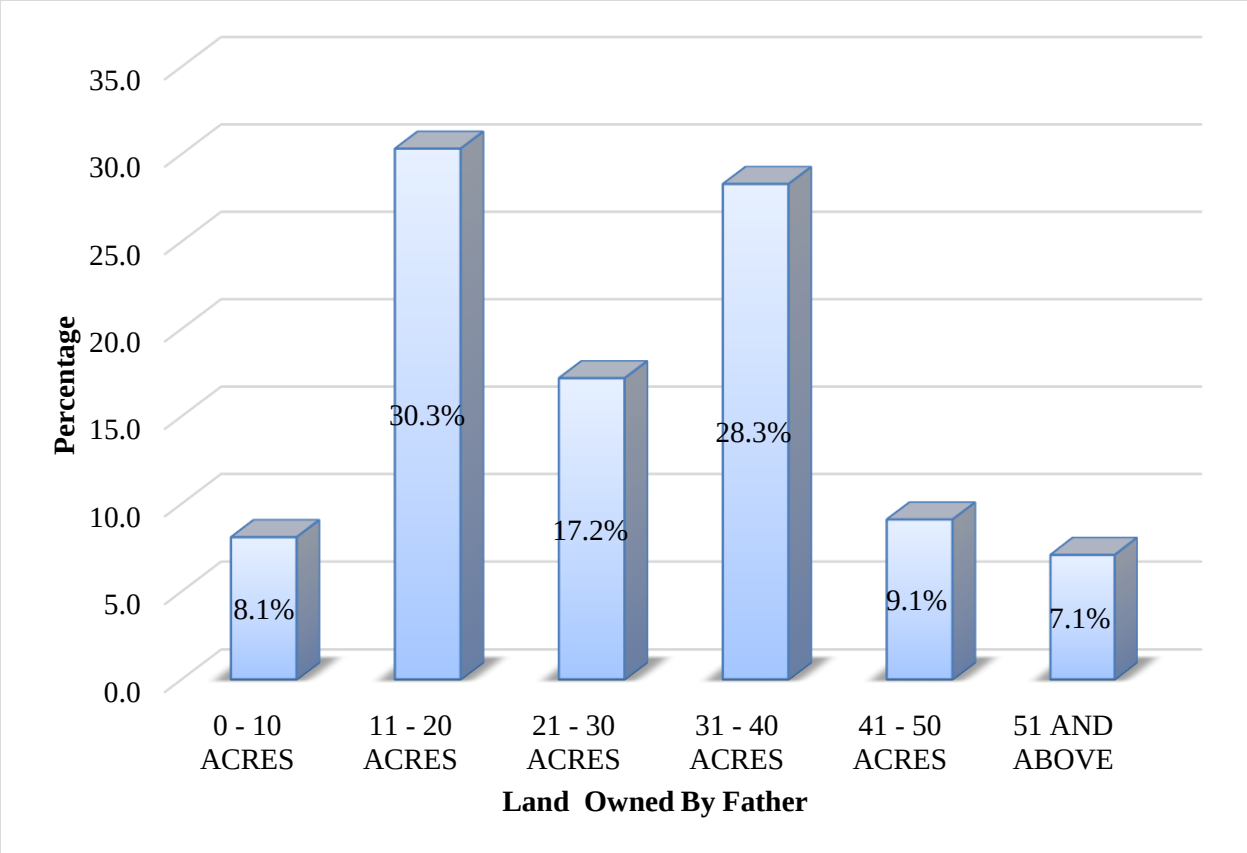


Figure 5.12 Land Ownership by Parent

Source: Field Survey, 2020

As can be deduced from Figure 5.12, majority of the respondents, at approximately 99.8 percent, their original parent's land before subdivision exceeded four acres indicating that mechanization and use of modern technology on land was very possible before subdivision. This in turn implied production was probably higher and possibly sustained a household all year round.

5.3.3 Current Household Land Sizes

From the investigation discoveries, 38.4 percent of the respondents demonstrated that they possessed 0 to 5 sections of land of land, while 19.2 percent of the respondents showed that they claimed 6-10 sections of land of land. Moreover, 18.2 percent of the respondents were found to claim 11-15 sections of land of land, 20.2 percent of the respondents were found to possess 16 - 20 sections of land of land and 4 percent others claimed 21-25 sections of land as shown in Figure

5.13. They indicated that the continued land subdivision amongst the family members as the main reason for the small land sizes they held.

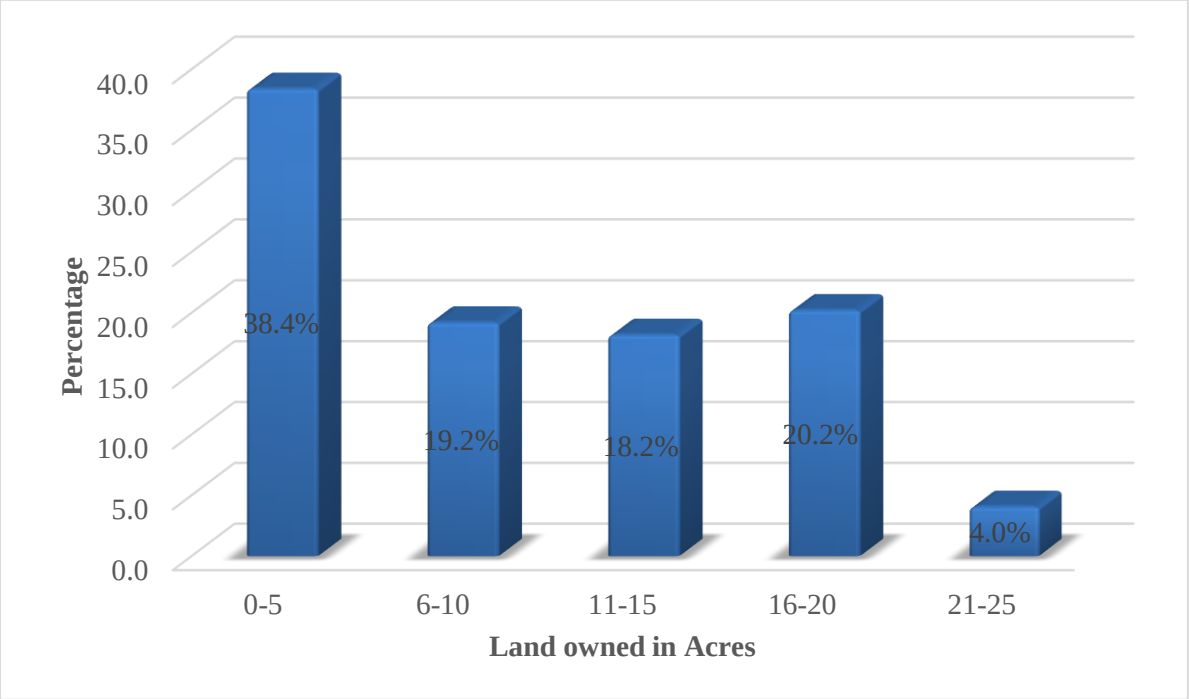


Figure 5.13 Current Household Land Sizes

Source: Field Survey, 2020

Additionally, families which had a few members had also large pieces as compared to the ones which had higher number of members. Also, encroachment of the agricultural land by markets was also mentioned as a key factor leading to increased land subdivision in the region which in turn has led to small land sizes. This, as Jayne et al. 2014 and Museleku et al. 2018 observe, has negative impact on agriculture in that it reduces land under agriculture leads to low agricultural production in the region affecting food and livelihood security of the local communities and the country in the long run.

5.3.3.1 Comparison of Current and Parent Land Sizes

Majority of households (58) own land in range category between 0-10 acres while majority of their parents (32) owned land within range category of 11-20 acres. This implies that household land size in the study area is decreasing over time and could result to unsustainable land sizes in future.

Table 5.1 Comparison of Current and Parent Land Sizes

Land size range (acres)	Current household land size	Land size owned by parents
0 -10	58	8
11-20	38	32
21-30	4	17
31-40	0	27
41-50	0	9
Above 50	0	7
Total households	100	100

5.3.4 Current Household Land Sizes under Forest Cover

From the investigation discoveries, 38.4 percent of the respondents demonstrated that they possessed 0 to 5 sections of land, while 19.2 percent of the respondents showed that they claimed 6-10 sections of land of land. Moreover, 18.2 percent of the respondents were found to claim 11-15 sections of land of land, 20.2 percent of the respondents were found to possess 16 - 20 sections of land of land and 4 percent others claimed 21-25 sections of land.

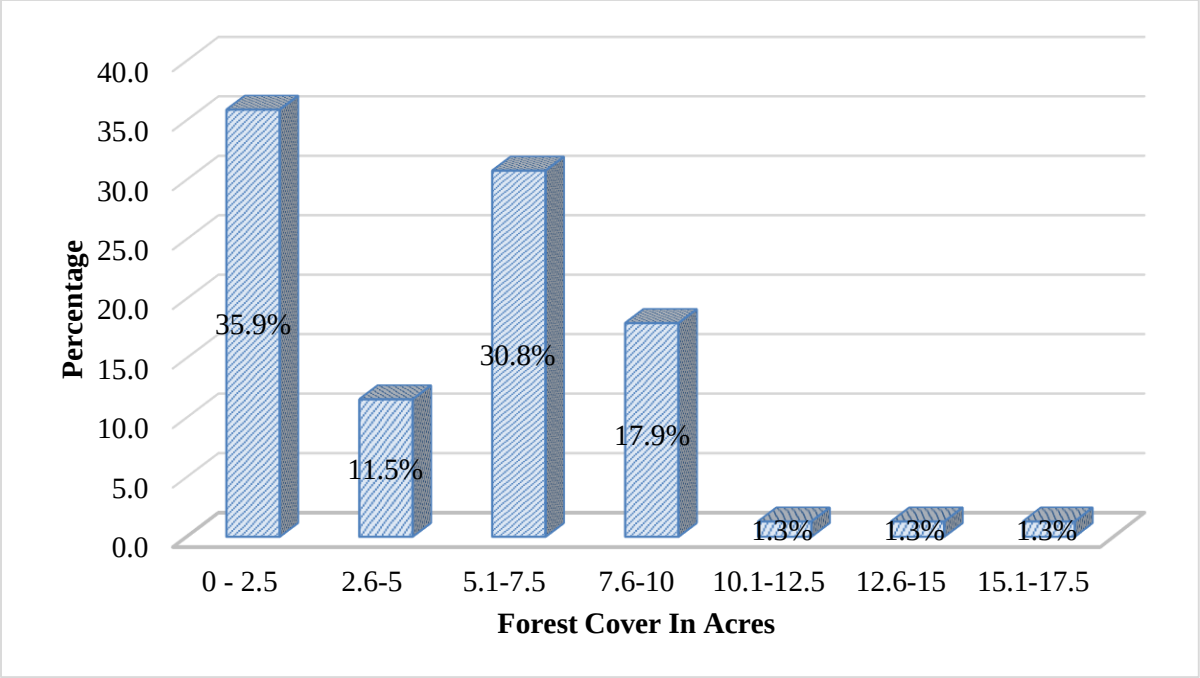


Figure 5.14 Current Household Land Sizes under Forest Cover

Source: Field Survey, 2020

5.3.5 Tree Species in the Study Area

There are many natural tree species in the study are which have medicinal, nutritional economic, ecological, adaptability and cultural values. Natural tree species provide shade for households, and act as wind breaks, some trees provide edible fruits for households and they provide firewood and charcoal for both domestic and commercial purposes. Indigenous tree species in the study area are *Acacia sp.*, *Adansonia digitata*, *Combretum collinum*, *Cordia africana*, *Croton macrostachyus*, *Croton megalocarpus*, *Dombeya kirkii*, *Erythrina abyssinica*, *Melia volkensii*, *Moringa oleifera*, and *Schejjlera actinophylla.* According to the study findings, 37 per cent of households had between 0 to 100 indigenous trees within their household land, 29 per cent of households had between 101 to 200 indigenous trees, 25 per cent of households had between 201 to 300 indigenous trees, 5 per cent of households had between 301 to 400 indigenous trees, 3 per cent of households had between 401 to 500 indigenous trees, and 1 per cent of households had between 401 to 500 indigenous trees.

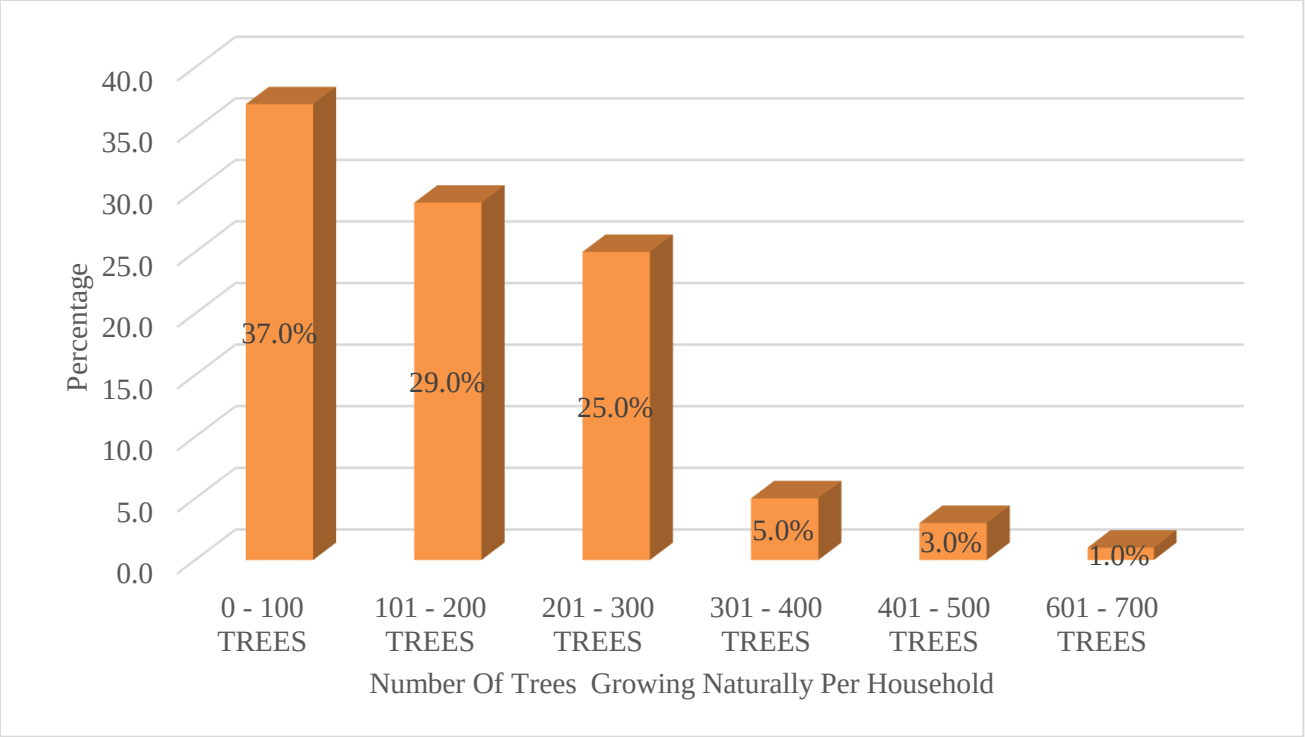


Figure 5.15 Tree Species in the Study Area

Source: Field Survey, 2020

Plate 1: *Acacia sp.* Trees species in the study area

There is scanty of research on the effects of tree species and appropriate tree species based on farmers' experience that need to be selected for planting that are ecologically suited for the agro-ecosystems of the study area and other semi-arid lands in Kenya. Planted species of *Melia volkensii*, *Terminalia* species, *Senna siamea*, *Grevillea robusta* and different fruit trees, like mangoes, oranges, guava, pawpaw, bananas and avocando. According to the study findings, Mango is the most planted species with 35 per cent, *Senna siamea* 'Mukengeka' with 21.6 percent, pawpaw with 11 per cent, oranges with 10 per cent, *Melia volkensii*, 'Mukau' with 8.5 per cent, *Croton macrostachyus,* Muthulu with 4.6 percent

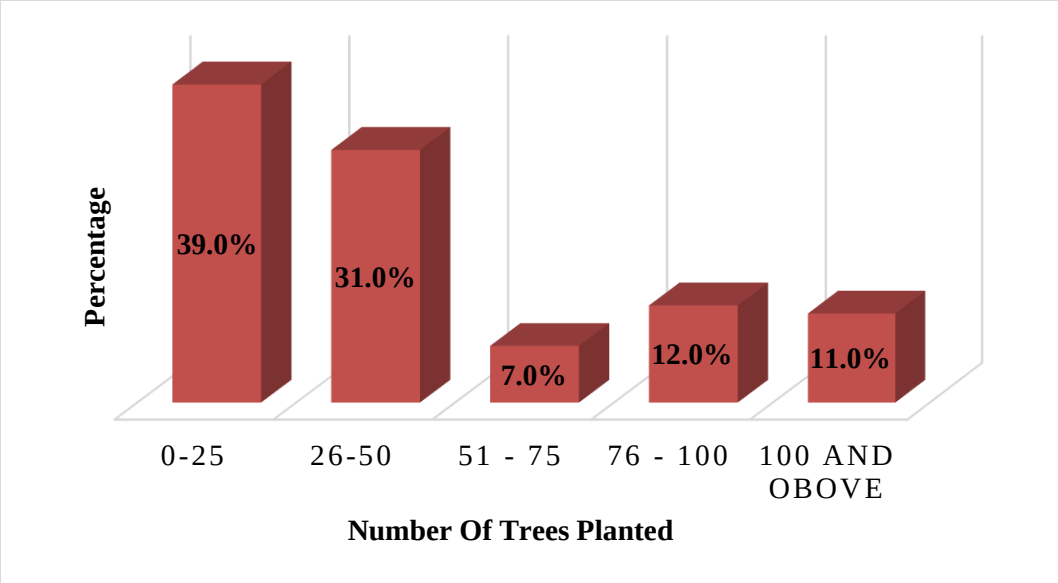


Figure 5.16 Number of Trees Planted within Household land per annum

Source: Field Survey, 2020

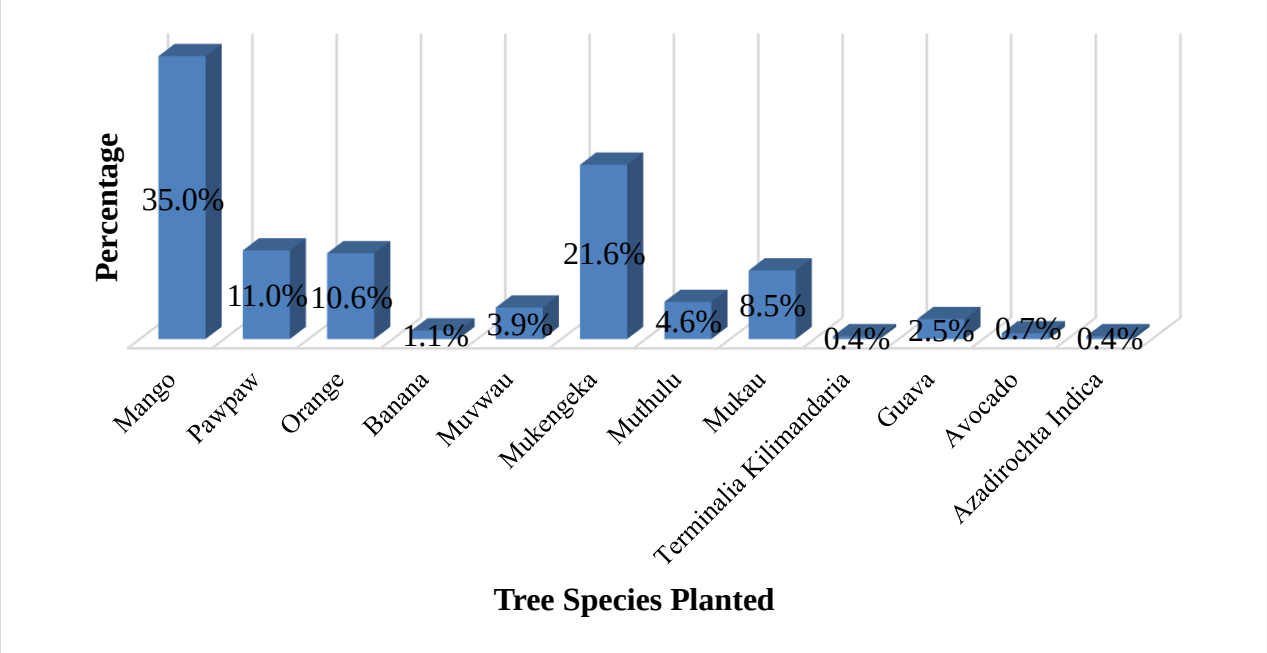


Figure 5.17 Tree Species Planted

Source: Field Survey, 2020

Plate 2: Mango trees intercropped with maize in the study area

Source: Field Survey, 2020

5.3.6 Forest cover change from 1990 - 2020

Forest cover analysis shows that Kyome/Thaana Ward had a forest cover of 60 per cent in the year 1990. The forest dropped to 27 per cent in the year 2000 as a lot of forest land was converted to other land uses. In the year 2010, the forest cover dropped to 21 per cent and finally dropped to 16 per cent in the year 2020. The following maps shows forest cover treads from the year1990 to year 2020.

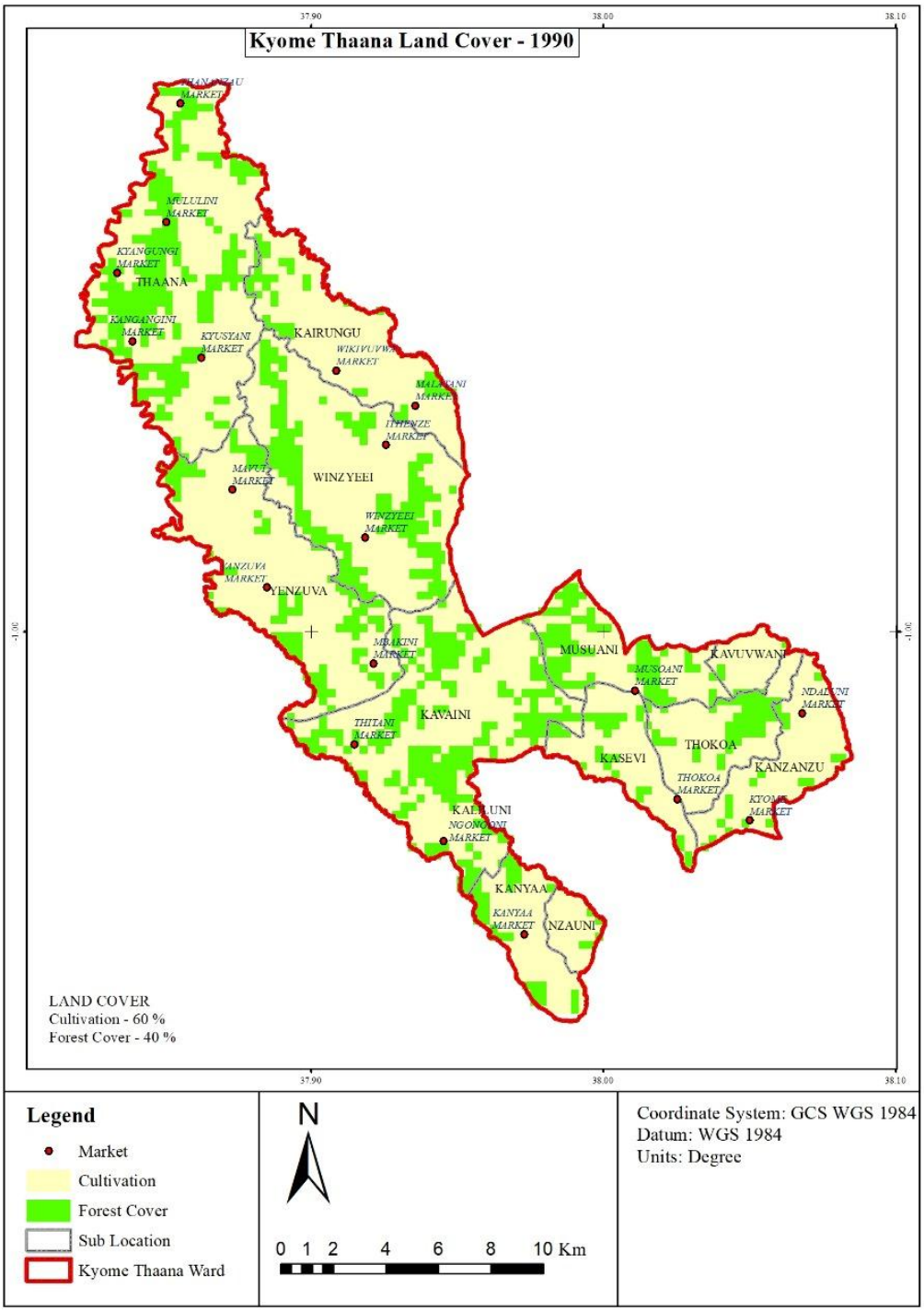


Figure 5.18 Forest cover map in the year 1990

Source: Author, 2020

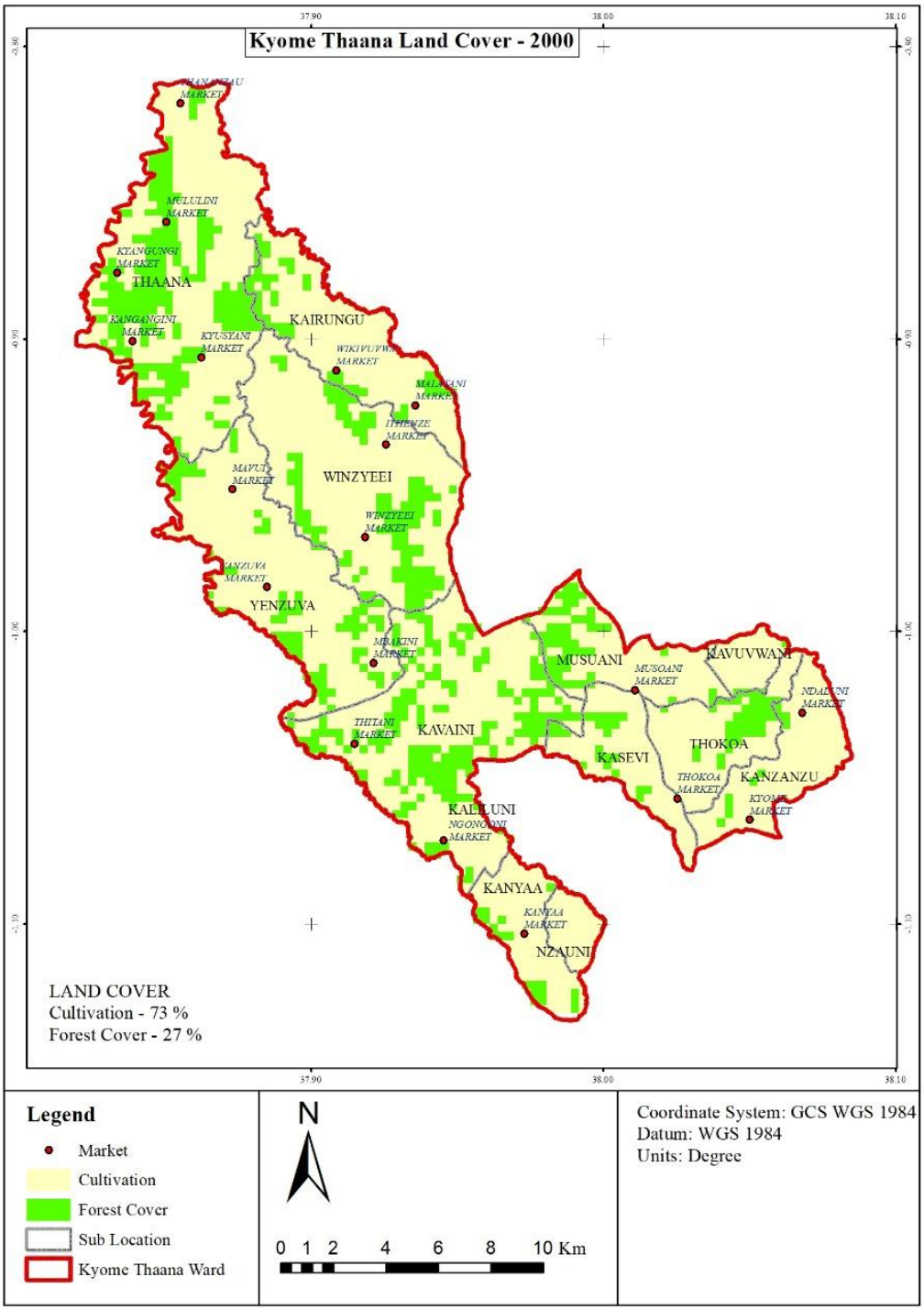


Figure 5.19 Forest cover map in the year 2000

Source: Author, 2020

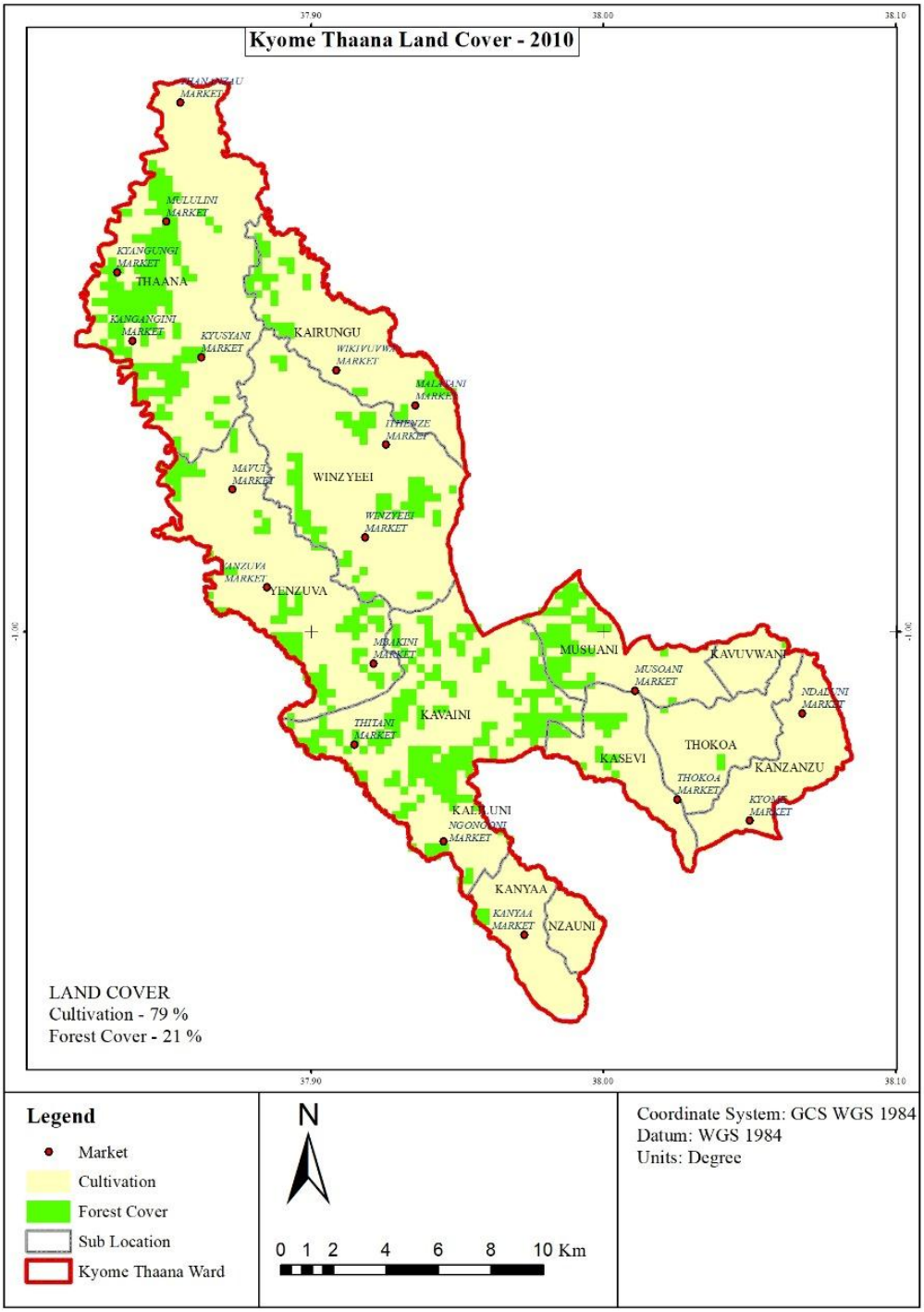


Figure 5.20 Forest cover map in the year 2010

Source: Author, 2020

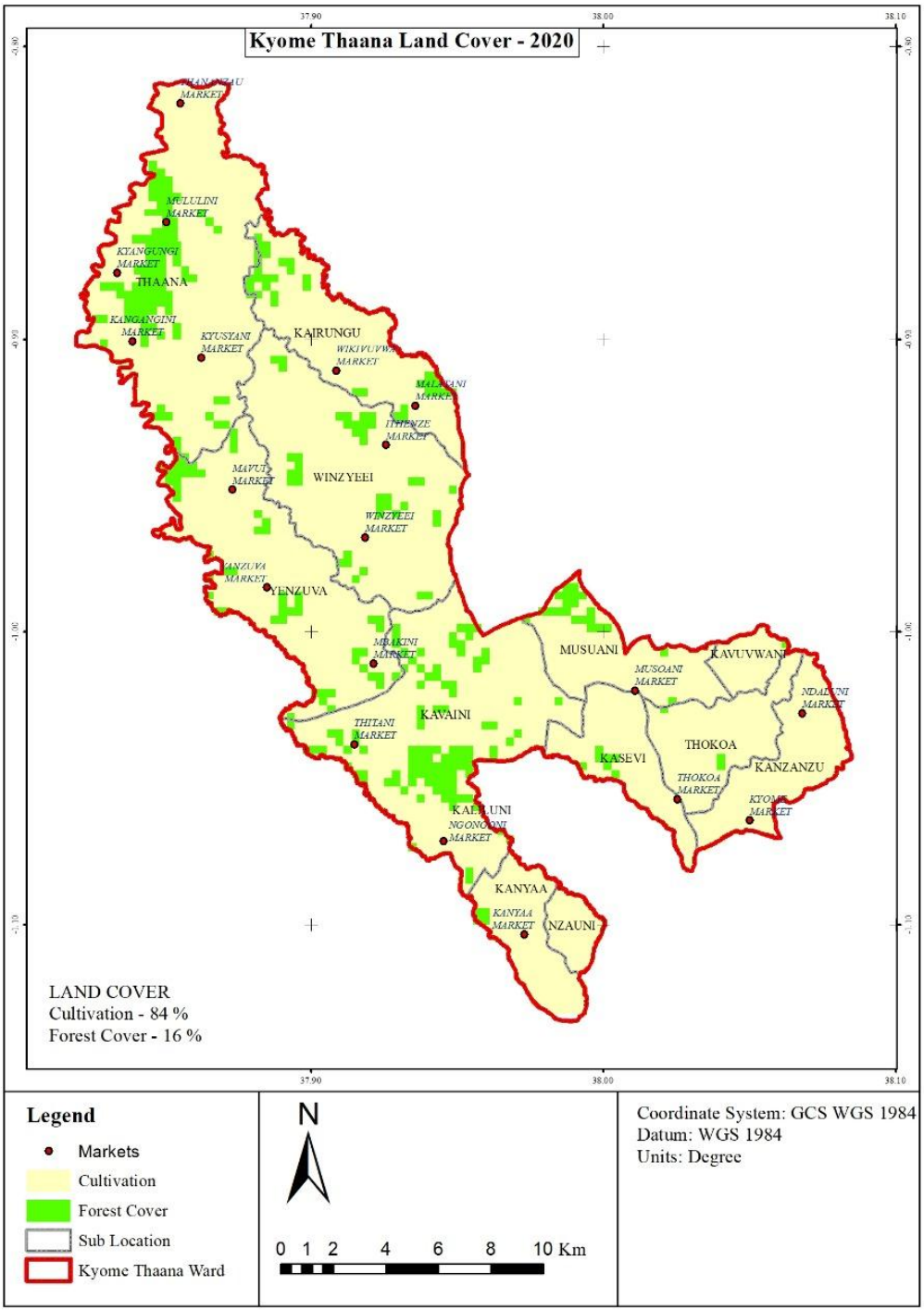


Figure 5.21 Forest cover map in the year 2020

Source: Author, 2020

5.4 Factors that contribute to variations to areas of land devoted to forest cover per household level in the study area.

According to the research findings, there many factors that contribute to variations to areas of land devoted to forest cover per household level in the study area. Literature review highlighted the following factors; Household size, Level of education of household head, Size of Land owned by the household, Household income, Preference for tree(s) on household land and Farming method used.

Correlation analysis and T-test were used to relate some of these factors with land devoted to forest cover within households in the study areas. Some of factors related included; Age and Land Devoted To Forest Cover, Gender and Land Devoted to Forest Cover, Education Level and Land Devoted to Forest Cover, Marital Status and Land Devoted to Forest Cover, Household size and Land Devoted to Forest Cover, Household income and Land Devoted to Forest Cover, Mode of Land Acquisition and Land Devoted to Forest Cover, Household Land Size and Land Devoted to Forest Cover, Acres Cultivated and Land Devoted to Forest Cover, Animal keeping and Land Devoted to Forest Cover and households visited by Visits By Extension Officers and Land Devoted To Forest Cover.

5.4.1 Age and Land Devoted To Forest Cover

There was a weak positive correlation ($r=0.051$, $p=0.620$) between age and land devoted to forest cover.

Table 5.2 Age and Land Devoted To Forest Cover

	Pearson value	P-value
Age	0.051	0.620

5.4.2 Gender and Land Devoted to Forest Cover

There was no significant association ($p=0.591$) between gender and land devoted to forest cover.

Table 5.3 T test between Gender of household head and Land Devoted to Forest Cover

	T value	Degrees of freedom	P-value
Gender	0.540	75	0.91

5.4.3 Education Level and Land Devoted to Forest Cover

There was a weak negative correlation (r=-0.024, p=0.823) between the level of education and land devoted to forest cover.

Table 5.4 Correlation of Education Level and Land Devoted to Forest Cover

	Pearson value	P-value
Level of education	-0.024	0.823

5.4.4 Marital Status and Land Devoted to Forest Cover

Marital status had a weak negative correlation (r= -0.110, p=0.282) with land devoted to forest cover.

Table 5.5 Correlation of Marital Status and Land Devoted to Forest Cover

	Pearson value	P-value
Marital status	-0.110	0.282

5.4.5 Household size and Land Devoted to Forest Cover

There was a weak positive correlation (r=0.081, p=0.430) between the household size and land devoted to forest cover.

Table 5.6 Correlation of Household size and Land Devoted to Forest Cover

	Pearson value	P-value
Household size	-0.081	0.430

5.4.6 Household income and Land Devoted to Forest Cover

Correlation analysis shows that there was a weak positive (r=0.049, p=0.0630) correlation between income and land area under forest cover

Table 5.7 Correlation of Household income and Land Devoted to Forest Cover

	Pearson value	P-value
Household size	-0.049	0.630

5.4.7 Mode of Land Acquisition and Land Devoted to Forest Cover

There was a significant association (p=0.038) between mode of land acquisition and land devoted to forest cover. The results indicated that people who inherited land had statistically higher land devoted to forest cover than those who bought.

Table 5.8 T-test between Mode of Land Acquisition and Land Devoted to Forest Cover

	T-value	Degrees of freedom	P-value
Mode of Land Acquisition	2.115	76	0.038

5.4.8 Household Land Size and Land Devoted to Forest Cover

Correlation analysis shows that land owned had a strong positive correlation (r=0.947, p=0.00) with land devoted to forest cover. The higher the land size in acres the higher the land devoted to forest cover.

Table 5.9 Correlation of Land Owned by household with Land Devoted to Forest Cover

	Pearson value	P-value
Land Size	r = 0.947	0.000

Correlation analysis also showed that land owned by father had a strong positive correlation (r=0.543, p=0.00) with land devoted to forest cover. The higher the land size in acres the higher the land devoted to forest cover

Table 5.10 Correlation of Land Owned By Parent with Land Devoted To Forest Cover

	Pearson value	P-value
Land Owned By Parent	r = 0.543	0.000

5.4.9 Acres of land Cultivated and Land Devoted to Forest Cover

There was a strong positive correlation (r=0.554, p=0.000) between land devoted to forest cover. The higher the land size in acres cultivated the higher the land devoted to forest cover

Table 5.11 Correlation of Acres Cultivated and Land Devoted to Forest Cover

	Pearson value	P-value
Acres cultivated	r= 0.554	0.000

5.4.10 Crops grown and Land Devoted to Forest Cover

There was a weak positive correlation (r=0.044, p=0.662) with land devoted to forest cover.

Table 5.12 Correlation of number of Crops grown and Land Devoted to Forest Cover

	Pearson value	P-value
Crops grown	0.044	0.662

5.4.11 Livestock keeping and Land Devoted to Forest Cover

There was a significant association (p=0.007) between livestock keeping and land devoted to forest cover. Respondents who kept animals had statistically significant higher land devoted to forest cover.

Table 5.13 T Test Animal keeping and Land Devoted to Forest Cover

	T value	Degrees of freedom	P-value
Animal keeping	-2.869	35	0.007

5.4.12 Visits By Extension Officers and Land Devoted To Forest Cover

There was no significant association (p=0.216) between households visited by extension officer and the land size devoted to forest cover.

Table 5.14 T-Test Visits by Extension Officers and Land Devoted To Forest Cover

	T-value	Degrees of freedom	P-value
Visits by Extension Officers	1.260	35	0.216

From the above analysis, it was found that factors that contribute to variations to areas of land devoted to forest cover per household level in the study area include the following; Household land size, the higher the land size in acres the higher the land devoted to forest cover. Mode of land acquisition also contributes to these variations as it was found that people who inherited land had significantly higher land devoted to forest cover than those who bought. The analysis shows that there was a strong positive correlation between the land cultivated and land devoted to forest cover.

The higher the land size in acres cultivated the higher the land devoted to forest cover. There was also a significant association between the number of livestock kept and land devoted to forest cover. Respondents who kept larger number of livestock had statistically significant higher land devoted to forest cover. Finally, it was observed that the households that plant most number of trees per year have larger pieces of land devoted to forest cover.

5.5 Hindrances to increasing and Sustaining Forest Cover in the Study Area

There are many hindrances that stand on the way of increasing and sustaining forest cover in the study area. These factors can be classified into human hindrances, policy hindrances, institutional hindrances, and physical environment hindrances

5.5.1 Human hindrances

5.5.1.1 Conversion of Forest Land into Farmlands

Transformation of woodlands into cropland is the fundamental driver of the expanding deforestation in dry terrains. The growing population and un-regulated conversion of woodlands into farmlands is probably is the main reason for loss of forest cover in the study area. The commonly used method of bush clearing using open fires leads to loss of bio-diversity, soil nutrients and eventually fertility.

Plate 3: Clearing of forest land to cropland using open fire in the study area

Source: Field Survey, 2020

5.5.1.2 High Rate of Land Sub- Division

As observed earlier in the analysis, inheritance is the main mode of land acquisition in the study area and in majority of the households, land is subdivided among the sons by the parents. As a result, in most of households the current, land sizes are between 0-5 acres. As observed during the field study, within 0-5 acres, very little land is allocated to forestry, as most land is used for farming and setting up of the household physical structures.

5.5.1.3 Overreliance on the forest resources for energy

From the study findings, 100 percent of households in the study area use firewood for cooking, while 96 percent use charcoal too. Within the high income households (45 percent) also use liquefied petroleum gas (LPG) for cooking. Most of the respondents indicated that LPG is used occasionally during the rainy seasons or during family events.

Plate 4: Women carrying firewood from private forests within the study area

Source: Field Survey, 2020

Table 5.15 Sources of Cooking Energy in the Study Area

COOKING ENERGY SOURCE	NUMBER OF HOUSEHOLDS	PERCENTAGE
Firewood	100	100%
Charcoal	96	96%
LPG	17	17%
Electricity	5	5%
Paraffin	2	2%

5.5.1.4 Energy wastage and unsustainable cooking practices

Results show that 38.6% of the respondents used firewood as main source while 37.1% used firewood and charcoal.

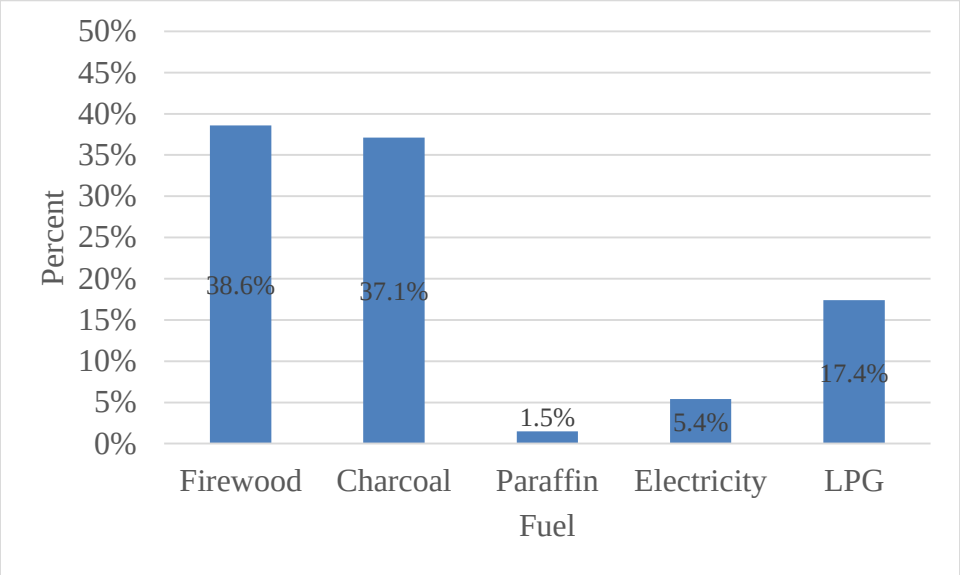


Figure 5.22 Main Fuel Used by Respondents for Cooking

Source: Field Survey, 2020

Majority of the respondents constituting 57 percent have heard of energy saving cooking stoves while 43 percent have not heard of them and use traditional three stone fire place which contribute to wastage of cooking energy hence firewood is consumed faster.

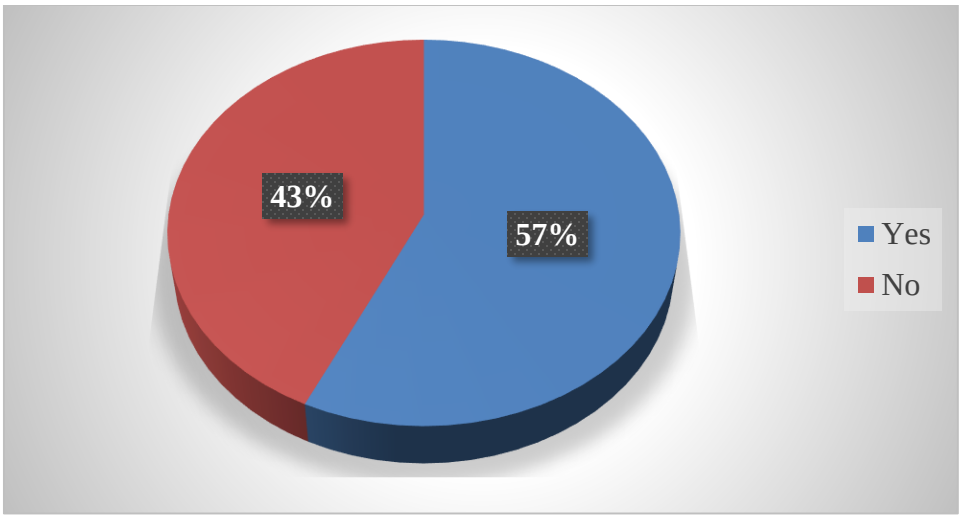


Figure 5.23 Heard Of Energy Saving Jikos

Source: Field Survey, 2020

5.5.1.5 Harvesting Of Trees for Illegal Charcoal Production

According to the study findings, 74 percent of respondents harvest trees for charcoal production which is either used for domestic or commercial purposes. Twenty six percent do not harvest trees for charcoal production. In addition, in a few cases, trees are harvested for timber and construction poles.

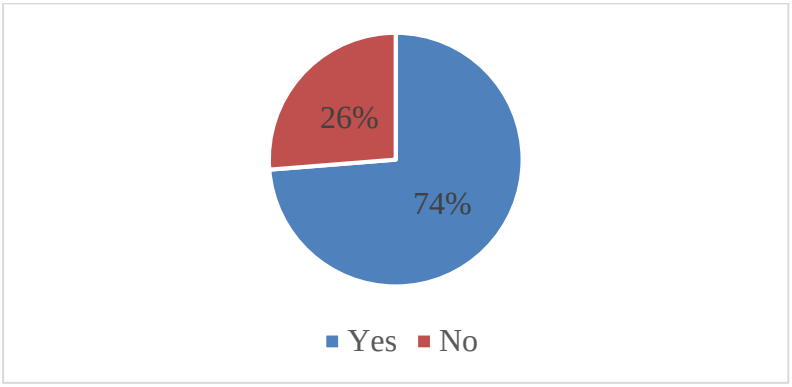


Figure 5.24 Harvesting Of Trees for Illegal Charcoal Production

Source: Field Survey, 2020

Plate 4: Charcoal dealers carrying a sack full of charcoal from a private forest

Source: Field Survey, 2020

5.5.2 Physical environment hindrances

5.5.2.1 Harsh Climatic Conditions and Lack of Adequate Water Resources

Kyome –Thaana Ward lies in arid and semi-arid area and experience hot and dry climatic conditions which make it difficult for trees to grow. From the study findings, 78 percent of respondents experience acute water changes in dry seasons of the year and some travel for very long distances to look for water for domestic use and also for livestock.

5.5.2.2 Poor soil fertility

Soils in arid and semi - arid areas are generally fragile and of low inherent producing capacity. The study area as observed during field study, has hihly erodible, relatively shallow, sticky, red, black, and brown clay and sandy soils which have relatively low soil fertility. Soil nutrient management is needed and will form a critical component for successful forestry.

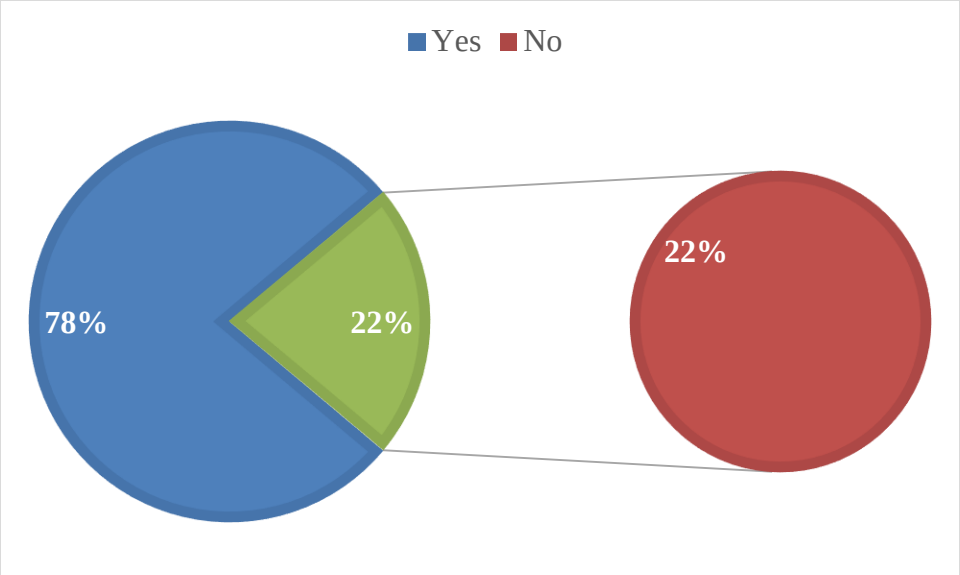


Figure 5.25 Adequacy of Water Supply

Source: Field Survey, 2020

5.5.3 Institutional hindrances

Forest institutions within the county authorities play a key role in promoting forestry in rural areas by educating communities on drought resistant species of trees which can survive in the study area. However, according to the key informant interviews, these institutions are currently understaffed and lack adequate financial resources to play their functions effectively. As a result, 89 percent of respondents have never been visited by a forest extension officer.

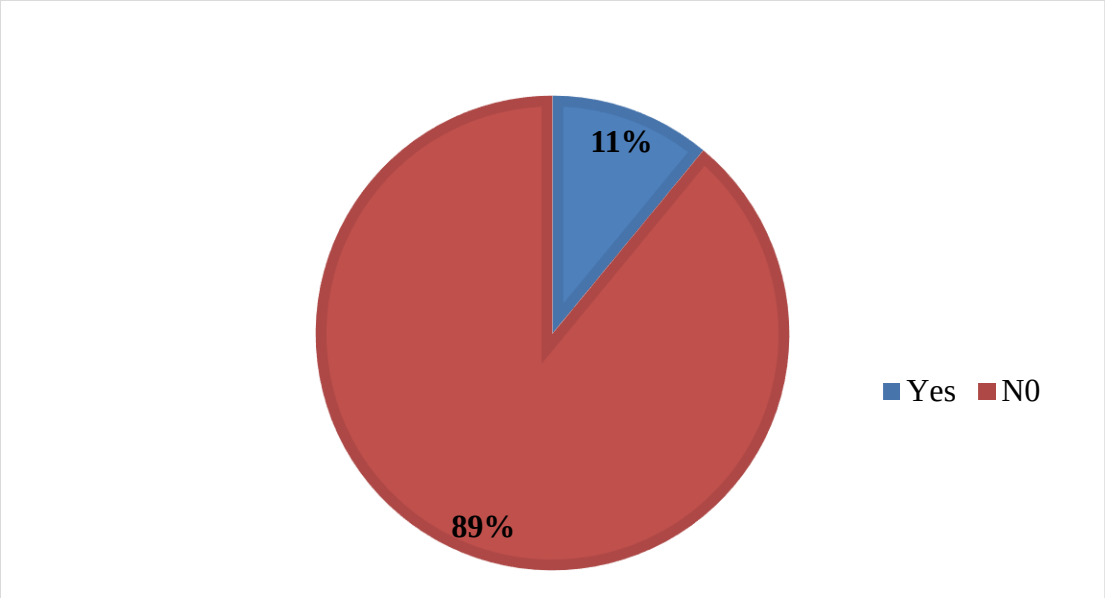


Figure 5.26 Visited By Forest Extension Officer

Source: Field Survey, 2020

5.5.4 Legislation and policy hindrances

The forestry sector has been characterized by ineffective regulatory mechanisms and inadequate law enforcement in the study area. The promulgation of the Constitution 2010 brought new requirements for natural resource management such as public participation, community and gender rights, equity in benefit sharing, devolution and the need to achieve 10% forest cover among others. These challenges are compounded by dwindling public land meaning that forestry development has to expand into private and community land, which need incentives and clear methods of engagement to encourage investments in commercial forestry on private land. Lack of the ability to enact laws and policies by both national and county governments to address these new dynamics has resulted to land use conflicts within private land holdings, with track of forest land being converted to farmlands.

While the Kitui County had enacted the Kitui County Charcoal Management Act in 2014, implementation of the act has been challenging. One such challenge is the overlapping mandates between agencies, with many institutions perceived to be controlling, guiding and regulating wood fuel value chains which have led to harvesting of millions of trees and clearance of forests.

Kitui County instituted a ban on charcoal movement out of the county in addition to the national logging moratorium. This affected commercial charcoal production despite local production on private land being permitted. Furthermore, wood fuel value chain governance is complicated by weak coordination and duplicity of roles among key government players in the county and other stakeholders as revealed by key informants.

5.5.5 Opportunities for sustainable forestry in the study area

The study also found that, amidst the development challenges cited in the above chapters, there were various forest based opportunities which can be exploited to enhance the growth and development of the region.

(i) The study established that average land holding size was 5 acres per household. This presents an opportunity to adopt forestry activities within the household land, and still maintain other land uses like settlements and crop farming, or integration of these land uses
(ii) The high population growth presents an opportunity in labour provision in carrying out forestry activities like tree planting, watering of tree seedlings and industrialization in timber products.
(iii) High demand for timber, charcoal and fuelwood in the country is an opportunity for rural households to grow trees for commercial timber, charcoal and fuelwood production of the same and boost their incomes and livelihoods

5.6 Findings on Planning Interventions That Could Increase Household Forest Land Cover in the Study Area

The investigation tried to build up intercessions which could expand family woodlands cover in the study territory. As indicated by the investigation discoveries, coming up next are the elements that could expand family forest land cover in the examination territory.

5.6.1 Maintain Land Size That Are Sustainable

From the study findings, 56.4 percent of the respondents thought that size of the household land is the main factor that determines the size of land set aside for forest cover. Households with large pieces of land had larger pieces of land set aside for forest cover. However, continued land subdivision has led to small pieces of land which are not sustainable for both agriculture and forestry.

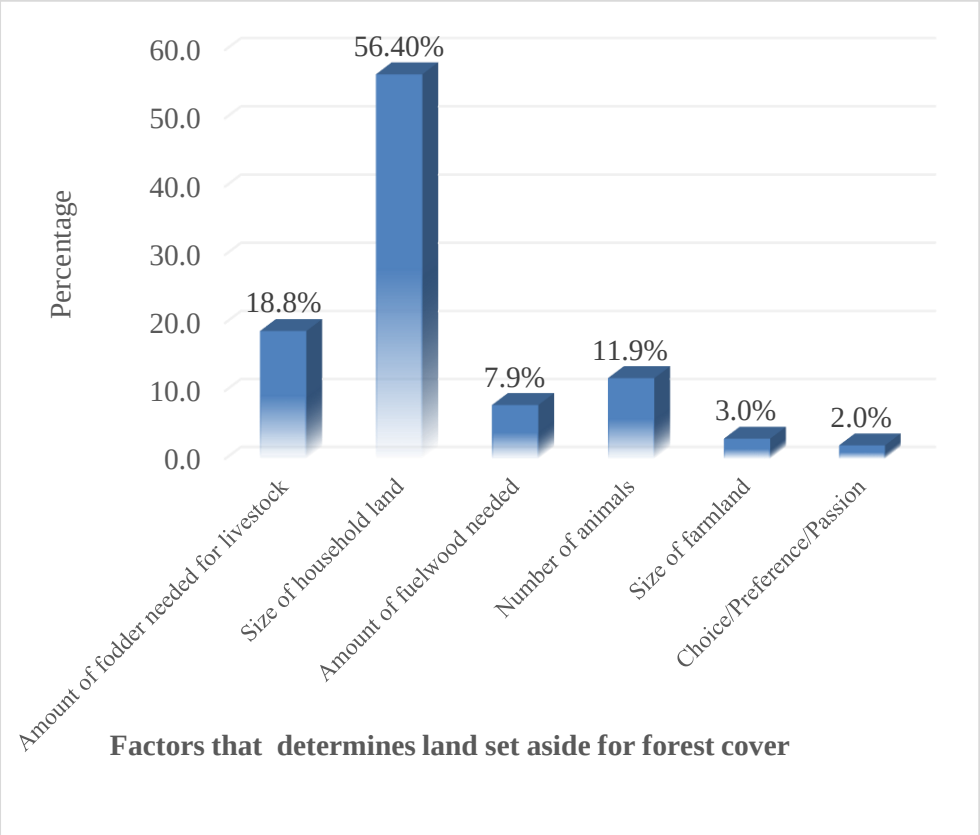


Figure 5.27 Determinants of Land Set Aside For Forest Cover

Source: Field Survey, 2020

5.6.2 Provide adequate tree seedlings and tree nurseries

According to the study findings, there is no single tree nursery in the study area. Tree nurseries are found within major towns like Mwingi and Migwani, which are both more than 20 kilometers from the study area. From the study findings, 59.8% of respondents obtain tree seedlings from Mwingi

town, 34.3% of respondents obtain tree seedlings from Migwani town, 4.9% of respondents obtain tree seedlings from the Eastern by-pass in Nairobi, while 1% of the respondents obtain tree seedlings from Kirinyaga.

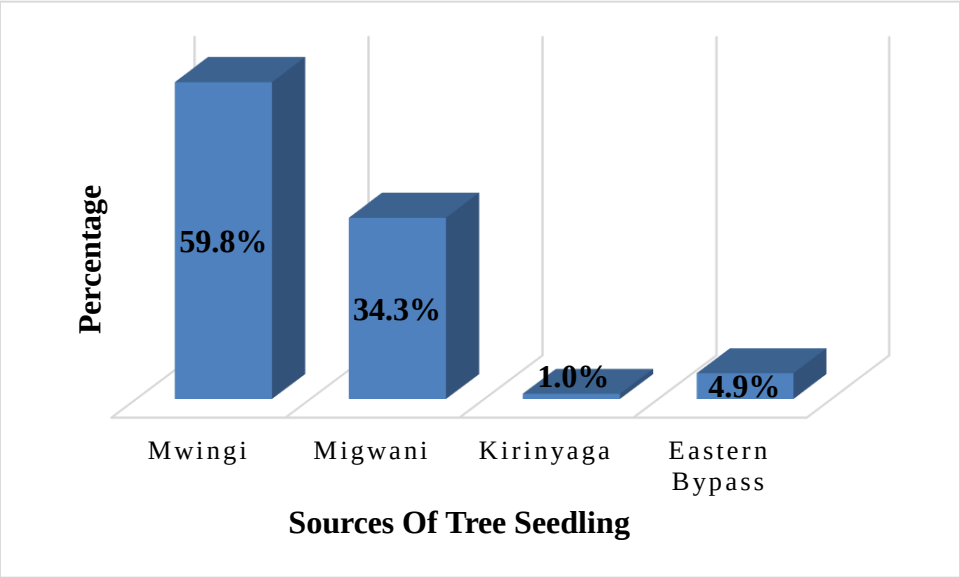


Figure 5.28 Where Tree Seedlings Are Obtained

Source: Field Survey, 2020

5.6.3 Provide water

Water availability affect development of both natural and planted forests. Up to 41 percent of the respondents highlighted from their own experience, provision of adequate water resources through boreholes or dams could motivate locals to plant trees hence increasing household forest cover.

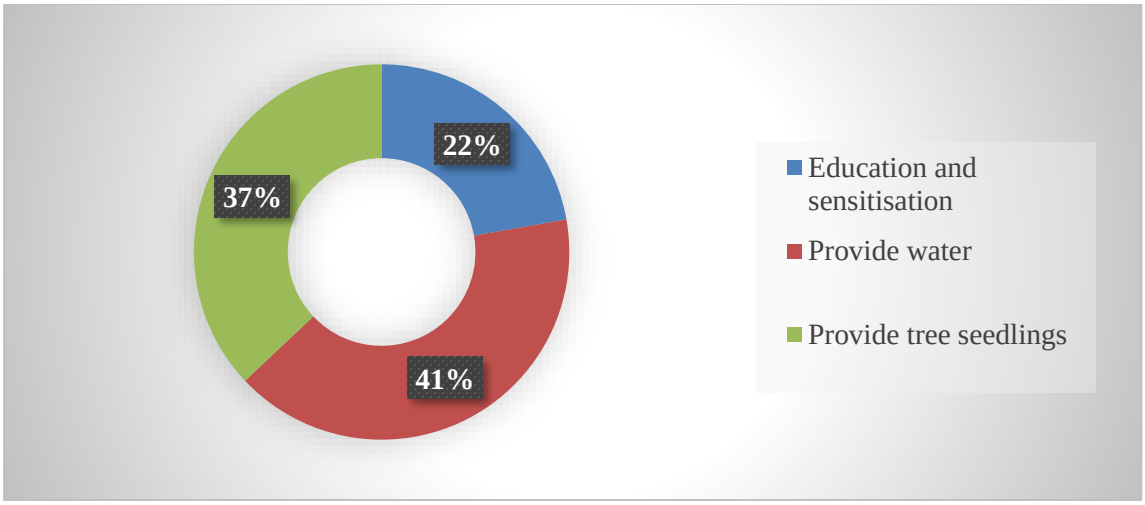


Figure 5.29 Strategies to Increase Household Forest Cover

Source: Field Survey, 2020

5.6.4 Education and Sensitization campaigns

According to the study findings, 22 percent of respondents highlighted that education, research and sensitization campaigns will mobilize people to plant more trees and conserve natural forests

5.7 Hypothesis Testing

5.7.1 Land Sizes and Land Area under Forest Cover

The first null hypothesis of the study indicated that households with larger land sizes have equal or lower land area under forest cover than those with smaller land sizes. To test the hypothesis, correlation analysis were conducted. There was a significant difference r = 4.225, p=0.000 in land area. The first hypothesis is therefore rejected and the first alternative hypothesis is retained. The study concludes that households with larger land sizes have significantly higher land area under forest cover than those with smaller land sizes.

Table 5.16 T Test between Land Sizes and Land Area under Forest Cover

	T value	Degrees of freedom	P-value
Land size	-4.225	35	0.000

5.7.2 Income and Land Area under Forest Cover

The second null hypothesis of the study indicated that households with higher incomes have equal or lower land area under forest cover compared to households with low income. To test the hypothesis. Results in Table 5.16 shows that there was no significant difference (t(98) =0.337, p=0.737).between income and land area under forest cover. The second null hypothesis is retained while the second alternative hypothesis is rejected. The study concludes that households with higher incomes have equal or lower land area under forest cover compared to households with low income.

Table 5.17 T-Test of forest land cover for high income and low income households

	T value	Degrees of freedom	P-value
Income	0.337	98	0.737

CHAPTER SIX: STUDY CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter comprises of two sections: Section two contains conclusions on the study findings while the last section provides recommendations as to how to increase household forest land cover in the study area.

6.2 Summary of findings

6.2.1 Average Area of Land under Forest Cover

The first objective of the study sought to determine the average area of land under forest cover at household level in Kyome /Thaana Ward. From the study findings, 35.9 percent of the respondents indicated that they have 0 to 2.5 acres of land under forest cover, 30.8 percent of the respondents indicated that they have 5.1 to 7.5 acres of land under forest cover. The average land under forest cover at household level in the study area was 5 acres. Research finding showed that households with large pieces of land have large areas of land allocated to forest cover.

6.2.2 Factors That Contribute To Variations in Areas of Land Devoted To Forest Cover

The study sought to establish factors that contribute to variations in areas of land devoted to forest cover at household level in the study area. There was a significant association ($p=0.038$) between mode of land acquisition and land devoted to forest cover. Correlation analysis shows that land owned has strong positive correlation ($r=0.947$, $p=0.00$) with land devoted to forest cover. Correlation analysis also showed that land owned by father had a strong positive correlation ($r=0.543$, $p=0.00$) with land devoted to forest cover. There was a significant association ($p=0.007$) between livestock keeping and land devoted to forest cover. Land size owned by the household was found to be the main factor that influence decision by household head to have either small or large size of their land under forest cover.

6.2.3 Hindrances to Sustaining Forest Cover in the study Area

The study assessed the hindrances that stand on the way of increasing and sustaining forest cover in the study area. Population expansion and conversions of forest land cover to farm lands and

settlements is one of the greatest hindrance in the study area. Flat and readily available forests with high-fertility soils appear to be the most susceptible to agrarian conversion. High poverty and dysfunctional farming systems often strain forestry, with people finding economic opportunities on the forest border, such as production of charcoal. From the study findings, many household heads sub - divide their land among their male children as part of their inheritance from their male parents. This trend could result to unsustainable land sizes in the future. The small land sizes have led to low agricultural production and low forest cover. Mobilization of financial resources for investment in forestry within households is another recommendation to increasing and sustaining forest cover in the study area. Forest production, which produces common goods and services, is a long-term, capital-intensive investment. The county government of Kitui should explore possibilities for further funding of growth of the forestry sector in order to sustainably maintain, control and support forestry operations, as well as encourage private sector investment.

6.2.4 Planning Interventions that Could Increase Household Forest Land Cover

The study also sought to propose planning interventions that could increase household forest land cover in the study area. Planning interventions need to be applied to prevent further land sub-division. Stakeholders need to come together and rethink some of the traditions in the study area, like sub – division of land as part of inheritance for children and provision of alternatives. Provision of adequate water for domestic use and irrigation farming could help to increase household forest cover. This is because less land will be required for crop production. Notable observation showed that there is overdependence on rain fed agriculture and with majority of household heads engaging in farming as their main occupation. Changes in climate and environment adversely affects livelihoods as household food security is in all circumstances affected.

There is need to provide adequate tree seedlings and tree nurseries in the study area. According to the research findings, there is no single tree nursery within the study area hence people travel for long distance (over 40 km) to buy tree seedlings as tree nurseries are only located in major towns. Adoption of alternative sources of energy for cooking such as biogas and LPG will ease pressure on available forest resources. The study established that over 90 percent of households use firewood and charcoal for cooking and many trees are harvested annually to meet energy needs.

Education and sensitization of the community on the importance of trees to the environment and livelihoods in rural areas is paramount for forest management and conservation. Strong forestry institutions need to be put in place in the study area. According to the study findings, 89 percent of respondents have never been visited by a forest extension officer.

6.3 Conclusion

Although the rate of global net forest loss slowed from an average of 7.3 million hectares per year in the 1990s to 3.3 million hectares per year in 2010–2015 (FAO, 2015a), deforestation remains a matter of deep concern (UN, 2015b). Given that private land holdings own 11% of the world's existing forests and the majority of farm land, land-use policies within private land holdings play a critical role in forest management, environmental resources, and biodiversity (FAO, 2018). Planning interventions towards the loss of forests will benefit millions of people, including many of the world's poorest people. It will also help combat climate change, protect habitats for 75 percent of the world's terrestrial biodiversity, and maintain ecosystem resilience – thereby supporting sustainable rural livelihoods.

The study concludes that there are many factors that determine the proportion of land devoted to forest cover at the household level in rural arid and semi – arid areas which include household land size, farming methods used, number of trees planted per year, and household head passion and preference to retain forest on the household land.

While Kenya aims to attain 10 percent forest cover by year 2030, deforestation and forest cover loss due to population increase and conversion of forest land to farmlands, human settlements and infrastructure developments and overreliance on biomass energy for heating and cooking have undermined efforts of increasing and sustaining forest cover in rural arid and semi – arid areas.

To protect the country's forest cover, efforts must be made on both the supply and demand sides. On the supply side, tree planting and forest farming promotion are expected, while on the demand side, implementation of alternative cooking technologies such as biogas and LPG could reduce pressure on the forest cover.

6.4 Recommendations

Based on the findings, the following recommendations are made to address the identified impacts.

6.4.1 Average Area of Land under Forest Cover

This study recommends at least 10 percent of each household land to be used for forest cover in the study area. The state has been prevailing upon Kenyans within private land holdings to plant trees on 10% of their land as one way of increasing the shrinking forest cover. Under a draft forest policy 2020, the government says it cannot achieve 10 per cent cover by only focusing on gazetted forests on public land managed by Kenya Forest Service. The Constitution states that the country shall raise and retain tree coverage to at least 10% of the total area of the soil. Article 69(1)(b) highlights the need for a tree coverage of at least 10% of Kenyan land area "working to attain and sustain"”.

6.4.2 Factors that Contribute To Variations in Areas of Land Devoted to Forest Cover

This study recommends livelihood diversification within the study area. This will ease pressure on the forest resources and overdependence on rain fed agriculture. In addition, it will help increase income levels within the households hence alleviating poverty. Promotion of adoption of enterprises like apiculture, commercial forestry, weaving and basketry and light industries. Apiculture for example, Kitui County has over 5000 beekeepers with an estimated 30,000 traditional beehives that once value addition measures are introduced, the residents will build a perfect brand for locally produced honey to boost the multi-million industry and ease dependence on rain-fed agriculture and tree harvesting for charcoal production. The government in partnership with other private and civil society organizations should develop strategies to reduce reliance on rain-fed agriculture by encouraging and promoting irrigation farming and forestry to mitigate the effects of climate change

6.4.3 Hindrances to Sustaining Forest Cover in the Study Area

Adoption of alternative sources of energy and fuel efficient cooking methods is highly recommended within the study area. This will include solar energy, bio-gas, electricity and LPG

gas in place of firewood and charcoal. Both the governments at national and county should set up clear arrangement, lawful and institutional systems to endorse suitable least conservative and ideal horticultural land sizes in the investigation region and other biological zones of the country.

Laws guiding subdivision/fragmentation of agricultural land should be observed through enhanced surveillance by the Government of Kenya. Individual titles should have restrictions on the minimum allowable sizes. Parents should identify alternative ways of bequeathing wealth to their children rather than land. Such mechanisms would include shares in the stock market and in companies among others or even operate businesses which they can run across generations.

Mobilization of financial resources for forestry within households in rural areas is another recommendation to increasing and sustaining forest cover in the study area. Forest production, which produces common goods and services, is a long-term, capital-intensive investment. The national and county governments should explore possibilities for further funding of growth of forestry sectors in order to sustainably maintain, control and support forestry operations, as well as encourage private sector investment.

Any tree planting must succeed with a sustainable supply of high-quality tree seedlings. The following measures are required to encourage the development of seedlings of high quality. Secure tree seeds through science and technology, Improve KFS tree nurseries capability within the field of study; Create model tree nurseries to produce seedlings of 20,000 seedlings per year and ensure tree nurseries are evenly distributed in the study area for example one tree nursery in every sub location

Training, literacy and awareness of tree cultivation in rural households. Educate, sensitize and sensitize the public to the use of trees. Initiating, developing and implementing a comprehensive communication strategy for tree cultivation, media campaigns by printing, electronic and social platforms, the organization of field days, exhibitions, events and the use of other national and global tree cultivation events, for example the World Environment Day, the World Day for Combating Desertification, and the World Wetland. Forestry regeneration research, science and advances on tree cultivation in rural households. Use the new forestry, defense and planting technology. Participatory technology creation is highly recommended, which promotes innovation

through farmer-driven technology through participatory processes and experimental skills that enable small farmers to make smarter choices about available technologies.

6.4.4 Planning Interventions That Could Increase Household Forest Land Cover

6.4.4.1 Proposed overall planning strategy: Communal rural settlements.

The study found out that the area has weak settlement systems due to dispersed settlement patterns. Population expansion and conversions of forest land cover to farm lands and settlements has become one of greatest hindrances to increasing and sustaining forest cover. The study recommends communal settlements like the case of Charlottenburg, a communal settlement in Romania where people live in communal villages while the rest of the land is left for farming and forestry, refer to plate 6 below. Human settlement planning seeks to improve the quality of the life of people with full respect for indigenous, cultural and social needs. Settlement re-organisation will make it easier for provision of infrastructure and other utilities which are currently lacking with the current settlement patterns in Kyome/Thaana Ward, and increase forest cover to sustainable standards.

The settlements are to be provided with adequate amenities such as schools, health facilities, social hall, electricity, police post among other services required of a complete neighbourhood. The study recommends harnessing of the cheap renewable energy i.e. sun and wind to provide for electricity for domestic use in the communal villages to solve the problem of overreliance on biomass energy. The communal villages will also take advantage of the high water table to sink boreholes to ensure adequate water for domestic and livestock use in the villages. The study recommends that the people in the villages form neighborhood associations which will consequently help in enhancing security within the villages as well as an organised decision making channel and information sharing. During re-organization of the settlements, particular attention to be paid to:

(i) Appropriate location of market places, community centers, potable water supply, health and education facilities and transport services including loading terminals;

(ii) Respect for local customs and traditions as well as to new needs and requirements;

(iii) Use of local resources and traditional techniques and styles of construction.

(iv) Beautification of human settlements through tree planting

Communal villages provide a means to realize the dream of having rural communities based on social equality, co-operation and mutual aid as well as to increase agricultural output and lead to sustainable forest cover in a region otherwise regarded as unproductive. The rest of the land surrounding the communal villages is left for agriculture and forestry.

Implementation of this model may face resistance from the local community who have strong cultural ties to their current households. Financial implications i.e. a lot of finances will be required to implement the communal villages.

Plate 6: Aerial view of Charlottenburg, a communal settlement in Romania

Source: (Rhard B, 2004)

6.4.4.2 Innovative farming methods

Innovative farming methods should be introduced in the study area for example crops could be intercropped with trees in the same spatial arrangements. Farmers with small pieces of land can

also practice agro-forestry with melia volkensii tree species. In the first three years of its growth, it can be intercropped with maize. Where growth spacing is 4 by 4 meters melia volkensii, can be intercropped with cereals like peas, green grams, and cowpeas for up to six years, without interfering with their yields, (KEFRI, 2016). According to KEFRI, *Melia volkensii* is proving economically and environmentally viable to plant in Kitui, as it cushions against climate change, and provides profitable timber, as end product.

Plate 7: Agro-forestry practice by a small-scale farmer in the study area

Source: Field Survey, 2020

6.4.4.3 Friendly environment for private sector investments in forestry

The development of environmentally-friendly landscapes for private sector land investment is an excellent approach for increasing forest cover in the field of research. Many countries have built effective conditions to boost private forest investment. In order to encourage private sector investment in, for example, Chile, China, Costa Rica, Turkey, Uruguay and Vietnam, favor some investment policy has performed a significant leveraging role. The benefits to encourage forests include subsidized credit, import subsidies, and tax cuts (Gregersen et al).

6.4.4.3 Improved infrastructure

Improve road, power, and water and markets infrastructure. Local communities cannot participate in forestry activities due to limited access to these infrastructure facilities, particularly water. Farm ponds are fast emerging as novel piers in the vast semi-arid ecosystems of Kitui County, Eastern Kenya, to foster integrated climate-smart technologies through Drylands Development. Therefore the study recommends adoption of farm ponds for water harvesting by a small-scale farmers to solve the problem of inadequate water shortage and enhance forestry activities

Plate 8: Farm pond for water harvesting by a small-scale farmer in the study area

Source: Field Survey, 2020

6.4.4.4 Improved forest institutions capacity

Increase forestry institutions capacity. Adopt multi-sector and multi-institutional plans to legitimize national policies and improve rural forestry governance and management. Provide them with adequate personnel and financial resources to enable effective service delivery. Good governance requires effective institutions as well as a sound policy and legal framework. The institutional framework should encompass local communities, civil-society organizations and responsible private-sector interests, as well as government departments and agencies. It may require building the capacity of organizations that support indigenous peoples, local communities and smallholders as well as the strengthening of public-sector organizations (including their capacity to facilitate participatory approaches).

6.4.4.4 Adoption of forestry as commercial enterprise

Adoption of forestry as a commercial enterprise in Kitui. Kitui and other Kenya's semi-arid regions grappling with climate change, rural communities are turning their attention to growing the drought tolerant *Melia volkensii* (mukau) tree. This fast maturing hardwood tree dubbed the mahogany of the dry lands, has many uses, and its timber is lucrative and in demand. A hectare of mature melia volkensii trees, can earn a farmer over Kshs3 million (USD $30,000), according to the Kenya Forestry Research Institute (KEFRI), and harvesting can begin at 10 years in ideal weather conditions. According to Albert Luvanda a Principal Research Officer with KEFRI-Kitui, melia volkensii's wood is comparable to Elgon teak, or camphor. That has made the tree be over exploited in forests, and created the need to replenish it, in its indigenous ecologies. Kitui, Tharaka Nithi, Embu, Meru, Taita Taveta, Makueni, Marsabit, Kibwezi, Isiolo and Mandera are some ecological regions the tree is suited to grow.

Plate 9: Private investment of *Melia volkensii* (mukau) by a small-scale farmer in the study area

Source: Field Survey, 2020

6.4.4.4 Forest restoration through natural and artificial regeneration

Forest regeneration is the process by which new tree seedlings become established after forest trees have been harvested or destroyed. Regeneration is key to sustainable forestry and can be applied in the study area. Forest regeneration is the act of renewing tree cover by establishing young trees naturally or artificially-generally, promptly after the previous stand or forest has been removed. The method, species, and density are chosen to meet the goal of the landowner. Forest regeneration includes practices such as changes in tree plant density through human-assisted

natural regeneration, enrichment planting, reduced grazing of forested savannas, and changes in tree provenances/genetics or tree species.

6.4.4.5 Homestead beautification through tree planting

Innovative planning within the human settlements which include use of trees as landscaping elements, boundary elements, hedgerows, windbreaks and orchards. Trees have the ability of bringing micro – climate elements, as well as creating beautiful living environments. One of the most attractive and uncompetitive niches for trees is the agricultural borders. In rows or strips around fields, pastures and complexes, multipurpose trees may be planting to delimit borders and to shield areas from wildlife and human invasion.

Plate 10: Homestead beautification through trees planting in the study area

Source: Field Survey, 2020

6.5 Suggestions for further studies

Due to limited time and resources, the study focused on determinants of forest cover in rural arid and semi-arid lands. However, there is need for further studies on two topics. First is the need to assess the role of land use planning in scaling-up agroforestry Activities in rural arid and semi-arid areas. Secondly, Potential of *Melia volkensii* tree growing to spur economic development in rural arid and semi-arid areas.

REFERENCES

Acharya, Y., Naz, S., Galway, L. P., & Jones, A. D. (2020). Deforestation and Household-and Individual-Level Double Burden of Malnutrition in Sub-saharan Africa. *Frontiers in Sustainable Food Systems*, *4*, 33. How Are Local People Driving and Affected by Forest Cover Change? Opportunities for Local Participation in REDD+ Measurement, Reporting and Verification

Adetoye A. et al. (2018). *Determinants of forest land use decisions among rural farm households in south-western Nigeria.*

Adetoye et al. (2017). *Agroforestry Practices and Carbon*. Retrieved from http://doi.org/10.4172/2157-7617.1000417. Accessed 27th September, 2019

Agarwala, M., Ghoshal, S., Verchot, L., Martius, C., Ahuja, R., & DeFries, R. (2017). Impact of biogas interventions on forest biomass and regeneration in southern India. *Global Ecology and Conservation*, *11*, 213-223.

Agidew, A. M. A., & Singh, K. N. (2017). The implications of land use and land cover changes for rural household food insecurity in the Northeastern highlands of Ethiopia: the case of the Teleyayen sub-watershed. *Agriculture & Food Security*, *6*(1), 1-14.

Alister, D. (2018). *Africa's deforestation twice world rate. U.N. Environment Programme (UNEP) about the 400- page atlas, a meeting of African environment ministers in Johannesburg. South Africa.* Retrieved from (https://www.reuters.com/article/us-africa-environment/africas-deforestation-twice-world-rate-says-atlasidUSL1064180420080610)

Allen, J. C., & Barnes, D. F. (1985). he causes of deforestation in developing countries, . In *Annals of the Association of American Geographers* (pp. 163-184.).

Anderson J. et al. (2006). *Forests, poverty and equity in Africa: A new perspectives on policy and practice;*. International Forestry Review.

Angelsen, A. (2007). *Forest Cover Change in Space and Time: Combining the von Thünen and Forest Transition.* World Bank Publications.

Angelsen, A. (2009). Realising REDD+: National strategy and policy options. Bogor: Center for International Forestry Research.

Babigumira, R., Angelsen, A., Buis, M., Bauch, S., Sunderland, T., & Wunder, S. (2014). Forest clearing in rural livelihoods: household-level global-comparative evidence. *World Development*, *64*, S67-S79.

Baynes, J., Herbohn, J., Smith, C., Fisher, R., & Bray, D. (2015). Key factors which influence the success of community forestry in developing countries. *Global Environmental Change*, *35*, 226-238.

Bong, I. W., Felker, M. E., & Maryudi, A. (2016). How are local people driving and affected by forest cover change? Opportunities for local participation in REDD+ measurement, reporting and verification. *PloS one*, *11*(11), e0145330.

Borokini T et al. (2012). *Community-based Forest Resources Management in Nigeria.* Retrieved from http://journals.sjp.ac.lk/ index.php/JTFE/article/view/571

Castro-Nunez, A., Charry, A., Castro-Llanos, F., Sylvester, J., & Bax, V. (2020). Reducing deforestation through value chain interventions in countries emerging from conflict: The case of the Colombian cocoa sector. *Applied Geography*, *123*, 102280.

Catterall, C. P. (2020). Influencing landscape-scale revegetation trajectories through restoration interventions. *Current Landscape Ecology Reports*, *5*, 116-126.

Cavendish, W. (2003). *How do forests support, insure and improve the livelihoods of the rural poor?* Bogor: Center for International Forestry Research.

Cedamon, E. D., Nuberg, I., Mulia, R., Lusiana, B., Subedi, Y. R., & Shrestha, K. K. (2019). Contribution of integrated forest-farm system on household food security in the mid-hills of Nepal: assessment with EnLiFT model. *Australian Forestry*, *82*(sup1), 32-44.

Chemshema S.A.. et al. (1992). *Suitability of Taunya system of North Kilimanjaro forest lantationTanzania.* Agro forestry system.

Chomitz, K. M., & Gray, D. A. (1996). *Roads, land use, and deforestation: A spatial model applied to Belize,*. The World Bank.

Climate focus. (2015). *Progress on the New York Declaration on Forests: An.* Retrieved from https://climatefocus.com/sites/default/files/NYDF_Progress_Report.pdf.

Dangal, S. P., Das, A. K., & Paudel, S. K. (2017). Effectiveness of management interventions on forest carbon stock in planted forests in Nepal. *Journal of environmental management*, *196*, 511-517.

Degen et al. (2010). *Goat production and fodder leaves offered by local villagers in the mid-hills.*

Duguma, L. A., Atela, J., Minang, P. A., Ayana, A. N., Gizachew, B., Nzyoka, J. M., & Bernard, F. (2019). Deforestation and forest degradation as an environmental behavior: unpacking realities shaping community actions. *Land*, *8*(2), 26.

Endale, Y., Derero, A., Argaw, M., & Muthuri, C. (2017). Farmland tree species diversity and spatial distribution pattern in semi-arid East Shewa, Ethiopia. *Forests, trees and LiveLihoods*, *26*(3), 199-214.

ERC. (2015). *Annual Report Financial Statement 2014-2015*. Retrieved from http://www.scirp.org/ References Papers.aspx? ReferenceID=1950350

FAO. (2015). *Global Forest Resources Assessment Kenya Country Report.* Rome.

FAO. (2018). *The State of the World's Forests. Forest pathways to sustainable development.* Rome.

FAO. (2019). *New UN Decade on Ecosystem Restoration offers unparalleled opportunity for job creation, food security and addressing climate change.* Retrieved from http://www.fao.org/news/story/en/item/1182090/icode/. (accessed on 20

Geist, H. J., & Lambin, E. F. (2001). What drives tropical deforestation. *LUCC Report series*, *4*, 116.

Ghazoul, J., Burivalova, Z., Garcia-Ulloa, J., & King, L. A. (2015). Conceptualizing forest degradation. *Trends in ecology & evolution*, *30*(10), 622-632.

Gibbs et al. (2010). *Tropical forests were the primary sources of new agricultural land*. Retrieved from https://doi.org/1073.pnas.0910275107

Githiomi, J. K., & Oduor. (2012). *Strategies for sustainable wood fuel production in Kenya.*

Government of Kenya. (2010). *REDD Readiness Preparation Proposal.*

Government of Kenya. (2015). The Energy Bill, Arrangement of Clauses, Energy Policy and Integrated Energy plans.

Grainger, A. (1995). The forest transition: an alternative approach.

Greengrass E. J. (2006). *A Survey of Chimpanzees in South-west Nigeria. National Conservation Foundation.*

Grossman, G. M., & Krueger, A. B. (1991). *Environmental Impacts of a North American Free Trade Agreement.* Cambridge.

Hettig, E., Lay, J., & Sipangule, K. (2016). Drivers of households' land-use decisions: A critical review of micro-level studies in tropical regions. *Land*, *5*(4), 32.

Keenan et al. (2015). Dynamics of global forest area. In *Results from the FAO Global Forest Resources Assessment 2015. Forest Ecology and Management,* (pp. 352, 9-20.).

Kimemia, J. (1998). *Studies on green manure application and intercropping in Coffee arabica Production (Doctoral dissertation, PhD Thesis, University of Nairobi).*

Kombo, D. Tromp. L,. (2006). *Proposal and thesiss writing .An introduction.* Nairobi: Pauline Publishers Africa.

Kumari, R., Banerjee, A., Kumar, R., Kumar, A., Saikia, P., & Khan, M. L. (2019). Deforestation in India: consequences and sustainable solutions. *Forest degradation around the world*, 1-18.

Lambin, E. F., & Meyfroidt, P. (2010). Land use transitions: Socio-ecological feedback versus socio-economic change, Land Use.

Langat, D. K., Maranga, E. K., Aboud, A. A., & Cheboiwo, J. K. (2016). Role of forest resources to local livelihoods: The case of East Mau forest ecosystem, Kenya. *International Journal of Forestry Research, 2016*.

Langat, D., & Cheboiwo, J. (2010). To conserve or not to conserve: A case study of forest valuation in Kenya. *Journal of tropical forest science, 5-12.*

Latawiec et al . (2015). *Creating space for large-scale restoration in tropical agricultural landscapes*. Retrieved from https://doi.org/10.1890/140052.

Lawrence, A. (2018). Do interventions to mobilize wood lead to wood mobilization? A critical review of the links between policy aims and private forest owners' behaviour. *Forestry: An International Journal of Forest Research*, *91*(4), 401-418.

Li, Y., Viña, A., Yang, W., Chen, X., Zhang, J., Ouyang, Z., ... & Liu, J. (2013). Effects of conservation policies on forest cover change in giant panda habitat regions, China. *Land use policy*, *33*, 42-53.

López, R. (1994). *The environment as a factor of production: The effects of economic growth and trade liberalization.*

Maliva, R., & Missimer, T. (2012). *Arid lands water evaluation and management*. Springer Science & Business Media.

Mather, A. S. (2007). *Recent Asian forest transitions in relation to forest transition theory.* International Forestry Review.

Matsvange, D., Sagonda, R., & Kaundikiza, M. (2016). The role of communities in sustainable land and forest management: The case of Nyanga, Zvimba and Guruve districts of Zimbabwe. *Jamba (Potchefstroom, South Africa)*, *8*(3), 281. https://doi.org/10.4102/jamba.v8i3.281

Melo at al. (2013). *Priority setting for scaling-up tropical forest restoration projects*. Retrieved from https://doi.org/10.1016/j.envsci.2013.07.013.

MEMR. (2012). *Master plan for the conservation and sustainable management of water catchment areas of Kenya.* Ministry of Environment and Natural Resources.

Metzger J., et al. (2017). *Best practice for the use of scenarios for restoration planning. Current Opinion in Environmental Sustainability*. Retrieved from https://doi.org/10.1016/j.cosust.2017.10.004.

Ministry of Environment and Forestry. (2019). *National srategy for achieving and maintaining over 10 percent tree cover by 2022.*

Mohammed, A. S. (2014). Deforestation and its effect on livelihood patterns of forest fringe communities in the Asunafo North Municipality (Doctoral dissertation).

Morse, S., & McNamara, N. (2013). The theory behind the sustainable livelihood approach. In *Sustainable livelihood approach* (pp. 15-60). Springer, Dordrecht.

Mugenda, O. (1999). *Research methods.Quantitative and Qualitative approaches.* Nairobi: African Centre for Technology Studies.

Mugenda, O. Mugenda, A. (2003). *Research methods in education.*

Musyoki, J. K., Mugwe, J., Mutundu, K., & Muchiri, M. (2013). Determinants of household decision to join community forest associations: a case study of Kenya. *International Scholarly Research Notices, 2013*.

Mutero, P. K. (2013). *The effect of Tea growing on Forest degradation in Chinga area of the Aberdare Ranges in Nyeri county, Kenya* (Doctoral dissertation, University of Nairobi,).

Mutua, B. M. (2018). *Challenges facing indigenous chicken production and adoption levels of biosecurity measures in selected areas of Makueni county, Kenya (Doctoral dissertation).*

Mwangi, et al.(2018). State of the Forests of Eastern Africa, Publications Office of the European Union,. Luxembourg: ISBN.

Nagayets, O. (2005). *Small farms: current status and key trends. The future of small farms,.*

Nuberg I et al. (2018). *Enhancing livelihoods and food security from agroforestry and community forestry in.* Retrieved from https://www.aciar.gov.au/publication/Enhancing-livelihoods-and-food-security-agroforestry-andcommunity-

Nugroho, H. Y., van der Veen, A., Skidmore, A. K., & Hussin, Y. A. (2018). Expansion of traditional land-use and deforestation: a case study of an adat forest in the Kandilo Subwatershed, East Kalimantan, Indonesia. *Journal of forestry research*, *29*(2), 495-513.

Oishimaya, Sen. (2017). *Continents of the World by Forest Cover. World Atlas.* Retrieved from https://www.worldatlas.com/articles/continents-of-the-worldby- forest-cover.html. Accessed 07/11/2018.

Pandit B.H. (2014). *Why cannot local communities do forestry business?Analysis of barriers in the value chain of private forestry products in.*

Perz, S. G. (2007). *Grand theory and context-specificity in the study of forest dynamics: Forest transition theory and other.*

Pirard, R., Wunder, S., Duchelle, A. E., Puri, J., Asfaw, S., Bulusu, M., ... & Vedoveto, M. (2019). Effectiveness of forest conservation interventions: an evidence gap map.

Rackham, O. (2008). Ancient woodlands: modern threats. *New Phytologist*, 571-586.

Rasolofoson, R. A., Ferraro, P. J., Jenkins, C. N., & Jones, J. P. (2015). Effectiveness of community forest management at reducing deforestation in Madagascar. *Biological Conservation*, *184*, 271-277.

Sandewall, M., Kassa, H., Wu, S., Khoa, P. V., He, Y., & Ohlsson, B. (2015). Policies to promote household based plantation forestry and their impacts on livelihoods and the environment: cases from Ethiopia, China, Vietnam and Sweden. *International forestry review*, *17*(1), 98-111.

Serrat, O. (2017). The sustainable livelihoods approach. In *Knowledge solutions* (pp. 21-26). Springer, Singapore.

Seth. (2018). *African Savanna Carbon Emissions Triple the Estimates*. Retrieved from https:// www.laboratory equipment.com/news/2018/08/african-savanna-carbonemissions- triple-estimates. Accessed 1/11/2018.

Shahbaz, B., Ali, T., & Suleri, A. Q. (2011). Dilemmas and challenges in forest conservation and development interventions: Case of Northwest Pakistan. *Forest Policy and Economics*, *13*(6), 473-478.

Tabor, K., Jones, K. W., Hewson, J., Rasolohery, A., Rambeloson, A., Andrianjohaninarivo, T., & Harvey, C. A. (2017). Evaluating the effectiveness of conservation and development investments in reducing deforestation and fires in Ankeniheny-Zahemena Corridor, Madagascar. *PloS one*, *12*(12), e0190119.

Tariq, M., & Aziz, R. (2015). An overview of deforestation causes and its environmental hazards in khyber pukhtunkhwa. *Journal of Natural Sciences Research*, *5*(1), 52-58.

Timko et al. (2010). *The socio-economic contribution of non-timber forest products to rural livelihoods in Sub-Saharan Africa.* International Forestry Review.

UN. (2015). *Demand for Wood in Africa Could Triple by 2050, Straining the Continent's Dwindling Forest Resources, United Nation Environment.* Retrieved from https://www.Unenvironment.org/news-and-stories/pressrelease/ demand-wood-africa-could-triple-2050-straining-continents-dwindling.

Veron, S. R., Paruelo, J. M., & Oesterheld, M. (2006). Assessing desertification. *Journal of Arid Environments*, *66*(4), 751-763.

Von Amsberg, J. (1994). Economic Parameters of Deforestation. Washington DC: World Bank.

Walker, R. . (2004). Theorizing land-cover and land-use change. In *The case of tropical deforestation, International Regional Science Review* (pp. 247-270.).

Worku, T., Tripathi, S. K., & Khare, D. (2018). Household level tree planting and its implication for environmental conservation in the Beressa Watershed of Ethiopia. *Environmental Systems Research*, *6*(1), 1-10.

World Bank. (2015, April 6). *Forest report (percentage of land area)*. Retrieved from World Bank Group, & IEA. (2017). SE4ALL Global Tracking Framework: progress towards sustainable energy 2017 (Text/HTML). Retrieved from http://www.worldbank.org/en/topic/energy/publication/Global-Tracking-Framework-Report

Zeb, A., Armstrong, G. W., & Hamann, A. (2019). Forest conversion by the indigenous Kalasha of Pakistan: A household level analysis of socioeconomic drivers. *Global Environmental Change*, *59*, 102004.

APPENDICES

Appendix 01: Household Questionnaire

Disclaimer: The details obtained during the survey is for scholarly purposes only and shall not be disclosed in any case to any other citizen.

Questionnaire number…….

Sub-Location…….....…….

Date of Interview…….. Name of Interviewer……...……..

SECTION 1: RESPONDENT'S INFORMATION

1. Name of Respondent (Optional)……Tel. …….

2. Relationship with HH…….

3. Age ……

4. Sex: Male…… Female……..

5. Marital Status:

Married…….. Single……. Divorced ……. Separated……. Widowed/Widower……

SECTION 2: DEMOGRAPHIC CHARACTERISTICS OF MEMBERS OF THE HOUSEHOLD

2.1 How many people reside in the Household? .....

Name of Respondent	R/ship to HH	Sex	Age	Highest Level of Education	Main Occupation	Other sources of income	Monthly income

1=Household head 2=Wife 3=Son 4=Daughter 5=Son in Law 6=Daughter in Law 7=Grandchild 8=Other Relatives

2.2 Were you born in this sub location? [a] Yes [ ] [b] No [ ]

If no in 2.2 above where were you residing before locating to this place? ……
……
……

SECTION 3: FARM CHARACTERISTICS

3.0 How did your family acquire this land …….

3.1 How much land does the family own in acres …….

3.1.1How much land did your father/parent own in acres ……

3.2 How many acres does the family cultivate ……..

3.3 How many acres are devoted to forest cover……

3.3 What are the main crops grown the acreage and annual yields?

	CROP	**ACREAGES**	**ANNUAL YIELDS**
1.			
2.			
3.			
4.			
5.			

3.4(i) Does the family harvest enough food crops for the whole year round?

……

(ii)If No, how much and when is extra food bought for the family?

……..

3.5 (i) Do you keep animals? [a] Y☐ [b] ☐

(ii) If yes

	TYPE OF ANIMAL	NUMBER OF ANIMALS	NUMBER SOLD ANNUALLY AND AMOUNT (KSH)
1.			
2.			
3.			
4.			
5.			

SECTION 4: TREE PLANTING

4.1 How many trees do you have in your farm?

……..

4.2 Approximately how many trees do you plant per year?

……..

4.3 Which tree species do you plant?

	Tree species	Purpose
1		
2		
3		

4		
5		

4.4 Where do you normally get the seedlings?

……

4.5 Which is your nearest tree nursery to your farm?

……

4.6 Have you ever been visited by forestry extension officer?

……

4.7 What according to you is the best way to make people plant more trees?

……

……..

SECTION 5: COOKING ENERGY SOURCES AND CONSUMPTION

5.1What type of energy do you use for cooking?

	Energy type	**Quantity used per day**	**Cost**
1.	Firewood		
2.	Charcoal		
3.	Paraffin		
4.	Solar		
5.	Electricity		
6.	Agricultural wastes		

5.3 Do you harvest trees for timber production?
[a] Yes [ ] [b] No [ ]

5.4 If yes in the (5.3 above) how many trees do you harvest per month/year?

……

5.5 Do you harvest trees for poles?

…….

5.6 If yes to 5.5, how many do you harvest per month/year?

SECTION 6: COOKING ENERGY CONSERVATION

6.1 Which kind of cook stove do you use as a family? (Household)

a) The traditional three stone fire place

b) Jiko kisasa

c) Kuni mbili

d) Kenya ceramic stone

e) LPG Gas cooker

f) Paraffin's stove

g) Electric cooker

h) Other (specify)

6.2Have you ever heard of energy saving jikos or stoves?

a) Yes…….

b) No……..

6.3 If yes in 6.2, from whom did you get the information?

……

SECTION 7: HOUSING CONDTIONS AND WATER

7.1 Observe the housing conditions and note:

Roofing material.....

Walling material..... ……

Flooring material……

7.2 Where do you get your water from?

a] Pipe [ ]

b] Well [ ]

c] River [ ]

d] Bore hole

e] Others [specify]

7.3 Is there a time when you do not have enough water?

……

7.4 How do you cope with such a time in 7.3 above?

……

Appendix 02: Observation Guide

1. Forest types, Tree species (indigenous and planted), and Canopy height

……...

……

2. Settlement patterns and population densities

……..

……

3. Organization of physical structures in the household, Building materials used

……

……

4. Total size of land per Homestead (acres)

……

……

5. Total size of land allocated to forest cover compared to the land size allocated to other land uses per household

……

……

6. Forest goods consumed each of sampled household ie. Firewood, Timber, Grass for thatching, Charcoal production methods, Types of cooking stove used per household

……

……

Appendix 03: Interview Checklist for Forest Extension Officers County government/ KEFRI

1. What are the practices in forestry in this area?

……

……

……

2. What are the hindrances to increasing forest cover in the study area?

……

……

……

3. What are some of the strategies (programmes/projects) in your department that have been put in place to ensure household farm tree planting in this Ward?

……

……

……

4. Who was the target group in projects in 3 above?

…….....

…….

5. What measure have you put in place to ensure seedlings availability within households in the study area?

……

……

……

6. What tree species are preferred by the community?

……

……

……

7. What are the constrains faced in increasing forest cover in this area?

……

……

……

8. In your opinion, what can be done to increase forest cover in this area?

……

……

……

Appendix 04: Focus Group Discussion Guide（Women）

1. What factors do you consider when allocating different land uses at households in this area?

……
……

2. What factors do you consider when allocating land for tree planting?

……
……

3. What are the main reasons for planting trees in this area?

……
……

4. Do you have community based groups for tree planting in this area?

……
……

5. Are there organizations which finance individual or community groups to do commercial forestry in this area?

……

6. If yes in 4, how many?

……
……
……
.

7. What is the main hindrance for increasing forest land cover in this area?

……
……
……..

Appendix 05: Focus Group Discussion Guide（Youth）

1. What factors motivate you to plan trees in your homes?

……
……

2. What are the main reasons for planting trees in this area?

……
……

3. Do you have youth community based groups for tree planting in this area?

……
……

4. Are there organizations which finance youth community groups to do commercial forestry in this area?

……

5. If yes in 4, how many?

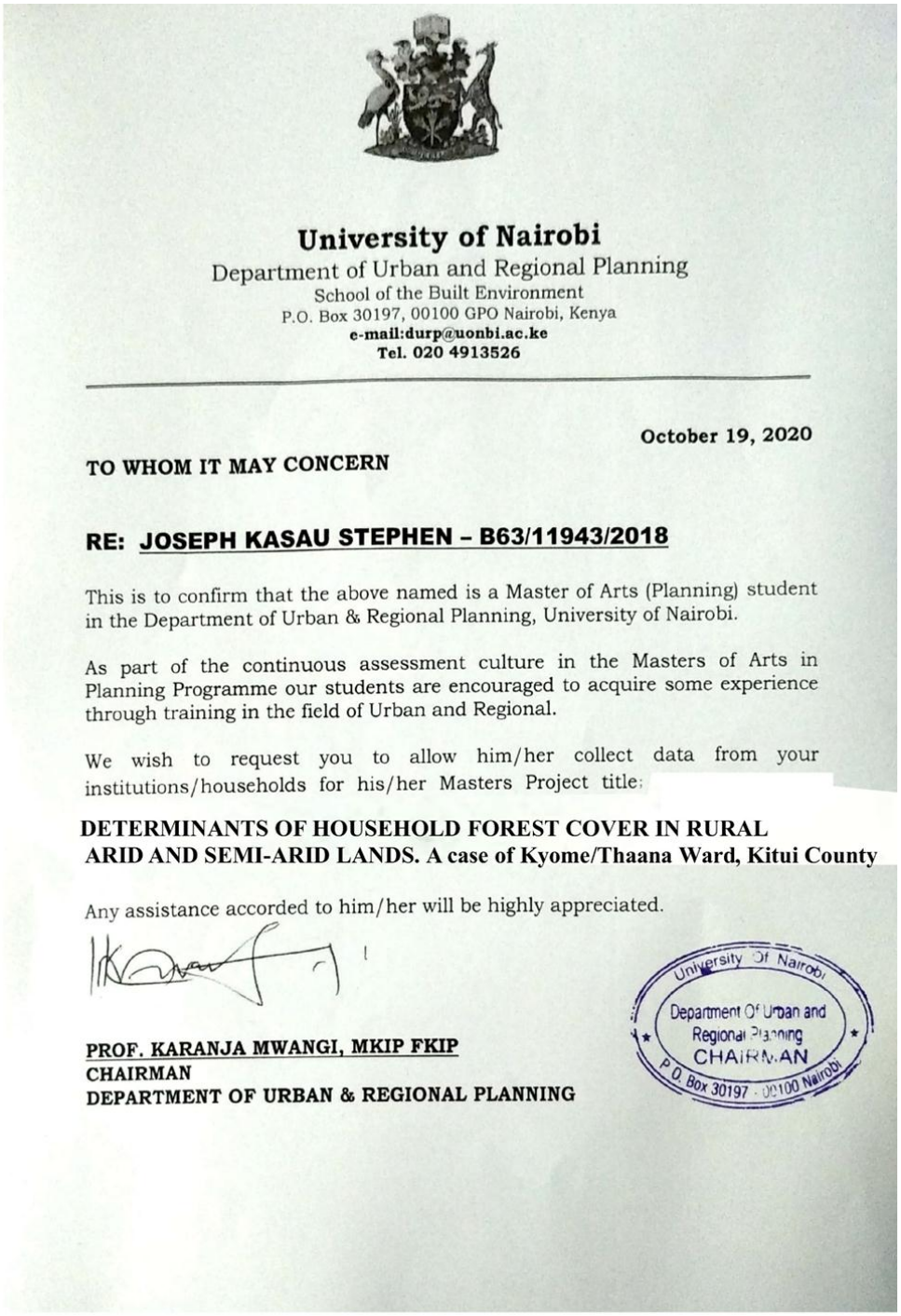
……
……
……
.

6. What is the main hindrance for increasing forest land cover in this area?

……
……
……..

7. What strategies do you recommend to be adopted for increasing forest land cover in this area?.....
.....
.....

Appendix 06: University Recommendation Letter



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October 19, 2020

TO WHOM IT MAY CONCERN

RE: JOSEPH KASAU STEPHEN – B63/11943/2018

This is to confirm that the above named is a Master of Arts (Planning) student in the Department of Urban & Regional Planning, University of Nairobi.

As part of the continuous assessment culture in the Masters of Arts in Planning Programme our students are encouraged to acquire some experience through training in the field of Urban and Regional.

We wish to request you to allow him/her collect data from your institutions/households for his/her Masters Project title:

DETERMINANTS OF HOUSEHOLD FOREST COVER IN RURAL ARID AND SEMI-ARID LANDS. A case of Kyome/Thaana Ward, Kitui County

Any assistance accorded to him/her will be highly appreciated.

University Of Nairobi
Department Of Urban and Regional Planning
CHAIRMAN
P.O. Box 30197 - 00100 Nairobi

PROF. KARANJA MWANGI, MKIP FKIP
CHAIRMAN
DEPARTMENT OF URBAN & REGIONAL PLANNING

Appendix 07:

Appendix 07: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **672063**

Date of Issue: **21/May/2021**

RESEARCH LICENSE

This is to Certify that Mr.. JOSEPH KASAU STEPHEN of University of Nairobi, has been licensed to conduct research in Kitui on the topic: DETERMINANTS OF HOUSEHOLD FOREST COVER IN RURAL ARID AND SEMI-ARID LANDS. A case of Kyome/Thaana Ward, Kitui County for the period ending : 21/May/2022.

License No: **NACOSTI/P/21/10776**

672063

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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