FACTORS INFLUENCING HOUSEHOLD PARTICIPATION IN EXTRACTION OF FOREST PRODUCTS IN MOUNT KENYA FOREST, NYERI COUNTY, KENYA

BY

MWANGI FLORA CAROLINE

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DECLARATION

Declaration by Candidate

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Signature…………………….…….   Date……………….……………..………

Mwangi Flora Caroline

SANR/PGA/009/013

Declaration by the Supervisors

This thesis has been submitted with our approval as the University supervisors.

Signature…………………………   Date……………………………………

Prof. Samuel Mwakubo
School of Business and Economics
Pwani University
P.O Box 195-80108
Kilifi, Kenya

Signature……………………………   Date……………………….……………

Dr. Ernest Kipkemei Saina
School of Agriculture and Natural Resources Management
Department of Agricultural Economics and Resource Management
Moi University
P.O Box 3900-30100
Eldoret, Kenya.

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DEDICATION

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LIST OF ACRONYMS AND ABBREVIATION

CADP:	County Annual Development Plans
CPR :	Common Pool Resources
FAO :	Food Agricultural Organization
GDP :	Gross Domestic Product
GOK :	Government of Kenya
IPCC:	Intergovernmental Panel on Climate Change
KEFRI:	Kenya Forestry Research Institute
KFS :	Kenya Forest Service
KNBS:	Kenya National Bureau of Statistics
KWS :	Kenya Wildlife Service
MFW :	Ministry of Forestry and Wildlife
MOA :	Ministry of Agriculture
Mt. :	Mount
NISR :	National Institute for Space Research
NTFP :	Non Timber Forest Products
ODA :	Overseas Development Administration
SPSS :	Statistical Package for Social Sciences
TREES:	Tropical Ecosystem Environmental observation by Satellite
UN :	United Nations
UNEP :	United Nations Environment Program
US :	United States
WCMC:	World Conservation Monitoring Centre

ABSTRACT

Forests play a critical role in sustaining rural livelihoods through provision of timber and non-timber forest products for both domestic and commercial use. However, unsustainable extraction of these products threatens the ecological and socio-economic benefits for over two million people who live around the forests, necessitating a deeper understanding of the factors influencing household participation in forest product extraction in Mount Kenya Forest, Nyeri County. This was actualized by testing the null hypothesis that there is no significant relationship between the social, economic, and environmental factors and participation in extraction of forest products based on the theory of tragedy of the commons. The research employed a cross-sectional survey design, utilizing both descriptive and inferential statistics. Data was collected from 361 households living within 10 kilometers radius of the forest through structured questionnaires and analyzed using a binary logistic regression model. Findings indicated that 77% of households engaged in forest resource extraction**,** with 70.91% utilizing products for both domestic and commercial purposes**.** Firewood collection was the most common activity (36.01%), followed by lumbering and farming. Socioeconomic characteristics such as household size, income levels, education, and occupation of the respondents significantly influenced forest dependency. Additionally, 61.5% of respondents lacked awareness of sustainable harvesting techniques and forest management policies, contributing to unsustainable practices. Encouragingly, 86% of respondents express willingness to participate in conservation initiatives without monetary compensation, indicating strong potential for community-driven conservation strategies. Social, economic, and environmental factors were found to significantly influence participation with household size, income level, and proximity to the forest ($p=0.0000<0.05$) emerging as key determinants. The model yielded a pseudo R^2 of 0.8920, indicating strong explanatory power. Education ($\beta = -0.1090$, $p = 0.002 < 0.05$) and awareness ($\beta = -0.0479$, $p = 0.000 < 0.05$) of forest management practices were found to negatively correlate with extraction, suggesting that increased knowledge and awareness reduces dependence. The study concludes that social, economic, and environmental factors significantly influence household participation. Based on these findings, the study recommends enhanced community sensitization on sustainable resource use through extension officers, alternative livelihood programs and employment of sustainable harvesting techniques such as selective and rotational harvesting. Strengthening forest management policies, promoting agroforestry, and increasing access to clean energy alternatives such as Liquefied Petroleum Gas (LPG) and biogas are essential for reducing forest dependence and ensuring sustainable resource use. Additionally, integrating rural households into conservation efforts through Community Forest Associations (CFAs) can enhance sustainable forest management. These strategies can help balance forest conservation with the livelihood needs of forest-adjacent communities. Further research should explore panel data analysis on forest dependence specifically investigating how forest dependence evolves over time, considering economic growth, conservation policies, and population dynamics.

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CHAPTER ONE: INTRODUCTION

1.0 Overview of the Chapter

This chapter gives the background to the study and shows the importance of forests to the rural livelihoods of those who live in the peripherals of Mt. Kenya forest. It also covers a brief introduction to the Mt. Kenya Forest, problem statement, objectives of the study, hypotheses significance and justification to the research.

1.1 Background Information

Forest products can be referred to as all the materials or goods that are taken from the forest environment and used in domestic settings, sold, or used for social, cultural, or religious purposes (FAO, 2016). These include creatures, such as birds, feathered reptiles, and fish, as well as plants and plant materials used for food, fuel, storage and feed, medicine, cottage and wrapping materials, and biochemicals. This definition reflects a range of potential products that a diverse range of people are interested in (FAO, 2010).

The livelihood of people living in and around forests depends heavily on timber and non-timber forest products (Agustino et al. 2011, FAO, 2016). Food items such as fruits, vegetables and roots, fuel wood, charcoal, thatching grass, medicinal plants, fodder, honey, construction materials, cultural, spiritual, and ceremonial places are just a few of the commodities and services that these indigenous woods offer to the local population (Geta, 2015). The provision of household jobs and income by the forests also helps to ensure food security (Geta, 2015).

Forests cover 31% of global land area playing a vital role of climate regulation, biodiversity conservation, supply of timber and non-timber forest products (NTFPs) and give non-use values such as existence, spiritual, and bequest values to approximately 1.6 billion people globally, according to the Food and Agriculture Organization (FAO, 2020). The forestry sector is estimated to contribute approximately $600 billion annually to GDP and provides over 33 million jobs (FAO, 2020).

However, the forests are shrinking at an alarming rate, with 10 million hectares lost annually due to deforestation. Over 50% of forest loss globally is driven by agricultural expansion, unsustainable logging, and illegal timber trade FAO, 2020). The extraction of forest products is influenced by various factors, including economic dependency, accessibility, institutional policies, and conservation efforts**.** In many developing countries, rural households rely heavily on forests due to limited access to alternative energy sources and income-generating activities (World Bank, 2021).

Community-based forest management (CBFM) has been promoted as a sustainable approach to balancing conservation with economic needs. Successful models in countries like Nepal and Brazil demonstrate that effective community participation, clear land tenure rights, and government support can lead to sustainable forest use. However, challenges such as over extraction, weak institutional structures, and climate change continue to hinder sustainable forest resource management worldwide leading to deforestation and biodiversity loss (Agustino et al., 2011).

In Sub-Saharan Africa, forests contribute significantly to household energy, food security, and income generation. An estimated 80% of households rely on firewood and charcoal as their primary source of energy (African Development Bank, 2019) as well as cash-generating activities associated with forests, such as the selling of firewood and charcoal, small-scale sawmilling, handicraft and commercial hunting (Mutoko et al., 2015).

The extraction of forest products is driven by poverty, population growth, weak enforcement of conservation policies, and inadequate access to alternative livelihoods**.** Studies indicate that countries like Ethiopia, Uganda, and Tanzania face similar challenges, where unsustainable forest extraction is fueled by land encroachment for agriculture, weak community involvement, and ineffective conservation policies (UNEP, 2020).

In Kenya, the forestry sector contributes approximately 3.6% to the country's GDP, which translates to roughly Ksh 44,441 million (FAO, 2016) with rural communities depending on them for both subsistence and commercial purposes (Kenya National Bureau of Statistics, [KNBS]2021). Specifically, over 2.9 million Kenyans depend on forests for livelihoods, but overexploitation threatens these resources. It is estimated that Kenya loses approximately 50,000 hectares of forest annually, driven by illegal logging, charcoal production, and agricultural expansion (FAO, 2016). Kenya's total forest cover is 7.2%**,** below the recommended global average of 10%**,** underscoring the need for sustainable practices.

Despite the existence of community forest associations (CFAs) under the Forest Conservation and Management Act (2016), household participation in sustainable practices remains low due to limited awareness, insufficient incentives, and weak law enforcement**.** Additionally, the demand for firewood and timber continues to exert pressure on forest ecosystems, leading to degradation and loss of biodiversity.

Nyeri County, located in central Kenya, is home to a significant portion of Mt. Kenya Forest**.** The forest is an extinct stratovolcano and the second-highest peak in Africa. It is a critical water catchment area and a home to unique afro-alpine species, large wildlife, and serves as a major water source while regulating climate. The forest provides essential resources for over 200,000 households living within 5 km of its boundaries (Kenya Forest Service, 2018).

Unfortunately, this critical resource faces continuous degradation from unsustainable extraction practices. The main forest products extracted by households include firewood, medicinal plants, fodder, honey, and timber**.** The degree to which a household depends on a forest resource depends on a number of factors such as socio-economic, geographical, institutional and environmental factors.

The community depends on resource extraction and the sustainability of the forest depends on its conservation. This makes sustainable conservation vital for balancing livelihoods and environmental health. Understanding the factors influencing household participation in the extraction of Mt. Kenya Forest products is essential for developing effective conservation strategies.

1.2 Problem Statement

Forests are vital for socio-economic development and environmental sustainability, providing essential resources such as firewood, medicinal plants, fodder, and timber. In Nyeri County, the Mt. Kenya Forest is a critical resource for over 200,000 people living near its edges (Kenya Forest Service, 2018). It is a UNESCO World Heritage site and home to diverse flora and fauna, contributing significantly to Kenya’s water supply and climate regulation (UNESCO, 2013). Despite its importance, the forest faces severe degradation owing to unsustainable human activities.

Studies indicate that Mt. Kenya Forest has lost approximately 30% of its cover in the last three decades due to unsustainable extraction practices, illegal logging, and encroachment (WWF, 2020). This depletion surpasses sustainable extraction levels by 20%, posing a significant threat to the environment and local livelihoods. For instance, 70% of households in Nyeri County rely on firewood as their primary energy source, while 40% depend on forest-derived income (KNBS, 2019). However, Sustainable practices such as selective harvesting and replanting, remain underutilized, with only 30% of households adopting them, by being involved in community forest associations (CFAs), compared to the recommended target of 70% set by conservation guidelines, for effective balance of conservation and livelihood needs (Kenya Forest Service, 2020).

While past studies have extensively analyzed deforestation rates and climate change impacts (WWF, 2020; UNEP, 2023), they often overlook localized socio-economic drivers behind resource over-extraction and the barriers preventing effective community involvement. To address these gaps, this study seeks to examine the socio-economic, and geographic factors influencing household participation in the extraction of Mt. Kenya Forest products in Nyeri County and propose evidence-based strategies for balancing conservation efforts with local economic needs.

By identifying key drivers of forest dependence and barriers to sustainable practices, this research aims to provide actionable insights for bridging these gaps. The findings will support sustainable forest management strategies, enhance CFA effectiveness, and ensure the preservation of this critical ecosystem for future generations

1.3 Justification of the Study

Mount Kenya Forest is a vital ecological and economic resource facing severe degradation due to deforestation, unsustainable extraction practices, and weak conservation enforcement (Kinyanjui, 2011). The loss of forest cover threatens biodiversity, water resources, and the livelihoods of local communities who depend on it for subsistence and commercial activities (Cheserek, 2018).

Despite existing conservation efforts, the ongoing depletion of forest resources indicates a gap in understanding the underlying socio-economic drivers of forest degradation (Mogaka et al., 2006). This study is essential to provide a comprehensive analysis of these factors, offering insights into the root causes of deforestation and unsustainable practices.

Furthermore, Mount Kenya Forest plays a crucial role as one of Kenya’s largest water catchment areas, supplying over 70% of the country’s hydroelectric power and providing water to millions of people (UNEP, 2009). The decline in forest cover due to logging, agriculture, and illegal settlements threatens the long-term sustainability of these resources (Kariuki et al., 2021). Without timely intervention, the negative impacts of forest loss, including soil erosion, declining water levels, and increased human-wildlife conflict, will intensify. Understanding the socio-economic and environmental consequences of forest degradation will provide essential data to guide more effective conservation policies and practices.

In addition to environmental concerns, there is an economic imperative to preserve the forest. The loss of forest products and ecosystem services directly affects the livelihoods of thousands of households that rely on fuelwood, timber, and non-timber forest products (Mutoko et al., 2015). This study will help bridge the gap between policy and practice by highlighting the socio-economic factors influencing resource extraction and identifying sustainable alternatives. By addressing these challenges, this research will contribute to the broader goal of achieving Kenya’s Vision 2030 sustainability objectives (Government of Kenya, 2007).

1.4 Significance of the Study

This study will provide valuable insights for policymakers, conservation organizations, and local communities, helping them implement more effective forest management strategies. By identifying the key drivers of deforestation and unsustainable extraction, the research will contribute to the development of policies that balance environmental conservation with the economic needs of local communities (Mwangi et al., 2018). Improved policy enforcement, coupled with alternative livelihood programs, can mitigate the adverse effects of resource depletion and foster a more sustainable use of forest products (FAO, 2010).

Additionally, the research will have broader implications for biodiversity conservation and climate change mitigation. Mount Kenya Forest hosts diverse plant and animal species, many of which are endangered (Wass, 1995). Addressing deforestation will help maintain biodiversity, protect wildlife habitats, and enhance the forest's ability to sequester carbon (Kinyanjui, 2011). The study's recommendations will support conservation organizations and stakeholders in designing community-driven forest management approaches that ensure the ecological and economic sustainability of Mount Kenya Forest for future generations (Cheserek, 2018).

Finally, this study will also contribute to the academic and scholarly body by filling existing knowledge gaps in forest conservation, resource management, and sustainable livelihoods. While previous studies have examined deforestation in Mount Kenya Forest (Kihiu, 2016), there remains a need for more interdisciplinary research that integrates socio-economic, environmental, and policy dimensions. By employing a multi-faceted approach, this research will provide a deeper understanding of the complex interactions between human activities and forest ecosystems. The findings will be valuable for scholars in environmental science, conservation policy, and rural development, serving as a foundation for future research and policy formulation.

1.5 Objectives of the Study

1.5.1 General Objective

The general objective of the study was to determine the factors influencing households' participation in the extraction of Mt. Kenya forest products, Nyeri County.

1.5.2 Specific Objectives

The specific objectives arising from the general objectives were to;

1. To determine the influence of social factors (age, gender, education level, household size, awareness, and period of residence) on household participation in extraction of Mt. Kenya forest products.
2. To assess the effect of economic factors (income, occupation, and land size) on household participation in Mt. Kenya forest resource extraction.
3. To analyze the influence of environmental factors (forest proximity and resources available) on household participation in Mt. Kenya forest resource extraction.

1.6 Hypotheses of the Study

1. **H_0:** Social factors (age, gender, education level, household size, awareness, and period of residence) have no significant influence on household participation in forest resource extraction.
2. **H_0:** Economic factors (income, occupation, and land size) do not significantly influence household participation in Mt. Kenya forest resource extraction.
3. **H_0:** Environmental factors (forest proximity and resources available) have no significant influence on household participation in forest resource extraction.

1.7 Scope and Limitation of the Study

Kenya is blessed with a variety of forests in various ecological regions. The opportunities and resources available in these ecological zones can persuade households in the forest's periphery to take part in the harvesting of its products. It could have been wise to select a sample from the entire nation, but the amount of time allotted for the study and the resources that were available prevented this from happening. As a result, the study was limited to the Mount Kenya Region and only 378 households were included in the sample. The findings of this study can easily be applied to provide insight into the entire nation.

Data collection in all of Nyeri County's constituencies was hampered by insufficient funding, time constraints, and logistical issues; however, purposive sampling was used to identify study participants. The study used voluntary responses, which are prone to a variety of errors. The lack of effective record keeping and family illiteracy may have contributed to the error. For instance, estimating farm size was challenging, therefore accuracy of the information provided by respondents was depended upon by the researcher.

Estimating monthly and yearly revenue was also challenging. Most farmers were reluctant to speak frankly with outsiders about matters relating to revenue. In order to check for accuracy, indirect questions were used to check and elucidate uncertain answers. Some cases involved the use of probing inquiries. Additional tactics employed to enhance the quality of the data included training and close monitoring of the enumerators.

1.8 Operationalization of Key Variables

1.8.1 Household Participation in Extraction of Forest Products

Participation refers to whether or not a household is involved in forest product extraction.

Extraction refers to the actual process of removing forest resources for use or sale.

Household participation in forest product extraction refers to the extent to which a household is involved in collecting, harvesting, or utilizing forest resources (timber and non-timber forest products) for subsistence, commercial or both purposes. Participation in this study was measured as a binary outcome (yes/no) based on household engagement in forest resource extraction, (1 = participates, 0 = does not participate). This is the Dependent Variable of the study. The level of extraction can depend on socio-economic incentives, proximity to forests, awareness of conservation rules and type of products available for extraction. These are the Independent Variables of the study.

1.8.2 Social Factors

Age: Measured in years of the household head.

Gender: Categorized as male or female

Education Level: Measured as the highest level of formal education completed (e.g., no formal education, primary, secondary, tertiary).

Household Size: The number of people living in a household.

Awareness of Forest Management Practices: Measured by household knowledge of conservation rules, sustainable harvesting techniques, and forest policies.

Period of Residence: The number of years a household has lived in a given location.

1.8.3 Economic Factors

Income: Measured in term of household earnings per month in Kenya Shillings.

Occupation: The primary source of livelihood for the household head (e.g., farmer, casual laborer, salaried employee)

Land Size: Measured in acres.

1.8.4 Environmental Factors

Proximity to the Forest: Measured as the distance (in kilometers) from the household to the nearest forest.

Forest Resources Available for Extraction: Measured in terms of types of forest products (e.g., timber, firewood, medicinal plants).

CHAPTER TWO: LITERATURE REVIEW

2.0 Overview of the Chapter

This chapter presents the reviewed literature. It covers the theoretical framework, review of previous studies, the conceptual framework and a brief explanation of how the livelihood factors relate to participation in forest extraction.

2.1 Theoretical Frame Work

Tragedy of the Commons: Managing Common Pool Resources

Natural resources that are exploited by many people collectively, like the Mount Kenya forest, are referred to as common property resources. Garret Hardin's 1968 Tragedy of the Commons theory, as cited in Ostrom (1990), is one of the most frequently used theories to explain the difficulties of managing natural resources and the negative effects to the resource itself, community and environment. The theory argues that individuals extract resources for their own short-term benefits from the common resources which leads to collective depletion. Lack of regulation encourages over-exploitation, harming long-term sustainability.

His theory focuses on unfavorable outcomes, such as environmental deterioration when many people have unrestricted access to a limited resource that they will utilize without restriction (Ostrom, 1990). Many academics agree with Hardin's theory and believe that the majority of common resources should be under state control. If not, the person will overuse it for their personal gain, which will cause depletion.

As part of the tradition of upholding the tragedy of the commons, it has been expected that actors using a common pool resource will be under pressure to produce at a subpar level due to their financial circumstances, which frequently has devastating outcomes.

As is the case with rural households in this study that rely on the forest resources for their livelihood, there are resource systems and resource units within the Common Pool Resources (CPR) that depend on one another. The term "resource system" refers to "stock variables that, under favorable conditions, are capable of producing maximum quantity of a flow variable without harming the stock or the resource system itself," such as grazing areas, ground water basins, and river streams that are vital to the livelihoods of those living close to Mount Kenya.

Together, the resource systems are utilized. The amounts that a person appropriates or uses from the resource system are known as resource units. If these resource units are not controlled (management of the forest) then the individuals will continue extracting and may end up depleting the resource system if not given time to regenerate.

Numerous elements, including household characteristics, institutional features, and regional characteristics, which are the drivers of extraction in this thesis and, therefore, the applicability of this theory, influence the decision to participate in the extraction of these forest resources.

2.2 The Mount Kenya Forest

The second-highest peak in Africa, after Kilimanjaro, is Mount Kenya, an extinct stratovolcano in Kenya. The meeting point of the counties of Tharaka Nithi, Kirinyaga, Meru, Embu, and Nyeri is currently the summit of Mount Kenya. It is located in what was once Kenya's Eastern and Central provinces, about 150 kilometers (90 miles) to the northeast of Nairobi, the nation's capital, and 16.5

kilometers (10.3 miles) south of the equator. Mount Kenya is the source of the Republic of Kenya's name.

The mountain has 12 remaining glaciers that are all fast melting, and it also has four secondary peaks that are located at the heads of U-shaped glacial valleys. One of the most stunning sceneries in East Africa is Mount Kenya, which has a rocky summit covered in glaciers and middle slopes covered in forest. Its afro-alpine flora's ecology and evolutionary history serve as a superb illustration of ecological processes.

The Government of Kenya through The Kenya Wildlife Service (KWS) advocated for the development of wildlife conservancies among landowners, particularly local communities, as a long-term plan to improve range for biodiversity conservation and management throughout the country. Local Wildlife Conservancy (LWC) is administered for the protection of biological diversity and hence meets the national legal standards for conservancy status.

Prior to its designation as a government-controlled protected area, tribes that resided nearby maintained and used Mount Kenya Forest by extracting and producing goods that served their daily needs. All the Kikuyu and Meru groups that live around the mountain revere it as a holy peak. They use the mountain for Traditional rituals and ceremonial purposes because they believe their traditional God Ngai and his wife Mumbi reside there.

In addition to some uncommon afro-alpine plant species, the forest is home to economically important, Podocarpus, Juniperus, Vitex, Olea and Ocotea wood species. It also has a high biodiversity value. A wide range of creatures can also find a home there, including four vulnerable mammal species and four endangered bird species (Amarasekara, 2008).

More than 25% of Kenya's population depends on the Tana and Ewaso Nyiro river basins, two of the country's five river basins, which are heavily dependent on the forest for their water supply. This comprises the five primary hydroelectric power sources, which supply almost three-quarters of the country's electricity needs, as well as sizable tracts of irrigated and rain-fed agricultural land, pastoralist rangelands, and major urban centers. Together, these make up more than half of the country's land area (Wass 1995; Richard A. et al., 2011).

Crop damage caused by elephants, buffalo, and other large species moving into fields along the lower edge of the Mount Kenya National/Forest Reserve is a major issue. Various attempts have been made to minimize the problem of human-wildlife conflict by fencing and erecting other barriers to prevent animals from leaving the reserve. Although the outcomes have been mixed, as previous experience has shown, effective and well-considered fence is likely to be the greatest solution for preventing human/wildlife conflict in such a densely populated terrain. (UNESCO, 2019)

Long-term efforts have reduced the risks previously posed by the establishment of commercial tree plantations and the attendant habitat damage and crop destruction. The threat to the property posed by plantation development and associated farming in the nearby buffer zone has greatly decreased because to government policy that forbids further conversion of natural forest for plantation development. However, the environmental effects of the unsuccessful plantation development efforts of earlier decades still exist. Instead of being allowed to return to their original state as natural forests, areas that were cut for plantations but never planted have been colonized by grasses and are being kept as open grazing fields. (UNESCO, 2019)

Despite ongoing problems, threats from illegal logging, grazing and poaching are trying to be controlled and seem to remain unstable. There will need to be ongoing observation and efficient handling of these problems. Particularly in the moorlands at high altitudes of the World Heritage site, fire poses a serious hazard. The hazard is made worse by the growing population of people who live close to the forest's edge and frequently climb the mountain to graze animals and gather non-timber forest products. (KWS, 2019)

2.3 The Economics of Forest Resources

Because forests may be used to produce goods and services that consumers demand, they are regarded as valuable economic resources. We can use a forest to help generate consumer goods like houses, paper, fuel wood, outdoor enjoyment, and environmental services when combined with labor and other inputs.

There are many ways in which a forest can be used. The wood might be harvested and utilized to make lumber, paper, or fuel wood. It might be kept standing to support recreational or aesthetic qualities or environmental services, or it could be saved for future generations' industrial usage. Often, a forest can provide more than one good or service simultaneously or sequentially, such as industrial timber, recreation, livestock fodder, wildlife habitat, flood control, and carbon storage, in which case the optimal combination and pattern of uses must be chosen. Forests are valued economic resources because of their utility. The greater the value of final commodities and services generated by forest products, the more important the forest is to civilization.

Throughout this study, it will be assumed that the overall goal of forest management and the production of forest products is to maximize net benefits or societal value.

2.4 Empirical Studies

Several studies have examined the factors influencing forest dependency among rural households in Kenya.

2.4.1 Socio-Demographic Factors Influencing Household Participation in Extraction of Forest Products

i. Age of the Respondent

Age, as a social factor, plays a significant role in influencing various aspects of forest product extraction. Age often correlates with knowledge and experience in forest environments. Older individuals tend to possess traditional knowledge and skills passed down through generations, impacting their approach to extraction methods (Yego et al. 2021). For example, older community members may rely on traditional techniques for gathering medicinal plants or harvesting non-timber forest products (NTFPs), contributing to sustainable resource use.

Studies have shown that older individuals tend to engage more in extraction activities due to their long-term reliance on forest resources for subsistence and economic support. Mutaki (2018) found that individuals above 40 years were more likely to extract fuelwood and medicinal plants in Kenya, attributing this to their familiarity with traditional practices and limited access to alternative sources of income. However, Kinyanjui (2019) observed that while older individuals dominate certain activities like timber and fuelwood collection, younger individuals are increasingly engaging in charcoal burning and commercialized forest exploitation due to rising unemployment.

Physical abilities decline with age, influencing the efficiency and safety of extraction activities. Studies indicate that younger individuals typically engage in more strenuous extraction tasks, such as timber harvesting or wild food collection, due to their superior physical strength (Hickey et al., 2014). This disparity can affect productivity levels and occupational safety measures within forest extraction industries.

Older individuals, often holding positions of authority or leadership, may influence resource management policies and practices (Martin et al., 2016). Understanding generational perspectives is essential for developing inclusive governance frameworks that address the diverse needs and priorities of all age groups involved in extraction activities. In addition, the adoption of new technologies in forest product extraction may vary across age groups. Younger individuals are generally more receptive to technological innovations, which can enhance efficiency and sustainability in extraction practices (Salick & Ross, 2018).

Conversely, older generations may exhibit resistance to change or require additional support and training to integrate new technologies effectively. Finally, Older community members may have limited alternative sources of income, leading to greater reliance on forest resources for sustenance (Dawson et al., 2019). Sustainable management approaches must consider the socio-economic dynamics associated with age to mitigate vulnerabilities and promote equitable resource distribution.

ii. Gender of Respondent

Studies have consistently highlighted the gendered division of labor in forest product extraction, where men and women often engage in distinct roles and tasks. For instance, research by Belem et al. (2015) in the Amazon region demonstrated that while men primarily focused on timber extraction, women were more involved in non-timber forest product (NTFP) collection, such as fruits, nuts, and medicinal plants. Similarly, Larson et al. (2016) found that in African forest communities, women played a central role in gathering fuelwood and non-timber forest resources essential for household subsistence. This is also associated with physical ability where men, assumed to have more strength are involved in strenuous activities such as lumbering and logging, while women are involved in firewood collection and farming activities.

Lidestav (2010) highlighted that female-headed households were more likely to depend on forest resources due to economic vulnerability and limited access to alternative income sources. Similarly, Nguyen et al. (2015) found that women's participation in forest management was crucial for conservation efforts, as they played a significant role in utilizing non-timber forest products sustainably. Both studies emphasized the importance of integrating gender-sensitive policies in forest governance.

Njenga et al. (2020) analyzed gender perspectives in forest management in Kenya, noting that female-headed households were more likely to rely on forests due to economic constraints. Mwaura and Mugambi (2019) assessed agroforestry adoption as an alternative to forest extraction in Kenya, finding that training and financial incentives significantly influenced uptake.

Gender influences the transmission of knowledge and practices related to forest product extraction within communities. A study by Mukul et al. (2017) highlighted the critical role of indigenous women in preserving traditional ecological knowledge essential for sustainable forest management. Additionally, research by Dressler et al. (2018) emphasized the importance of recognizing women's expertise in identifying and conserving medicinal plants, which are often integral to forest extraction activities.

Forest product extraction serves as a significant source of livelihood for many communities, with gender playing a crucial role in shaping socioeconomic outcomes. Analysis by Peters et al. (2020) revealed that women's participation in forest-based enterprises not only contributed to household income but also enhanced their decision-making agency and empowerment within households. Furthermore, the study emphasized the need for gender-sensitive policies and interventions to address the socioeconomic vulnerabilities faced by women engaged in forest product extraction.

iii. Education of the Household

Education plays a crucial role in shaping individuals' attitudes, knowledge, and behavior towards natural resource management, including forest product extraction. Several studies have explored the relationship between educational level and forest product extraction practices. Higher levels of education are often associated with greater awareness and understanding of sustainable forest management practices. Research by Smith et al. (2015) found that individuals with higher educational attainment are more likely to possess knowledge about the ecological impacts of unsustainable forest product extraction methods. This awareness leads to more responsible harvesting practices and a reduced likelihood of overexploitation.

Studies by Johnson and Brown (2018) have shown that individuals with higher levels of education are more likely to adopt advanced technologies for timber harvesting, such as GPS-guided logging equipment and remote sensing tools. This adoption of technology can improve efficiency, minimize environmental damage, and promote sustainable resource management practices. This also can enhance individuals' understanding of forestry regulations and policies, leading to greater compliance with legal frameworks governing forest product extraction.

According to research by Jones et al. (2020), higher levels of education are positively correlated with adherence to logging regulations and sustainable harvesting guidelines. Educated stakeholders are better equipped to navigate complex legal frameworks and make informed decisions that align with conservation objectives.

Finally, Educational attainment influences individuals' participation in community-based forest management initiatives. Studies by Smith et al. (2015) have shown that higher levels of education are associated with increased involvement in collaborative forest management programs. Educated community members are more likely to contribute to decision-making processes, advocate for sustainable practices, and support initiatives aimed at conserving forest resources.

iv. Household Size

The size of a household often correlates with its economic capabilities and resource needs, thereby affecting forest product extraction. Larger households tend to have higher resource demands and labor availability. Studies have consistently shown that households with more members extract more forest resources due to increased consumption needs for fuelwood, timber, and non-timber products. Mutune et al. (2017) found that in Kenya, larger households collected more firewood and forest foods to sustain their daily needs, especially in rural areas where alternative energy sources were limited.

Similarly, Nyongesa and Ongugo (2019) reported that households with more than five members exhibited higher participation in forest-related activities, primarily due to labor availability for extraction and processing. This aligns with findings by Ndegwa et al. (2020), who noted that larger families tend to rely more on forest resources for both subsistence and commercial purposes, as they often have more dependents and lower per capita income.

On the other hand, some scholars argue that while larger households may extract more forest products, their level of dependence varies based on economic activities and access to alternative livelihoods. Kiprop and Wambua (2020) observed that in some communities, large families with stable incomes were less dependent on forests since they could afford alternative energy and construction materials.

Karanja et al. (2019) further noted that household decision-making structures influence extraction patterns, as families with multiple income earners often diversify their sources of livelihood, reducing direct reliance on forests. However, Chomba et al. (2016) cautioned that in resource-scarce areas, larger households might exacerbate forest degradation, as they resort to overharvesting to meet their growing needs. These findings suggest that while household size is a key driver of forest resource extraction, interventions should focus on promoting sustainable alternatives and economic diversification to mitigate pressure on forest ecosystems.

v. Awareness of Forest Management

In the realm of forest product extraction, the awareness of forest management among stakeholders plays a pivotal role in shaping the sustainability and efficiency of extraction practices. Awareness of forest management is intricately linked with the promotion of sustainable practices in forest product extraction. Studies have shown that individuals with higher awareness are more likely to adopt conservation-friendly behaviors, while those with limited knowledge may engage in unsustainable extraction. Studies emphasize that heightened awareness among stakeholders, including local communities, policymakers, and industry players, contributes to the adoption of sustainable harvesting techniques (Njenga et al. 2020).

Owuor et al. (2020) examined the relationship between awareness of forest management practices and conservation behavior among rural communities. The study found that households with higher awareness levels were more likely to adopt sustainable harvesting techniques. However, the research also pointed out that enforcement of conservation policies remained weak, calling for strengthened institutional frameworks to enhance compliance.

According to a research Journal by Rist et al., (2012) on Challenges in integrating local and scientific knowledge for assessing forest ecosystem services, awareness fosters a deeper understanding of the ecological intricacies of forest ecosystems, promoting the implementation of selective harvesting methods and the preservation of biodiversity.: Lessons from case studies on International Forestry Review indicates that informed stakeholders are more likely to support initiatives aimed at reforestation and habitat restoration, thereby mitigating the environmental impact of extraction activities.

Karanja et al. (2018) found that in Kenya, only a small percentage of forest-adjacent communities were well-informed about forest regulations, leading to continued illegal logging and charcoal production. Similarly, Mutune et al. (2017) reported that low awareness of forestry laws contributed to poor compliance, with many rural households unknowingly violating conservation policies due to a lack of education on sustainable alternatives. Njenga et al. (2020) further noted that community-based sensitization programs improved local participation in conservation, suggesting that policy awareness is essential for reducing forest degradation.

Conversely, some scholars argue that while awareness is crucial, it does not always translate into compliance or reduced forest dependency. Mwaura and Mugambi (2019) observed that despite awareness campaigns, some households continued unsustainable extraction due to economic constraints and limited livelihood alternatives. Gelo and Koch (2018) also highlighted that enforcement mechanisms play a bigger role than awareness alone, as weak institutional frameworks allow for continued illegal exploitation even among informed individuals.

Additionally, Mwangi and Muthee (2020) emphasized the need for participatory approaches, noting that top-down policy dissemination often fails to resonate with local communities. These findings indicate that while awareness of forest management policies is necessary for conservation, it must be accompanied by economic incentives, enforcement, and community engagement strategies to ensure effective implementation.

vi. Period of Residence

The length of time a household has resided near a forest influences its interaction with forest resources, shaping both extraction behaviors and conservation attitudes. Long-term residents often develop deep knowledge of forest ecosystems and traditional resource use practices, which can either promote sustainable management or contribute to overexploitation. Kinyanjui (2019) found that households that had lived near Mt. Kenya Forest for over 30 years were more engaged in forest product extraction, primarily due to their historical dependence on the forest for fuelwood, timber, and medicinal plants.

Similarly, Muthee et al. (2019) reported that in Kenya’s Mau Forest region, long-term residents exhibited greater reliance on forest resources compared to newer settlers, who were more likely to seek alternative livelihoods. This aligns with the findings of Nyongesa and Ongugo (2019), who noted that familiarity with the forest environment and customary rights to resource use often led long-term residents to resist conservation restrictions, sometimes resulting in conflicts with forest authorities.

On the other hand, some studies suggest that newer settlers may also contribute to forest degradation, particularly when migration is driven by land scarcity and agricultural expansion. Chomba et al. (2016) highlighted that recent migrants to forest-adjacent areas often engage in unsustainable land-use practices, such as clearing forested land for farming and settlement, exacerbating deforestation. Ndegwa et al. (2020) observed that recent arrivals in Kenya's forest peripheries tended to have limited awareness of forest management regulations, leading to increased illegal logging and charcoal production.

However, Njenga et al. (2020) argued that with proper integration into community-based conservation programs, both long-term and recent settlers could be encouraged to adopt sustainable practices. These findings suggest that forest conservation strategies should consider the varying levels of dependency and awareness among long-term and new residents, implementing tailored interventions to promote responsible forest resource use.

2.4.2 Economic Factors Influencing Household Participation in Extraction of Forest Products

i. Income of the Respondents

Household income plays a significant role in determining the extent of forest resource extraction, as it influences access to alternative livelihoods and energy sources. Studies have shown that lower-income households are more dependent on forests for subsistence needs, including firewood, timber, and non-timber forest products. Mutune et al. (2017) found that in Kenya, approximately 65% of low-income households in forest-adjacent areas relied on firewood as their primary source of fuel, compared to only 20% of higher-income households who used alternatives like LPG and electricity.

Similarly, Nyongesa and Ongugo (2019) reported that over 70% of households earning below Ksh 10,000 per month engaged in activities such as charcoal production and small-scale logging, which often contributed to forest degradation. In Ethiopia, Gelo and Koch (2018) found that rural communities experiencing financial hardship increased their reliance on forest resources by 40% during economic downturns, highlighting the role of forests as a safety net for vulnerable populations.

Conversely, higher-income households tend to have more diversified income sources, reducing direct dependence on forest extraction. Kinyua et al. (2018) found that in Kenya, only 18% of households earning above Ksh 30,000 per month depended on firewood or charcoal, compared to 82% of those earning less than Ksh 10,000. Similarly, Kiprop and Wambua (2020) noted that individuals with stable formal employment had extraction rates 50% lower than those engaged in casual labor, as they relied more on purchased goods than harvested forest products.

However, Mwaura and Mugambi (2019) cautioned that higher income levels could sometimes lead to commercial exploitation, such as large-scale logging for timber businesses, particularly in Kenya’s Mau and Aberdare forests. These findings suggest that while poverty drives subsistence dependence, affluence can facilitate large-scale exploitation. Policies aimed at providing affordable alternative energy, promoting sustainable income-generating activities, and strengthening forest governance are essential to mitigate both subsistence-driven and commercial overexploitation.

Kiprop and Wambua (2020) focused on income diversification strategies for reducing forest dependency in Kenya, advocating for increased government support in alternative livelihood projects. Muthee et al. (2019) evaluated the effectiveness of participatory forest management (PFM) programs in Kenya, reporting that well-implemented PFM models improved conservation outcomes.

A few studies on the contribution of forest products to household welfare have been conducted in Zambia. In five of the eight sites studied in the Central, Copperbelt, and Northern Provinces of Zambia, Jumbe et al. (2007) estimated that the combined contribution of forest products to total household income was 20.6%, placing them among the top two sources of income. According to (Bwalya, 2013), in the provinces of Luapula, Central, and Eastern, forest products account for around 29.6% of all household income.

In northeastern Brazil, revenue from the collection and processing of babaçu palm kernels was demonstrated to contribute for 39% of income from cash and from total household income amounted to 34% during the seasonal agricultural lull. Many of the poorer farmers relied on this money to buy seeds and other planting supplies for the upcoming season (Nielsen et al. 2013).

ii. Occupation of the Household

Household occupations serve as a significant determinant of forest product extraction, as they dictate the need for resources and the extent of reliance on forests. Different occupational groups engage in varying levels and types of forest exploitation based on their economic activities, time availability, and resource needs.

Studies have shown that households engaged in subsistence and commercial agriculture often rely heavily on forest products for supplementary income and sustenance (Malla & Timilsina, 2015). Furthermore, the type of occupation influences the choice of forest products extracted, with artisanal and small-scale logging activities prevalent among communities' dependent on forestry-related livelihoods (Pokharel et al., 2019). These households frequently gather firewood and other non-timber forest products (NTFPs) to reduce household expenses. In contrast, households involved in commercial farming may have different extraction patterns. While they may still rely on the forest for certain products, they might also have the financial means to purchase alternative resources. However, they may exploit forest resources for commercial purposes, such as collecting medicinal plants or honey to sell in local markets, driven by the demand for additional income.

Households involved in livestock farming often depend on forested areas for grazing and fodder collection. Livestock farmers may drive their animals into forested areas for pasture, leading to potential overgrazing and forest degradation. The collection of fodder, such as grass and leaves, from the forest is also a common practice among these households. According to a study by Kinyanjui et al. (2021), overgrazing and fodder collection have significant impacts on forest regeneration and biodiversity.

Households with members employed in forest-related industries, such as timber and charcoal production, have a direct influence on forest product extraction. These occupations often involve large-scale extraction activities, which can lead to deforestation and forest degradation if not managed sustainably. The demand for timber and charcoal in urban areas drives these industries, creating economic incentives for increased extraction.

Conversely, households with members employed in conservation and ecotourism activities may have a more positive impact on forest management. These individuals often possess greater environmental awareness and may advocate for sustainable extraction practices. According to Mutune et al. (2019), employment in conservation-related fields can foster a sense of stewardship and responsibility towards forest resources.

Households with members engaged in non-farm employment, such as business or formal sector jobs, may have different forest resource extraction patterns compared to farming households. With alternative sources of income, these households might rely less on forest products for subsistence. However, they may still engage in the collection of high-value forest products, such as medicinal plants or honey, for supplemental income. Studies, such as those by Karanja et al. (2019), indicate that diversification of income sources can reduce pressure on forest resources, although the extent varies based on the nature of off-farm employment.

Households that depend on seasonal or casual labor may experience fluctuations in forest product extraction based on employment cycles. During periods of unemployment or low-income seasons, these households might increase their reliance on forest resources to meet their needs. For example, during the agricultural off-season, households may engage in more intensive extraction of firewood or NTFPs to compensate for reduced income. This cyclical pattern of extraction can lead to seasonal pressures on forest resources, impacting their sustainability (Karanja et al. 2020).

iii. Land Size of the Household

Land size plays a crucial role in determining household dependency on forest resources, as it influences agricultural productivity, income levels, and access to alternative resources. Households with smaller land sizes often have limited capacity to grow sufficient crops or rear livestock, leading them to depend more on forest products for fuel, fodder, and income generation.

Mutune et al. (2017) found that in Kenya, households with land sizes of less than one acre were 45% more likely to extract fuelwood and charcoal from forests compared to those with larger landholdings. Similarly, Nyongesa and Ongugo (2019) observed that small landowners in forest-adjacent communities were more engaged in timber harvesting and firewood collection, as they lacked alternative energy sources and construction materials. In contrast, households with larger land sizes had more opportunities to practice agroforestry, reducing their direct reliance on forests for essential resources.

The relationship between land size and forest extraction is also influenced by land-use practices and economic activities. Kinyua et al. (2018) found that in Kenya, households with land sizes above five acres were less dependent on forests, as they could cultivate sufficient fodder for livestock and grow trees for timber and fuelwood. However, Mwaura and Mugambi (2019) cautioned that while large landowners generally extract fewer subsistence-based resources, they may engage in commercial deforestation for agriculture and timber production.

In Ethiopia, Gelo and Koch (2018) reported that households with small land sizes relied on forests for up to 60% of their livelihood needs, highlighting the strong link between land scarcity and forest degradation. These findings suggest that promoting agroforestry, sustainable land management, and alternative livelihood strategies can help reduce forest dependency among small landowners while ensuring conservation efforts are effective.

Finally, it is constantly argued that understanding the relationship between land size and forest product extraction is crucial for designing effective policies and interventions. Targeted interventions aimed at improving land access and livelihood opportunities for small landholders reduce their dependence on forest resources (Sunderlin et al., 2015). Additionally, promoting sustainable land management practices and alternative income-generating activities can mitigate the pressure on forests from households with limited landholdings.

2.4.3 Environmental factors Influencing Household Participation in Extraction of Forest Products

i. Proximity to the Forest

The previous researches reported that as the distance to the forest edge grows, the rate of extraction reduces. This could lead to a lower proportion of a village's population using forest fuel wood or a decrease in the relevance of forests as a fuel wood source in general or it could be that accessibility reduces the cost and effort of harvesting, making it economically viable for local communities to extract forest products.

According to Nkonya et al. (2008), access to the village markets, infrastructure, and services affects awareness and hastens the depletion of natural resources. The study discovered that when market access expanded, so did the value of natural resources. They also propose that access to roads and communication infrastructure lowers the transaction costs associated with resource gathering, hence encouraging the use of forests in areas where institutions governing natural resources are weak or nonexistent. Harvesting woods near roads, for instance, is probably going to be less expensive than harvesting forests farther away from the road. In remote places without roads, law enforcement officers may face difficulties when employing the same mode of transportation to enforce legislation pertaining to natural resources.

Karanja et al. (2020) investigated the role of proximity to forests in determining the level of household participation in extraction activities. Their research showed a strong correlation between proximity and reliance on forest products, with households closer to forests engaging in higher levels of extraction. The study recommended targeted conservation programs focusing on communities residing near forested areas to minimize degradation risks.

Mwangi et al. (2013) conducted a study on the impact of road accessibility on forest product extraction in the Mt. Kenya Forest. They found that areas closer to roads and settlements experienced higher extraction pressures due to easier access for local communities. The reduced transportation costs and effort associated with accessible areas make them more attractive for harvesting activities.

This result is consistent with that of Banana et al. (2001), who discovered that forest resources in Uganda were used less near the capital city of Kampala than they were farther out. The forest department lacked the means to travel to isolated locations in order to police laws governing forest harvesting, which is why the authors explained their findings. The study also discovered a negative correlation between the degree of awareness of laws pertaining to tree planting and protection and the distance to all-weather roads. This finding suggests that towns located further away from all-weather roads may have less access to information regarding these laws.

ii. Forest Resources Available for Extraction

Currently, wood extraction for charcoal and firewood is the dominating activity, particularly in arid and semi-arid woods. The Ministry of Forestry and Wildlife's (2022) study on the fundamental factors influencing the changes in forest cover in Kenya's different forest types revealed that the country's primary direct drivers of forest cover loss were agricultural growth and the harvesting or extraction of wood for firewood and charcoal. Interestingly, the underlying drivers of deforestation and forest degradation tended to vary between regions even if they shared the same direct drivers.

Karanja et al. (2018) found that over 80% of households living near Kenyan forests depended on firewood for cooking, with an estimated 60% also engaging in charcoal production. Similarly, Njenga et al. (2020) highlighted that timber extraction for construction and furniture making is a significant activity, with some communities illegally harvesting indigenous tree species despite conservation regulations. In Ethiopia, Gelo and Koch (2018) reported that non-timber forest products such as wild fruits and medicinal plants were a crucial source of nutrition and income for low-income households, contributing to 30–40% of household earnings in some cases

The availability and sustainability of these forest resources are influenced by factors such as extraction intensity, forest management policies, and community participation in conservation efforts. Mutune et al. (2017) found that overharvesting of fuelwood and timber in Kenya’s forested regions has led to a decline in indigenous tree cover, increasing reliance on exotic species such as eucalyptus.

Similarly, Nyongesa and Ongugo (2019) observed that unregulated harvesting of medicinal plants had resulted in the depletion of key species, threatening traditional herbal medicine practices. In Malawi, Ndegwa et al. (2020) reported that communities extracting fodder for livestock had significantly altered forest regeneration patterns, affecting biodiversity and ecosystem stability. These findings suggest that while forests provide essential resources for local communities, unsustainable extraction practices pose a threat to their long-term availability. Strengthening policies on sustainable harvesting, promoting agroforestry, and enhancing community-based conservation efforts are crucial for ensuring that forest resources remain accessible for future generations.

Mwangi and Muthee (2020) studied household energy use patterns in Kenya, finding that firewood and charcoal remained primary energy sources despite the availability of cleaner alternatives. Chomba et al. (2016) explored reforestation initiatives and their social impacts in Kenya, emphasizing the need for community incentives to enhance participation.

Kwale District, which is already being targeted for a programme on sustainable charcoal production, has the main source of energy as wood energy (GOK, 2020) A proposal on REDD Readiness Preparation written and submitted to the Forest Carbon Partnership indicated that mining is also a key concern since it creates circumstances for settlement formation through employment and infrastructure development, in addition to the direct effects of mining sites. Commercial agriculture for white sugar and other biofuel crops in the Tana Delta would deplete forest area while also endangering fragile and biologically significant riverine and delta habitats. (GOK, 2020)

Over a million people in Uganda depend on the Mabira forest for their livelihood. The forest officers are faced with a challenge of balancing the provision of forest habitat for 27 species of endangered birds, endemic forest trees, and providing economic livelihood for the populations. Pressure on this forest includes agricultural plantation of tea and sugarcane. The result has caused forest encroachment, which in turn has caused a decrease of forest cover (Baranga, 2007).

The type of forest product extraction is also influenced by market access. In regions with good market connectivity, there is a tendency to extract high-value products that have a ready market. For instance, timber and charcoal are commonly extracted near accessible markets due to their high demand and lucrative returns. Conversely, in more remote areas with limited market access, local communities may focus on extracting products that are easier to transport and sell within local markets, such as non-timber forest products (NTFPs) like fruits, nuts, and medicinal plants. Studies such as those by Mwangi et al. (2013) have illustrated how market access drives the selective extraction of forest products based on their economic value and market demand.

The primary driver for agricultural expansion in the Mau and North Rift Conservancies has been both commercial and subsistence farming. This is because growing wheat and tea has taken up a large amount of forest area. This has been made possible by an unspoken government strategy that existed before 2002 that called for the removal of over 50,000 hectares of land from the Mau Forest Area alone. The primary underlying issues were governance and the demand for tea in global markets. (MFW, 2015).

2.5 Case Studies Review:

2.5.1 Introduction

Participation in the extraction of forest products in Kenyan forests, including the Mt. Kenya Forest, varies widely across different communities and regions. This review examines several case studies to understand the factors driving participation, the impact on forest ecosystems, and the effectiveness of different management approaches. The case studies provide insights into how local communities engage with forest resources and the implications for sustainable forest management.

2.5.2 Lessons Learned from unsustainable extraction practices

Case Study 1: Charcoal Production in Mt. Kenya Forest

Charcoal production is a significant economic activity for many households around Mt. Kenya Forest. However, it also poses a major threat to the forest due to unsustainable harvesting practices. Mugo and Gathui (2020) conducted a study on charcoal production in Mt. Kenya Forest, focusing on its socioeconomic and environmental impacts. The study found that charcoal production provides essential income for many households, especially during periods of low agricultural productivity.

This contributed to the economic importance of the forest product. However, the study also found that there is very high demand for charcoal in the urban areas which drives large-scale production leading to overharvesting of trees. In addition, there is very weak enforcement of regulations**.** Despite existing regulations, enforcement is often weak due to corruption and lack of resources, allowing illegal charcoal production to thrive.

On the other hand, residents apply traditional methods of charcoal production which are inefficient and wasteful, with significant loss of biomass during the process. The unsustainable charcoal production practices lead to deforestation, soil erosion, and loss of biodiversity. This contributes to the increased the revamping environmental degradation. On the contrary, while community members participate in charcoal production, they often lacked awareness about sustainable harvesting practices and legal regulations. This calls for community participation and creation of awareness.

The case study highlights the need for interventions to promote sustainable charcoal production techniques and alternative energy sources. Developing and promoting alternative energy sources, such as briquettes and solar energy, can reduce reliance on charcoal. Introducing more efficient charcoal production methods, such as improved kilns, can minimize waste and reduce environmental impact. Community education and awareness programs are essential to ensure that participation in charcoal production does not compromise forest sustainability. Enhancing the enforcement of regulations and involving local communities in monitoring and management can help curb illegal activities.

Case Study 2: Medicinal Plant Extraction in Kakamega Forest

Kakamega Forest, located in western Kenya, is known for its rich diversity of medicinal plants. Local communities rely on these plants for traditional medicine and income generation. A study by Kigenyi et al. (2012) investigated the extraction of medicinal plants in Kakamega Forest. In specific, Prunus Africana, is a medicinal plant, highly valued for its bark, which is used to treat various ailments. However, unsustainable harvesting practices have led to its decline in Kakamega Forest.

The study found that the high market demand for Prunus africana bark in the pharmaceutical industry drives overharvesting. Harvesters often strip entire trees of their bark, leading to tree death and reducing the plant's regeneration capacity. Inadequate management plans and lack of regulation enforcement have exacerbated overexploitation. In addition, this medicinal plant extraction is deeply rooted in the cultural practices of local communities and is an important aspect of their traditional knowledge systems. Initiatives involving local healers and community groups in the sustainable harvesting and cultivation of medicinal plants should promise reducing pressure on wild populations by practicing community based conservation.

The case study underscores the importance of integrating traditional knowledge with modern conservation practices. Educating harvesters on sustainable techniques, such as rotational harvesting and partial bark stripping, can help ensure the plant's regeneration. Community-based conservation initiatives can enhance the sustainability of medicinal plant extraction while preserving cultural heritage. Implementing comprehensive management plans that include inventory assessments, monitoring, and enforcement can help regulate harvesting activities. Encouraging the cultivation and domestication of Prunus africana can provide an alternative source of the medicinal plant, reducing pressure on wild populations.

Case Study 3: Illegal Logging in Mau Forest Complex

The Mau Forest Complex has faced extensive illegal logging activities, leading to severe deforestation and environmental degradation. Kipkoech et al. (2021) investigated the socio-economic drivers behind illegal logging in the Mau Forest Complex. The study found that poverty, lack of alternative livelihoods, corruption within forest management agencies and weak governance structures have allowed illegal logging to flourish. In addition, local communities often turn to illegal logging due to the lack of alternative income-generating activities. Insufficient resources and capacity for effective law enforcement have hindered efforts to combat illegal logging.

Deforestation: Illegal logging has resulted in extensive loss of forest cover, impacting the forest's ability to provide critical ecosystem services. Climate Change: Deforestation in the Mau Forest Complex has contributed to climate change by reducing the forest's capacity to sequester carbon. Water Resource Depletion: The degradation of the Mau Forest has affected water catchment areas, leading to reduced water availability for downstream communities and ecosystems.

Strengthening Governance and Transparency: Enhancing governance structures and increasing transparency in forest management can help reduce corruption and illegal activities. Community-Based Forest Management: Involving local communities in forest management through initiatives like PFM can promote sustainable practices and provide alternative livelihoods. Capacity Building and Resource Allocation: Increasing the capacity and resources for law enforcement agencies can improve their ability to monitor and control illegal logging activities.

2.5.3 Successful Models of Sustainable Extraction

Case Study 4: Participatory Forest Management in Arabuko-Sokoke Forest

The Arabuko-Sokoke Forest, located on the Kenyan coast, is one of the largest remaining fragments of coastal forest in East Africa. The forest is known for its rich biodiversity and provides critical ecosystem services to surrounding communities. Kigenyi et al. (2002) studied the implementation of Participatory Forest Management (PFM) in Arabuko-Sokoke Forest. The PFM approach involved local communities in forest management decisions and activities. First, the study found that PFM led to increased engagement of local communities in forest management activities, such as reforestation, fire control, and monitoring of illegal activities.

Secondly, Community members benefited from sustainable extraction of non-timber forest products (NTFPs), such as honey, medicinal plants, and ecotourism opportunities thereby enhancing their livelihoods. Finally, the involvement of local communities resulted in better protection of the forest, reduced illegal logging, and improved biodiversity conservation resulting in improved Conservation outcomes.

The case study demonstrated that involving local communities in forest management can lead to positive conservation outcomes and enhanced livelihoods. The PFM model in Arabuko-Sokoke Forest highlights the importance of community participation in achieving sustainable forest management.

Case Study 5: Ecotourism and NTFP Extraction in Mau Forest Complex

The Mau Forest Complex is one of Kenya's largest forest ecosystems and provides vital ecosystem services, including water catchment and carbon sequestration. Ecotourism and NTFP extraction are key activities in the area. Kariuki and Simiyu (2015) examined the role of ecotourism and NTFP extraction in the Mau Forest Complex. The study found that Ecotourism and sustainable extraction of NTFPs, such as honey and fruits, provide significant economic benefits to local communities.

Ecotourism generates incentives for forest conservation by creating alternative income sources that depend on the forest's health and biodiversity. This is a positive step to observing conservation incentives. Finally, the study found that there is increased community involvement. Effective ecotourism and NTFP initiatives involve local communities in planning, management, and benefit-sharing, ensuring that conservation efforts are inclusive and equitable.

The case study illustrates the potential of ecotourism and sustainable NTFP extraction to support both conservation and local livelihoods. Community involvement and equitable benefit-sharing are crucial for the success of these initiatives.

2.5.4 Summary of Case Studies

The reviewed case studies highlight the diverse ways in which local communities participate in the extraction of forest products in Kenyan forests. Successful models, such as Participatory Forest Management in Arabuko-Sokoke Forest and sustainable NTFP extraction in the Mau Forest Complex, demonstrate the benefits of involving communities in forest management. However, challenges such as unsustainable charcoal production in Mt. Kenya Forest, overharvesting of medicinal plants in Kakamega Forest and illegal logging in Mau forest complex indicate the need for targeted interventions, including education, sustainable practices, and alternative livelihoods. Integrating traditional knowledge with modern conservation strategies and ensuring effective governance are essential for achieving sustainable forest management. Future research should continue to explore innovative approaches to balance forest conservation with the socioeconomic needs of local communities

2.6 Summary of Literature Review

A large body of literature distinguishes between households who utilize forest resources voluntarily and those that use them because they have no other option. This classification is based on the assumption that although wealthier households participate in forest extraction for accumulation, poorer households do it for survival. According to this theory, low-asset rural families use activities related to forest extraction to fund their present consumption or prepare for risks and shocks like drought and floods (Nguyen et al. 2015). In contrast, wealthier households are drawn to the extraction of high-value forest products in order to increase their asset endowment. (Mutoko et.al 2015).

Recent research, however, has called into question these classifications of forest users by demonstrating that some impoverished households actively choose to engage in forest extraction in order to amass wealth (Yego et.al 2021). According to data, some affluent households participate in forest extraction to support consumption or prepare for shocks and dangers including crop failure and animal epidemics.

Economic considerations, division of labor, social dynamics, and environmental impacts are among the key factors through which social characteristics influences extraction patterns. Understanding these dynamics is essential for designing effective policies and interventions aimed at promoting sustainable forest management and livelihoods.

The period of residence emerges as a significant social factor influencing forest product extraction. Long-term residents exhibit distinct behavioral patterns, social dynamics, economic dependencies, cultural attachments, and interactions with governance systems compared to newcomers. Understanding these dynamics is essential for designing effective policies and interventions aimed at promoting sustainable forest management and conservation.

Age serves as a multifaceted determinant of forest product extraction, shaping knowledge systems, physical capabilities, decision-making processes, technological adaptation, and livelihood strategies within forest-dependent communities. Understanding the nuanced interplay between age and extraction activities is essential for promoting sustainable resource management and fostering inclusive development strategies.

As a result, the empirical data on the factors that influence the removal of forests is still fragmented and ambiguous.

2.7 The Conceptual Framework

2.7.1 Social Factors

i. Age of the respondent

The age difference was used to determine which group (young or old) were more involved in the business activities related to extraction of forest products. Younger household heads may have the physical capacity to engage in strenuous activities involved in extraction and trade of forest products more than the old. Age was also used to determine the awareness and adaptiveness to technology as well as knowledge of various uses.

ii. Gender of the Household

Gender serves as a fundamental social factor influencing various dimensions of forest product extraction, including labor division, access to resources, knowledge transmission, and socioeconomic outcomes. Households with a male head may have higher chances of being involved in physical and strenuous activities related to forest products such as charcoal production and logging. Household with female heads, may be involved in less strenuous activities such as collection of firewood and farming. Gender disparities need to be recognized and addressed in order to foster equitable and sustainable practices, thereby promoting inclusive development and enhancing community resilience.

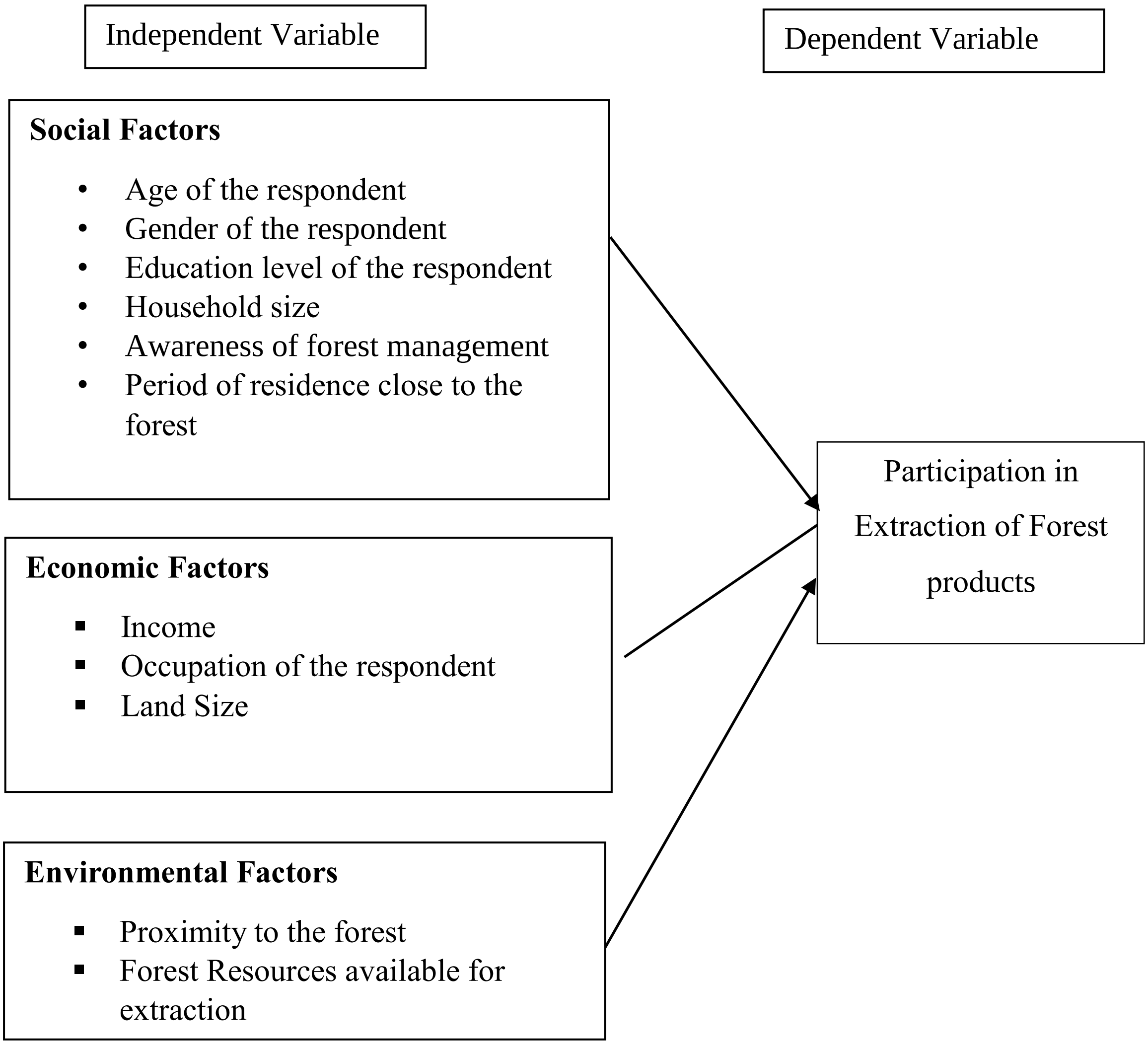

Figure 1: Conceptual Framework

***Source**: Author's Own Compilation, (2025)*

From the diagram, livelihood is a function of three factors i.e social, economic and environmental factors. These factors were evaluated so as to determine their influence in household participation in extraction of the forest products.

iii. Education Level

Education level affects awareness, income and decision-making regarding forest resource use since it impacts the livelihood activities a household participates in. Farmers who are able to read and write are less likely to disturb the reserve than those who have not attended school. This is because education enhances meaningful work opportunities, lowering the likelihood of participating in forest products activities. In contrast, higher education may mean employing sustainable extraction practices thereby fostering conservation and utilization of forest resources

iv. Household Size

Unquestionably, one of the most important socioeconomic variables that could change how forest resources are used is population growth. An increase in population density may lead to a higher likelihood to participate in forest resources extraction, presumably due to increased market for the forest products. Alternatively, the larger the household size, the higher the chances that the members will be involved in various livelihood strategies that depend on forests resources. However, as more families' extract, more pressure is placed on forests, resulting in a shortage of the products, leading to scarcity. Furthermore, a high population density may cause more forest land to be removed for cultivation and development, which would reduce the amount of available products.

v. Awareness of Forest Management Policies

Awareness of forest management was used to determine the enforcement of extractive activities. It was measured by household knowledge of conservation rules, sustainable harvesting techniques, and forest policies. Households with heightened awareness contributes to the conservation of forest resources and the enhancement of socio-economic well-being by promoting sustainable practices, fostering community engagement, and influencing policy formulation. On the contrary, if households are not aware of management practices, chances of over exploitation will be very high.

vi. Period of Residence Near the Forest

This may have either a positive or negative impact on extraction of forest products. Long-term residents exhibit distinct behavioral patterns, social dynamics, economic dependencies, cultural attachments, and interactions with governance systems compared to newcomers. Long term residents may preserve the forest or exploit it as a way of feeling entitled to its usage. Understanding these dynamics is essential for designing effective policies and interventions aimed at promoting sustainable forest management and conservation.

2.7.2 Economic Factors

i. Income of the Respondent

Higher-income households may have alternative energy sources and rely less on forests, while low-income households may depend more on extraction. If a household has other sources of income that are sufficient for them, there is a lesser chance of them being involved in the forest activities. This is because they will have a lower share of income from the forest products as compared to the total income and therefore less value from the forest products. In addition, poorer households are expected to have a high affinity to forest resources as a means of supplementing their incomes.

ii. Land Size of the Household

This will be measured by the size of land, in acres, a household has for cultivation. A household will yield more and become self-sufficient in terms of income and food security if it has a large plot of land to cultivate. Consequently, reduce pressure on the forest. On the contrary, households with small land holdings may be forced to venture into forest resources in order supplement their land for food security.

iii. Occupation of the Respondent

Occupation of the respondent was measured as the primary source of livelihood for the household head (e.g., farmer, salaried employee, not employed.) It is expected that respondents with a better occupation have better ways of gaining income, or are quite busy to be involved in extraction activities.

On the other hand, households who have no formal occupation will often rely heavily on forest products for supplementary income and sustenance. Furthermore, the type of occupation influences the choice of forest products extracted, with artisanal and small-scale logging activities prevalent among communities' dependent on forestry-related livelihoods

2.7.3 Environmental Factors

i. Proximity to the Forest

Households living closer to the forest, have higher the chances of participating in use of the forest resources. This may be because those households who live near the forest have no opportunity cost of walking there. The increased distance between homesteads and the forest limits the forest's contribution to the livelihood of local inhabitants.

ii. Forest Products Available for Extraction

The types and availability of forest products extracted plays a pivotal role as they directly influence the demand for and utilization of forest resources. Households may be involved in commercialization or domestic use of forest products such as lumbering, charcoal production, logging, farming in the forest land and firewood harvesting. Market dynamics and infrastructure affects the extraction for sale. Similarly, domestic use and house needs influence extraction. Over exploitation and overharvesting may lead to degradation thereby reducing the amount of forest resources.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Overview of the Chapter

This chapter is an account on how research was conducted. It includes the description of the study area, the research methods applied, the sample size and sampling procedures as well as the process used for data collection, the econometric model for the study and the analysis

3.1 Study Area

The research was conducted in the peripheries of Mt. Kenya Forest, within a radius of 10 km, in Mathira, Nyeri County. The county is located on the southwest flank of Mount Kenya. The Locals are predominantly of the Kikuyu ethnicity. Mt. Kenya lies at $00^0$10'S latitude and $37^0$18'E longitude. It is a solitary volcanic peak with a base diameter of around 120 kilometers, located 180 kilometers north of Nairobi on the equator. Its broad cone shape reaches an altitude of 5199 meters, with deeply incised U-shaped valleys in the top regions. The mountain is breathtaking, with its craggy peaks and tropical snow.

Mathira constituency is well known for its education, traditionally referred to as "Mathira ma Githomo" (The Mathira of Education). The largest open-air market in Kenya is found in Karatina and the people are known to be very industrious and hardworking with most activities starting at 4am and ending at 10pm. The major economic activities are agriculture and small scale mixed agro enterprises. The major cash crops are tea and coffee which largely finance the people of Mathira. Other small scale farming activities are livestock, maize, cabbages, potatoes and tomatoes.

Due to the proximity to Nairobi, Nyeri, and other towns surrounding Mount Kenya, small-scale farmers are guaranteed access to external markets, which has strengthened the local economy through external demand. Women make about 75% of the traders in Karatina Mathira East Constituency.

Activities related to agriculture make up 90% of the sales in Mathira Constituency. 70% of food is produced by women, much of which is either eaten at home or sold in the market to help support the family (Otieno 2012). Women in the counties of Nyeri, Tetu, and Mukurweini had a system of migrant labor between Nyeri and Ndia (in Kirinyaga County) as early as the 1920s.

There are two rainy seasons in the Mount Kenya region, from March to June and from October to November. Rainfall on the mountains varies from 900 mm in the north to 2300 mm on the slopes in the southeast that are exposed to the dominant breeze from the Indian Ocean. The majority of the mountain is covered in forest vegetation, with the majority of the native forest being protected within forest reserves.

The Mount Kenya, Imenti, and Ngare Ndare Forest Reserves are the three most significant and interconnected forest reserves on Mount Kenya. The indigenous forest of Mount Kenya encompasses a vast altitude range (from 1200 m to 3400 m), and there are significant climate changes across the slopes. As a result, the forest vegetation is very diverse. One of Kenya's five principal "water towers," together with the Aberdare Range, Mau Complex, Cherangani Hills, and Mt Elgon, Mount Kenya is crucial to the country's water catchment. Together, these four "water towers" supply the majority of the country's water.

3.2 Research Design

This study incorporated a cross- sectional survey research design. Both descriptive and Analytical research design were used. Descriptive analysis included surveys and fact-finding enquiries through administration of questionnaires and interviews.

Results were presented using tables, frequencies and means. The main importance of descriptive analysis was to present the state of affairs as they existed. Analytical research design was used to analyze the acquired information so as to establish the relationship between the dependent and independent variables. It was used to make estimates, test hypothesis and make predictions.

3.3 Target Population

This study targeted all rural households living within a radius of 10km (Fisher, 2004), in the peripherals of Mt. Kenya Forest in the sub-locations of Nyeri County. The estimated population is 23,552 households (KNBS,2019)

3.4 Sampling Technique

Multistage sampling was used to narrow down the study area from county level to sub location level. From Nyeri county to Mathira Constituency to Magutu location. This location was specifically selected since it's the only location nearest to the forest and whose selections have direct access to the forest. Magutu location has five sublocations namely Karatina, Magutu, Ragati, Muthea and Gathehu. Purposive sampling was used to deliberately choose the three sub locations where there are households living within a radius of 10km in the peripheries of Mt. Kenya.

The three sub locations near the forest are Muthea, Magutu and Gathehu. The sampling frame was all the households living in all the villages of these three sub locations. Once the sample frame was established, Simple Random Sampling was used to select households from each village of the selected sub locations. Using proportionate probability distribution, a sample size of 378 household heads was used for the study.

SUB-LOCATION	VILLAGES	TOTAL	PERCENTAGE	SAMPLE SIZE
GATHEHU		**1,682**	**25.76%**	**97**
	Gathehu	729	43.36%	42
	Giakaibei	624	37.11%	36
	Ndumanu	329	19.54%	19
MAGUTU		**2,452**	**37.54%**	**142**
	Gaikuyu	809	32.99%	47
	Gitimaini	334	13.62%	19
	Gitunduti	1,309	53.39%	76
MUTHEA		**2,398**	**36.70%**	**139**
	Gatei	718	29.94%	42
	Kagochi	837	34.91%	48
	Kanjuri	843	35.15%	49
TOTAL				**378**

3.5 Sample Size

The approach described by (Kothari, 2004) was used to determine the sample size. The author states that to estimate the sample size of a given population the formula below is used.

$$n = \frac{z^2 pqN}{e^2(N-1) + z^2 pq}$$

Where:

n = Sample size.

z = The standard variate value at a given confidence level, which may be calculated using the table that displays the area under the normal curve. z = 1.96 at 95% confidence level

p = The proportion of the sample. The study assumed a p value of 0.5.

q = 1 – p

N= shows the target population- 23,552 households.

E= the error term. The assumed value of 0.05 was used.

Using the above formula, a sample size of 378 respondents was arrived at.

3.6 Data Types and Sources

Both primary and secondary data types were used.

Primary data was directly obtained from the selected respondents. This source provided first-hand information collected through administration of well-structured questionnaires, interviews, and participant observation. The questionnaires were designed to acquire information on the relationship between the rural livelihoods and extraction of forest products.

Secondary data aimed at complimenting the results of primary data. The data was used to provide already documented information relating to this area of study. Information obtained from books, scholarly journals and published dissertations was used to write the Literature on this study. Government publications and reports such as Kenya National Bureau of Statistics(KNBS) and County Annual Development Plans (CADP) were used to obtain data on population size, number of households in the targeted sub locations, economic activities of the area, deforestation and extraction rates

3.7 Research Instruments

The study adopted a semi-structured survey questionnaire as the primary tool for collecting quantitative data. It was divided into two sections; the first section was to determine the factors influencing participation and the second section established the people forest interactions. Most questions were treated as categorical awhile others were continuous variables. The questionnaires captured all the rural households living in the peripheries of Mt. Kenya forest. A total of 378 questionnaires were issued.

The questions were designed to acquire information on the relationship between the rural livelihoods and extraction of forest products.

3.8 Reliability Analysis using Cronbach's Alpha

Cronbach's alpha is typically evaluated in empirical research to determine the dependability of a collection of question items (Henson, 2001). According to Cronbach (1951), internal consistency evaluates the reliability coefficient alpha and is defined as the percentage of test variation attributable to a set of items:

$$\alpha = \frac{I}{I-1}\left(1 - \frac{\sum_{i=1}^{I}\sigma_i^2}{\sigma_X^2}\right) \qquad (3.1)$$

$n = 1, 2, 3\cdots, I$ are the numbers of items in the scale a used in this model, σ_i^2 is the variance of item i, and σ_X^2 is the variance of the observed total test scores. A high Cronbach's alpha value indicates that the construct X^2 has a better level of internal consistency. Yet it does not imply uni-dimensionality of X, however, the interpretation of X depends on the dimensionality and the construct validity (Cortina, 1993) and (Schmitt, 1996).

3.9 Descriptive Statistics

Descriptive statistics was used to give the true description of data as it was. The approach was quite useful in examining all of the quantitative data. In this scenario, cross tabulation, frequency tables, and generic statistics such as mean and standard deviations of specific variables were used. Descriptive measures were developed for household characteristics such as age, gender, and income levels, allowing the study to better understand their socioeconomic status as a potential predictor of their engagement in forest product extraction.

3.10 Specification of Econometric Models

The following econometrics models were specified and estimated.

3.10.1 The Binary Logit Model

Empirical research typically employs three statistical functional forms for analyzing binary choice problems, including the Linear Probability Model, Probit Model, and Logit Model. The linear probability models/Tobit model, models a censored dependent variable, where the outcome is partially observed (e.g., when data is cut off at a lower or upper limit). The model assumes the dependent variable is a latent (unobservable) variable that follows a normal distribution, but its observed value is censored due to limits in measurement or data collection. The link function is linear. These characteristics do not make this model a suitable one for this study since it can only be used for situations like modeling expenditure where some data points are zero (e.g., people who didn’t purchase anything).

The Probit Model on the other hand predicts a binary dependent variable but it assumes the normal (Gaussian) distribution instead of the logistic distribution to model the probability of the outcome. The Outputs probabilities is between 0 and 1. It has a Symmetric S-shaped curve, similar to the logit model but slightly steeper in the tails. The link function is the probit function, which uses the cumulative distribution function (CDF) of the normal distribution. This model is often used in economics and fields where a normal distribution assumption is preferred and therefore is was ruled not suitable for this study.

The Logit Model is also used to Predicts a binary dependent variable (e.g., 0 or 1, true or false, participate or not participate). The Key Assumption is that it uses the logistic distribution to model the probability of the outcome. The link function is the logit function. This model was chosen for this study because the outputs probabilities lies between 0 and 1 and is characterized by a symmetric S-shaped curve. The sampled model considered in this research explored how participation of extraction of forest products was affected by independent covariates. The model postulates that the probability (P) of a household participating in extraction of forest products is a function of some livelihood factors (X_i). The model uses a logistic curve to transform binary responses into probabilities within the 0 - 1 interval.

The binary logit model that was estimated is represented below.

In this model Λ indicates a link function, the cumulative standard logistic distribution function (Cameron and Trivedi 2009). The probability that Y equals 1 given X is equal to the logistic function, denoted by Λ(Xβ), which is the inverse of the logit link function. This is expressed as the exponential of Xβ divided by one plus the exponential of Xβ.

$$\Pr(Y = 1 | X) = \Lambda(X\beta) = \frac{\exp(X\beta)}{1 + \exp(X\beta)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3.2)}$$

Where:

Pr(Y=1) - Probability of household participation in forest extraction.

Y- Participation in extraction of forest products

X- Livelihood Factors: Defined in this research as social, economic and environmental factors

Λ - Indicates a link function

B- Beta multiplier

e = Exponential function (approximately 2.718).

The prediction equation is as follows

$$Log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n X_n \text{..............................} \quad (3.3)$$

Where:

P(Y=1) = Probability of household participation in forest extraction.

β0 = Intercept (constant).

β1,β2,...,βn = Coefficients of independent variables.

X1,X2,...,Xn = Independent variables (e.g., household size, age, income, proximity to forest).

3.10.2 Measuring Goodness of Fit of the Model

To evaluate a Logit model, both goodness of fit metrics and estimated coefficients must be examined (Long and Freese, 2003 and Allison, 1991). According to the model specification, a measure of goodness of fit must be estimated (Cameron and Trivedi, 2005). The process should be facilitated by employing an analysis of the percentage correction prediction method.

The model that was used to estimate the goodness of fit is described as follows:

$$\hat{Y}_i^* = 1 \ if \ Y_i^* > 0.5 \quad and \quad \hat{Y}_i^* = 0 \ \ Otherwise \text{..................................} \quad (3.3)$$

A two by two matrix is generated. The generated matrix was then used to calculate percentage of correct prediction for both conditions $Y_i = 1 \ and \ Y_i = 0$. Following Greene (2008) the next test was to calculate a Pseudo R-squared by applying the following model specification;

$$Pseudo\, R - Squared = 1 - \ In\, L / InL_0 \text{..} \quad (3.4)$$

In this model L_0 is the log likelihood from the model with a constant term only (Greene 2007).

3.10.3 Procedure for Data Processing and Analysis

After examining and editing the questionnaires for completeness and consistency, 361 questionnaires were identified as useful for analysis and assigned a serial number based on the sub location of administration. The survey questions were numerically coded and stored in Microsoft Excel spreadsheet software, with variable names assigned.

The data was then exported to STATA 12.0 Econometrics software for regression analysis. Inbuilt commands for Logit estimation, likelihood ratio test, goodness of fit, sigma and pseudo R-Squared were used. Descriptive statistics such as means, maximum, minimum and deviation values were used to summarize quantitative variables. Key econometric assumptions such as multi-collinearity, autocorrelation and heteroscedasticity were considered and tested as necessary. The problem of autocorrelation was assumed to be minimal because the study utilized a cross-sectional data set

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.0 Overview of the Chapter

This chapter entails the reliability analysis, results and discussions for the descriptive statistics, Logistic regression analysis and the test of hypothesis for the study.

4.1 Reliability Analysis

The first stage of the analysis was to perform Cronbach's alpha analysis in order to check the reliability of the research instrument; whether the instrument was consistent with the study. The value of Cronbach's coefficients Alpha is generally required to be 70 percent and above. With 10 items in the scale, average inter item covariance was found to be 0.5998, average inter item correlation was found to be 0.0724 and scale reliability coefficient of 70.17 percent for the variables under study. The results also showed that the entire items had their reliabilities above 70 percent. Therefore, it was concluded that the research instrument was reliable and suitable for data analysis and interpretation.

4.2 Response Rate

From the sample size formula in chapter 3, a sample size of 378 respondents had been arrived at. However, some challenges were encountered during data collection and cleaning. some respondents were not cooperative while others never returned the questionnaires. During data cleaning some questionnaires were not properly filled and others had unreliable data. In view of this, out of the 378 respondents, only 361 respondents were captured and found suitable for this study.

$\frac{361}{378} \times 100 = 95.5\%$...(4.1)

A response rate of above 50% is standard. Therefore, the response rate of 95.5% is considered excellent and acceptable as a representative of the population. It was large enough to allow reasonable and accurate interpretation of the results.

4.3 Descriptive Statistics

4.3.1 Participation in Extraction of Forest Products

The study sought to find out the number of households participating in extraction of forest products. The results are reported in figure 4.1.

Among the 361 respondents sampled, results show that 77 percent (279 respondents) of the households actually do participate in extraction of forest products and only 23% are non-participants. A further prompt as to what they do with the forest products indicate that majority use it for both commercial and domestic needs (table 4.1). This shows a very high rate of extraction of forest resources and exactly what was expected as the basis for this study.

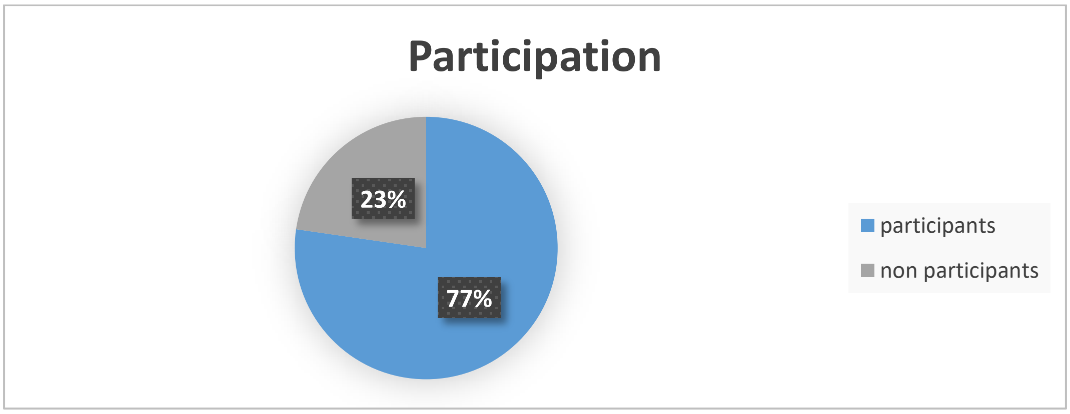

Figure 2:Participation in Extraction of Forest Products

4.3.2 Reasons for Extraction of Forest Products

The respondents were asked what was their major reason for extracting forest products. The results are as shown in Table 1 below.

Table 1: Reasons for Extraction of Forest Products

Reason for Extraction	Frequency	Percent
Domestic use	73	20.22%
Commercial Use	32	8.86%
Multipurpose	256	70.91%

Majority of the respondents amounting to 70.91% extract products for multipurpose use i.e they sell some and some others they use it for domestic purposes. This is followed by 20.22% whose households use it for purely domestic purposes. Only 8.86% extract the products purely for commercial purposes.

Several studies have documented the high rate of forest product extraction in Kenya, with significant community participation for both domestic and commercial purposes. Mutaki (2018) found that over 70% of households surrounding Kakamega Forest actively extract resources such as fuelwood, charcoal, medicinal herbs, timber, fodder, and honey, with firewood and fodder primarily used for domestic needs, while charcoal and timber are often sold for income. Similarly, Yego et al. (2021) reported that in the Mt. Elgon region, more than 65% of households rely on forest products, with firewood mainly for household use and timber extracted for both subsistence and commercial purposes. These findings highlight the widespread dependence on forest resources, increasing pressure on Kenya's forests and calling for sustainable management strategies.

4.3.3 Forest Products Extracted by Households

The major forest activities practiced by the rural households living in the peripherals of Mt. Kenya forest are Farming, firewood collection, charcoal burning and Lumbering. Firewood collection being practiced by the majority with 36.01 percent, followed closely by lumbering then farming and a smaller percentage doing charcoal production. Firewood collection maybe used for domestic needs especially as a source of energy for the households. Those who do farming in the forest may use the farm products for their own subsistence or they can sell to earn income. Lumbering and charcoal production can be used mostly for commercial purposes. These activities are aa major cause of degradation and therefore sustainable extraction is needed for the benefit of both the forest and the households. Collection of herbs and medicinal products are rare practices in this area.

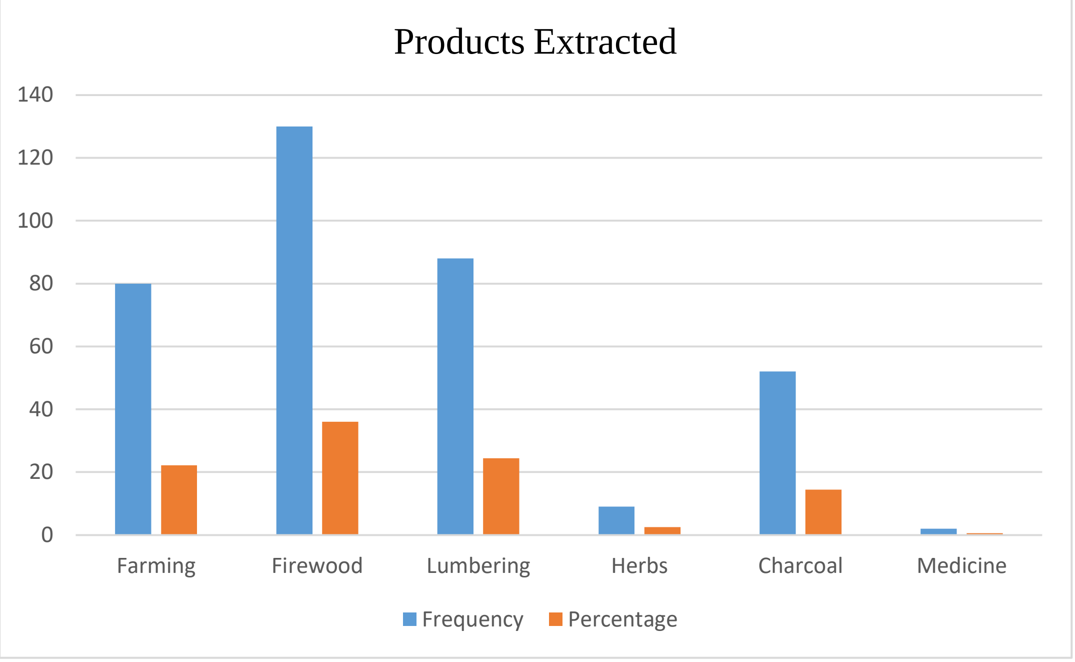

Figure 3:Descriptive Statistics of the Major Forest Extraction Activities

Previous scholars have highlighted the diversity of forest products extracted in Kenya and their significant impact on both local communities and forest resources. Yego et al. (2021) found that in Mt. Elgon, widespread extraction of timber for commercial purposes and firewood for domestic use has contributed to deforestation, reducing forest cover and affecting water catchment areas. Additionally, Mutaki (2018) identified firewood, charcoal, timber, medicinal plants, fodder, and honey as the most commonly harvested resources in Kakamega Forest, with firewood being the primary source of household energy.

While these resources support livelihoods by providing fuel, income, and medicinal benefits, overharvesting has led to forest degradation and biodiversity loss. These studies collectively emphasize the need for balancing resource use with conservation efforts to ensure long-term benefits for both communities and the environment.

4.3.4 Age of the Respondent

Table 2 presents descriptive statistics of age. Majority of the household heads were 41 years and above showing a greater percentage of 72.58% (36.57% for respondents between 41-50years and 36.01% for respondents above 50 years). Only 25% were between the age of 31-40 years and 2% between 18-30 years. These results indicate that the older generation is predominant in the rural areas and are more involved in extraction of forest products compared to the younger generation.

Table 2: Descriptive Statistics of Age

Age Bracket	Frequency	Percent
18 – 30 Years	8	2.2
31 - 40 Years	91	25.21
41 – 50 Years	132	36.57
Above 50 Years	130	36.01

Source: Research Data, 2025

The results indicating that individuals aged 40 years and above are more involved in forest product extraction can be attributed to several socioeconomic and cultural factors. Older individuals often have greater knowledge and experience in harvesting forest resources, having engaged in these activities for a longer time. They also tend to rely on traditional skills to collect fuelwood, medicinal plants, and fodder, which are essential for their livelihoods. Furthermore, many older adults have limited alternative income sources, making them more dependent on forest products for both domestic use and commercial purposes.

Unlike younger individuals, who may pursue formal employment or migrate to urban areas, older individuals are more likely to remain in rural settings where forest extraction is a key economic activity.

These findings align with previous studies. Mutaki (2018) observed that in Kakamega Forest, older individuals were more engaged in fuelwood collection and charcoal production due to their familiarity with traditional methods and their limited access to alternative energy sources. Similarly, Yego et al. (2021) reported that in Mt. Elgon, older members of the community were more involved in timber and firewood extraction, as younger individuals often sought off-farm employment.

However, Karanja et al. (2020) found that younger people are increasingly involved in commercial extraction activities, particularly in charcoal production and timber harvesting, driven by high unemployment rates. These comparisons suggest that while older individuals dominate forest extraction in many areas due to experience and necessity, economic pressures may also push younger individuals to participate, especially in commercial ventures. This brings out the necessity to incorporate traditional harvesting skills with modern harvesting skills for sustainable harvesting.

4.3.5 Gender of the Respondent

Table 3: Descriptive Statistics of Gender

Gender	Frequency	Percent
Male	151	41.83
Female	210	58.17

Source: Research Data, 2025

Among the 361 respondents, results show that the female headed households 58.17% are more than the male headed households (41.83%). This implies that more women were involved in participation of extraction of forest products. More women participating in extraction of forest products can be attributed to economic vulnerability, household responsibilities, and limited alternative livelihoods.

Women rely on resources like firewood, charcoal, and fodder for both subsistence and income. Without male support, they face greater pressure to provide for their families. Additionally, women in rural areas typically have fewer employment opportunities and limited access to land and financial resources, making forest extraction one of the most accessible economic activities. Studies by Mutaki (2018) and Yego et al. (2021) confirm this trend in Kakamega and Mt. Elgon forests that female-headed households are more dependent on forests for survival, with firewood collection being a primary responsibility. This highlights the need for alternative livelihoods and sustainable forest management.

The study results are in agreement with some studies that concluded that harvesting of food products from the forest is usually viewed as women's work because of gender norms that limit them to reproductive and subsistence-based roles (Pouliot and Treue 2013; Powel et al. 2013). Their results explained why female-headed households extracted wild vegetables at a higher intensity for home consumption.

However, these results are in contrast with several studies which advocated for different gender roles. These studies came out discouraging women from participating in forest activities especially extraction for commercial purposes. (Mai et al. 2019; Amevenku et al. 2019). Their findings are consistent in showing limited engagement in commercial- based forest livelihood among women.

In addition, some studies indicate that men naturally dominate the jurisdiction over forest resources which could imply an uneven access to forest activities thus disadvantaging women. (Lidestav 2010; Nguyen et al. 2015)

4.3.6 Education level of the Respondent

Table 4 represents the education level of the respondents. The results indicate that most respondents involved in forest product extraction have at least some formal education, with the majority (50.69%) having attained secondary education, followed by 32.41% with primary education.

Table 4:Descriptive Statistics of Education

Education Level	Frequency	Percent
No formal education	9	2.5
Primary	117	32.41
Secondary	183	50.69
Tertiary	52	14.40

Source: Research Data, 2025

This suggests that forest-dependent communities have a moderate level of literacy, which may influence their understanding of sustainable extraction practices and alternative livelihood opportunities. The 14.40% of respondents with tertiary education likely have access to better employment opportunities outside forest-related activities, reducing their reliance on forest resources. The low percentage (2.5%) of those without formal education suggests that even individuals with minimal schooling still engage in forest extraction, possibly due to limited economic alternatives.

These findings align with previous studies. Kibet et al. (2020) found that in Kenya’s Mau Forest region, individuals with lower education levels were more involved in firewood and charcoal collection, as formal employment opportunities were scarce.

Similarly, Kamau and Ngugi (2018) reported that in the Aberdare Forest area, higher education levels were associated with reduced dependence on forest resources, as educated individuals were more likely to seek alternative livelihoods. Education is an important issue in development of livelihood strategies as it determines which livelihood activity a household is involved in.

4.3.7 Occupation of the Respondent

The study sought to determine the different occupations of the rural households and the results were as shown in Table 5. Majority of the respondents were basically farmers representing 74.79 percent of the rural households. This was followed by 16.62% who were salaried employees. Only a small percentage represented casual labourers and those who were totally unemployed at 3.88% and 4.71% respectively.

Table 5:Descriptive Statistics of Occupation

Primary Occupation	Frequency	Percent
Unemployed.	17	4.71
Farmer	270	74.79
Casual labourer	14	3.88
Salaried employee.	60	16.62

Source: Research Data, 2025

The results indicate that farming is the primary source of livelihood for most rural households, with 74.79% of respondents engaged in agriculture. This explains their reliance on forest resources for farming, firewood and charcoal production for their subsistence and income. The relatively small proportion (16.62%) of salaried employees' highlights limited formal employment opportunities in rural areas, making agriculture the dominant economic activity. Casual laborers (3.88%) and the unemployed (4.71%) form a minority, likely reflecting seasonal employment patterns and economic challenges that limit stable job opportunities.

These findings are consistent with previous studies. Owuor et al. (2020) found that in rural Kenya, farming remains the backbone of household economies, with many families combining it with forest resource extraction to sustain their livelihoods. Similarly, a study by Kinyanjui (2019) in Nyeri County revealed that limited access to formal employment pushes most rural dwellers into agriculture, often supplemented by informal work. However, Chikulo (2017) in Malawi observed that casual labor and informal trade are increasingly becoming key sources of income for landless rural households, particularly where land fragmentation limits farming opportunities. These comparisons highlight the central role of agriculture in rural economies, while also underscoring the need for employment diversification to reduce pressure on natural resources.

4.3.8 Household Size of the Respondent

The study sought to establish the size of the rural households. The results are as shown in table 6 below.

Table 6:Descriptive Statistics of Household Size

Household Size	**Frequency**	**Percent**
Below 2 people	25	6.93
3-5 people	42	11.63
5-8 people	175	48.48
Above 8 people	119	32.96

Source: Research Data, 2025

The results indicate that most households in the study area are relatively large, with 46.48% having between 5 to 8 members and 32.96% having more than 8 members.

This suggests a high dependency ratio, where more household members rely on limited resources for sustenance. Large household sizes often increase the demand for essential resources such as firewood, food, and fodder, leading to higher rates of forest product extraction. Additionally, families with more members may engage in diverse income-generating activities, including farming and forest resource harvesting, to meet their needs.

These findings align with previous research. Mutune et al. (2017) found that in rural Kenya, larger households exert more pressure on forests due to increased energy and food needs, often leading to unsustainable resource extraction. Similarly, Nyongesa and Ongugo (2019) in their study on forest-dependent communities observed that households with more members are more likely to extract firewood and timber for both domestic use and commercial purposes.

However, a study by Ndegwa et al. (2020) noted that some large households diversify their income by engaging in non-forest-related economic activities, reducing their direct dependence on forests. These studies highlight the link between household size and natural resource utilization, emphasizing the need for sustainable livelihood strategies to balance household needs with environmental conservation.

4.3.9 Income of the Respondent

Most of the respondents 39.89% had an average monthly income of between Ksh 5,000 and 10,000 from all their sources, followed by 25.48% who were earning a total of less than 5000 Kenya shillings per month. The smaller percentages of 18.01% and 16.62% had over 10 000 and 20000 respectively.

Table 7:Descriptive Statistics of Income of Respondent

Income in Kshs	Frequency	Percent
Below 5000	92	25.48
Between 5000 and 10000	144	39.89
Between 10000 and 20000	65	18.01
Above 20000	60	16.62

Source: Research Data, 2025

This suggests that most rural households have low-income levels, which may drive them to rely on forest products, for both subsistence and income generation. The smaller percentage of respondents earning above Ksh 10,000 (18.01%) and Ksh 20,000 (16.62%) indicates that only a few households have relatively stable or higher-income sources, likely from formal employment or business ventures. Low income often limits access to alternative energy sources, reinforcing dependence on firewood and charcoal as primary energy sources.

These findings are consistent with other studies on rural livelihoods. For instance, Kinyua et al. (2018) found that low-income households in rural Kenya are more likely to engage in forest extraction activities as a means of supplementing their earnings. Similarly, Njenga et al. (2020) observed that in areas with limited economic opportunities, households with lower incomes depend more on forests for fuelwood, timber, and other resources to sustain their livelihoods.

However, a study by Mwaura and Mugambi (2019) suggested that communities with access to alternative income sources, such as formal employment or small businesses, tend to reduce their reliance on forest products. These studies highlight the strong link between income levels and forest dependency, emphasizing the need for livelihood diversification and sustainable resource management.

4.3.10 Period of Residence

The study sought to know how long the residents had lived in the peripheries of Mt. Kenya. Results show that Majority of the residents 47.65% had lived there for more than 30 years while the smallest percentage 11% had been there for less than 10 years. Living in a place for such a long time creates a tradition of familiarity with the forest owing to the close proximity of these residents to the forest. Long-term residents are more likely to have traditional knowledge of forest utilization, including both sustainable and unsustainable harvesting practices. Newly settled households may have different forest use patterns.

Table 8: Period of Residence of the Respondent

Period of Residence	**Frequency**	**Percent**
Below 10 years	40	11.08
11-20 years	63	17.45
21-30 years	86	23.82
Above 30 years	172	47.65

These findings are in line with previous studies. Karanja et al. (2018) found that in rural Kenya, communities with long-term settlement near forests tend to rely heavily on forest products for fuel, construction, and medicine, often passing down extraction practices across generations. Similarly, Kiprop and Wambua (2020) observed that long-term residents in the Mau Forest region had a greater impact on forest resources due to established farming practices and high fuelwood dependency.

However, a study by Muthee et al. (2019) in Aberdare Forest noted that new settlers, particularly those engaging in commercial activities, could accelerate deforestation at a faster rate than long-term residents. These findings highlight the complex relationship between settlement duration and forest resource use, emphasizing the need for sustainable management practices targeting both long-term and new residents.

4.3.11 Awareness of Forest Management Practices

Table 9 below shows that majority of the households (61.5% percent) lack full awareness and understanding of forest management practices, while only 38.5% are aware.

Table 9: Descriptive Statistics of Forest Management Awareness

Awareness	Frequency	Percent
Aware	139	38.50
Not Aware	222	61.50

This suggests a gap in knowledge regarding conservation efforts, sustainable resource use, and the role of communities in forest protection. It also indicates that households may not apply sustainable extraction practices. Limited awareness may stem from inadequate education programs, weak enforcement of conservation policies, or lack of direct engagement with forest management authorities. Without proper knowledge, households may continue unsustainable extraction practices, accelerating deforestation and environmental degradation. On the other hand, the 38.5% of respondents who are aware of forest management practices may have benefited from conservation training, community-based forest programs, or exposure to environmental policies. However, this percentage remains low, indicating the need for broader outreach and education initiatives.

These findings align with previous studies on community participation in forest conservation. Karanja et al. (2019) found that in the Mau Forest region, lack of awareness significantly contributed to illegal logging and unsustainable firewood collection, as many households did not understand the long-term impact of deforestation. Similarly, Kiprop and Wambua (2021) reported that in Aberdare Forest, communities with more knowledge about forest management were more likely to engage in conservation efforts and sustainable livelihoods such as agroforestry. However, a study by Mwangi and Muthee (2020) in Kakamega Forest showed that even when awareness levels were high, economic constraints often forced communities to continue unsustainable practices. These studies suggest that while awareness is crucial, it must be complemented by alternative livelihood support and strong policy enforcement to achieve.

4.3.12 Willingness to Conserve Without Pay

As a follow up question for awareness, the respondents were asked if they would be willing to participate in Community Forest Associations (CFA) and engage in community activities such as forest education, soil conservation and tree planting in Mt. Kenya forest without any pay.

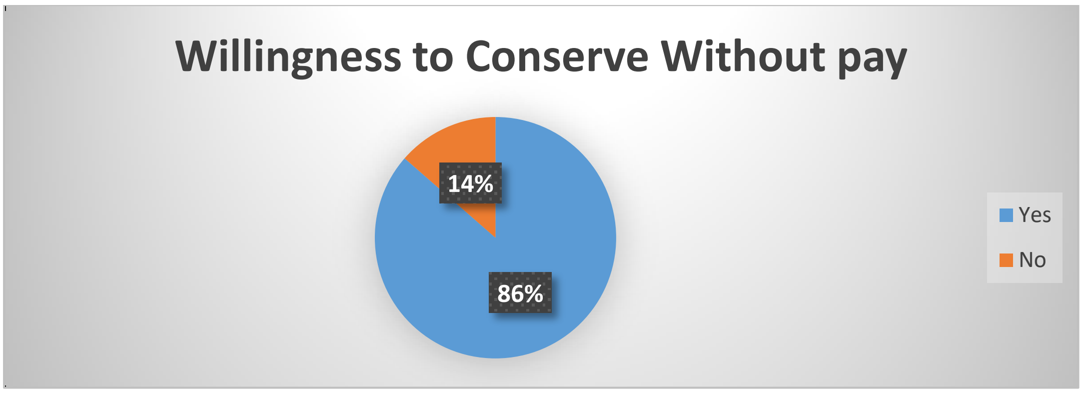

Figure 4: Willingness to Conserve Without Pay

The results were quite encouraging with 86% of the respondents willing to engage in communism without any pay. These results shows that the households are ready to improve their surroundings in order to curb the rate of deforestation as well as conserve the forest. The willingness to participate without pay may stem from the direct benefits they derive from the forest, such as firewood, timber and agricultural benefits for both domestic and commercial use, which motivates them to protect these resources for long-term sustainability.

Additionally, cultural and traditional values may play a role in fostering a conservation mindset, where communities view forests as part of their heritage and are willing to safeguard them voluntarily. However, 14% of the households not willing to participate could be hindered by economic constraints, competing livelihood needs, or lack of structured conservation programs that harness this community enthusiasm into meaningful action.

Studies support the finding that communities willingly engage in conservation due to perceived long-term benefits. Mutune et al. (2017) found similar trends in Kenya's Mau Forest, where residents participated in afforestation to secure water sources. Chomba et al. (2016) in Tanzania also observed voluntary reforestation efforts linked to improved soil and climate conditions. However, Gelo and Koch (2018) in Ethiopia emphasized that while willingness is high, providing incentives like training and alternative livelihoods enhances long-term conservation success. This suggests that structured support can maximize community efforts in forest conservation.

4.4 Diagnostic Analysis

Logit regression analysis was tested for heteroscedasticity to ensure that there was constant variance. Results of Breusch-Pagan and Cook-Weisberg test for heteroscedasticity indicated constant variance (p –value 0.9872 > 0.05). Also the model was tested for identification. Results showed that the estimated model was correctly specified both AIC and BIC were > 30.

Table 10: Diagnostic Analysis Results

Test Statistics	Df	χ^2 (1)	P –Value
Breusch-Pagan		0.00	0.9872
Cook-Weisberg		0.00	0.9872
Cameron & Trivedi's decomposition of IM-test			
Heteroskedasticity	57	205.07	0.0675
Skewness	10	18.75	0.0435
Kurtosis	1	3.08	0.0790
Total	68	226.90	0.0000
Ramsey RESET	F(3,347)=274.98		0.0000
Model Identification AIC		385.8705	>30
Model Identification BIC		339.209	>30

4.5 VIF Analysis

To test the level of multi collinearity in the regression analysis, the variance inflation factor was carried out. The results generated for each variable shows moderate correlation. The mean VIF is 2.41 which shows the variables are moderately correlated since its between 1-5.

Table 11:Variance Inflation Factor Analysis Results

Variable	*VIF*	*1/VIF*
Age	1.12	0.894881
Gender of Respondent	4.46	0.224425
Education Level	1.99	0.502512
Household Size	1.83	0.546448
Period of Residence	4.31	0.232018
Awareness	1.64	0.609756
Income	1.25	0.797854
Occupation	4.63	0.215983
Land Size	2.17	0.460829
Proximity to forest	1.42	0.704225
Forest products extracted	1.74	0.574712
Mean VIF	**2.41**	

4.6 Regression Analysis

The study sought to establish if there is any significant relationship between the social characteristics of rural households such as age, gender, household size, education level, awareness, period of residence, economic characteristics such as land size, income, economic activities and participation in extraction of forest products.

Table 12: Regression Results on Household Participation in Extraction of Forest Products

			Number of observations = 361	
			LR χ^2 (11) =	806.27
			Prob > χ^2 =	0.0000
Log Likelihood = 204.93526			Pseudo R^2 =	0.8920
Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Age	0.0469751	.0157356	2.99	0.0030*
Gender of Respondent	0.1921618	.0319773	6.01	0.0000*
Education Level	-0.1090673	.035483	-3.07	0.0020*
Household Size	0.3892169	.0190999	20.38	0.0000*
Awareness	-0.0479597	.0126739	-3.78	0.0000*
Period of Residence	0.0157422	.0139997	1.12	0.2620
Income	-0.0175515	.0044474	-3.95	0.0000*
Occupation	-0.2058009	.0100655	-20.45	0.0000 *
Land Acreage	-0.0112691	.0468383	-2.24	0.0021 *
Proximity to Forest	0.082112	.0051251	16.02	0.0000*
Resources Available	-0.0174074	.0166023	-3.05	0.0020*
Constant	0.104164	.1241342	0.84	0.4020

Legend '*'indicates that the statistic value is significant at 5% level of significance.

From the table above, extraction of forest products is highly influenced by social economic and geographical factors except for the period of residence.

The prediction equation was as follows

$$Log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n X_n \text{……………………………………………} (4.1)$$

Where:

P(Y=1) = Probability of household participation in forest extraction.

β0 = Intercept (constant).

β1,β2,...,βn = Coefficients of independent variables.

$X1, X2, \ldots, Xn$ = Independent variables (e.g., household size, age, income, proximity to forest).

The logistic regression equation is

$$Log\left(\frac{p}{1-p}\right) = 0.1041 + 0.0469Age + 0.1922Gender - 0.1091Edu + 0.3892hh - 0.0479Awareness - 0.0176Income - 0.2058Occupation - 0.0113LS + 0.0821Proximity - 0.0174Resources$$

4.6.1 Social Factors

The logistic regression results indicate that household size is the most significant factor influencing forest product extraction, with a p-value of 0.0000 at a 5% confidence level**,** meaning the relationship is highly statistically significant. The beta coefficient of 0.3892 suggests a positive relationship, meaning that as household size increases, the likelihood of engaging in forest extraction activities also rises by 38.92%. Larger households typically have higher resource demands, including firewood, agriculture, and timber, which increases their dependence on forest products. Additionally, more household members may provide additional labor, making it easier to extract and transport resources from the forest. These results reinforce the idea that population pressure within households contributes significantly to forest degradation.

From the results, age is a significant factor with a p-value of 0.0030 and a positive Beta coefficient of 0.0469751. The positive Beta coefficient (0.0469751) suggests that as age increases, the likelihood of engaging in forest product extraction also rises by 4.69%. This implies that older individuals are more likely to participate in harvesting forest resources, possibly due to their experience, established livelihood patterns, and traditional reliance on forests for subsistence. Older individuals may also have fewer alternative income sources compared to younger generations, making them more dependent on forest products for firewood, timber, and other needs. These results are backed up by the descriptive statistics which showed that most of the households heads were 40 years and above and hence the increased participation in extraction.

Results also indicated that Gender is a significant factor with a p-value of 0.0000* at 5% confidence level. The positive Beta coefficient (0.1921618) suggests that one gender—likely women—has a higher likelihood of engaging in forest product extraction. From the descriptive statistics female headed households were seen to participate more in extraction than the males, indicating that, a shift from male to female headed households increases the likelihood of participation in extraction of forest products by 19.2 percent. This is largely due to traditional gender roles, where women are primarily responsible for collecting firewood and other forest resources for household use. Additionally, female-headed households, often facing economic hardship, may rely more on forest products for both subsistence and income generation.

The results indicate that education level and awareness of forest management practices are both statistically significant factors influencing forest resource extraction. Their negative Beta coefficients (-0.1090673 and -0.0479597, respectively) suggest that as education levels and awareness of management practices increase, the likelihood of engaging in forest extraction decreases.

This implies that more educated individuals and those with better knowledge of sustainable forest practices are less dependent on direct forest resource extraction, possibly due to greater access to alternative livelihoods or a better understanding of conservation principles. Higher education levels often provide individuals with opportunities for non-extractive income sources, reducing reliance on forests for subsistence. Similarly, greater awareness of forest management practices fosters responsible resource use and encourages participation in conservation efforts.

4.6.2 Economic Factors

The study sought to establish if there is significant effect of economic characteristics of rural households such as income, occupation, land size and economic activities on participation in extraction of forest products.

The results indicate that income and land size are statistically significant factors influencing forest resource extraction, with p-values of 0.0000 and 0.0021 respectively shows a strong relationship. Their negative Beta coefficients (-0.0175515, -0.0112691 respectively) suggest that as income levels and land size increases, the likelihood of reliance on forest resources decreases.

A higher income level reduces dependence on forest products, as wealthier households can afford alternative energy sources, such as gas or electricity, and purchase construction materials instead of extracting timber. Similarly, households with larger land sizes are less likely to rely on forests, as they can source fuelwood from their own farms, do agriculture in their own farms or engage in agroforestry, reducing pressure on communal forests.

Additionally, results show that occupation plays a critical role with a statistically significant p-value of 0.0000*. The negative beta value of -0.2058009 shows that as households engage in more formal occupations, the likelihood of extracting forest resources decreases. This could imply that more formal employment or business activities have more stable income sources, lowering their dependence on forest resources compared to those relying on casual labor or farming. These findings highlight the importance of improving economic opportunities, promoting alternative energy sources, and encouraging land-use diversification to reduce forest overexploitation.

4.6.3 Environmental Factors

The study also sought to determine if there is significant relationship between proximity to the forest and participation in extraction of forest products. From the results, a p-value of 0.0000 (<0.05) indicates a strong statistical relationship where proximity to the forest significantly influences participation in the extraction of forest products. The positive Beta coefficient (0.082112) suggests that households located closer to the forest are more likely to engage in extraction activities. This can be attributed to the ease of access, lower transportation costs, and reduced restrictions compared to those living farther away.

Households near forests often rely on them for essential resources like firewood, fodder, timber, and medicinal plants, either for domestic use or as a source of income. Additionally, living near the forest may increase familiarity with its resources, making extraction a more convenient and frequent activity. However, this close interaction may lead to overexploitation and degradation, especially in communities where alternative livelihood options are limited. Shorter distances therefore encourage participation in forest extraction.

Further, the results indicate that the type of forest products extracted has a statistically significant influence on extraction levels, with a p-value of 0.0020**,** confirming a strong relationship. The negative Beta coefficient (-0.01789) suggests that as the extraction of forest products increases, the availability of these resources decreases. This inverse relationship can be attributed to overharvesting**,** where excessive extraction reduces the natural regeneration of forest resources.

Additionally, high demand for specific forest products may lead to their rapid depletion, further contributing to declining availability. The implication of these findings is that unsustainable extraction patterns could lead to resource exhaustion, negatively affecting both household livelihoods and ecosystem stability**.** These results underscore the need for sustainable harvesting techniques and forest management policies**,** promoting controlled extraction and encouraging community participation in conservation efforts to ensure long-term resource availability.

4.7 Hypothesis Testing

1. **H_0:** Social factors (age, gender, education level, household size, awareness, and period of residence) have no significant influence on household participation in forest resource extraction.

However, at a 5% significance level ($\alpha = 0.05$), the p-values for the variables, Age (0.0030), Education Level (0.0020), Household Size (0.0000), Gender (0.0000), and Awareness of Forest Management Policies (0.0000), are all less than 0.05. Since these p-values fall below the significance threshold, the study rejects the null hypothesis (H_0) and adopts the alternative hypothesis stating that Social factors have a statistically high significant influence on household participation in forest resource extraction.

2. **H_0:** Economic factors (income, occupation, and land size) do not significantly influence household participation in Mt. Kenya forest resource extraction.

From the results, the p-values of the variables Income (0.0000) Occupation (0.0021) and Land size (0.0000) at a 5% significance level ($\alpha = 0.05$) are all less than 0.05 significance threshold. The second null hypotheses is rejected and the study concludes that economic characteristics of rural household significantly influence household participation in extraction of forest products.

3. **H_0:** Environmental factors (forest proximity and resources available) have no significant influence on household participation in forest resource extraction.

At a 5% significance level ($\alpha = 0.05$), the p-values for the variables, forest proximity (0.0000) and forest resources available for extraction (0.0020) are all less than 0.05. Since these p-values fall below the significance threshold, the study rejects the third null hypothesis (H_0) and adopts the alternative hypothesis stating that Environmental factors have a high statistical significant influence on household participation in forest resource extraction.

CHAPTER FIVE:

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview of the Chapter

This chapter provides a summary of findings, conclusions, and recommendations. It gives a brief discussion of the main findings and conclusions made based on the analysis, implications to policy and suggestions for further research

5.1 Summary of Findings

The study examined household participation in forest product extraction in the peripheries of Mt. Kenya, revealing that 77% of respondents engage in extraction activities**,** while only 23% are non-participants**.** The majority (70.91%**)** extract forest products for both domestic and commercial purposes**,** whereas 20.22% use them solely for domestic needs, and 8.86% extract for commercial purposes only. The primary forest activities include firewood collection (36.01%)**,** lumbering, farming, and charcoal burning**,** with firewood collection being the most prevalent.

Demographically, 72.58% of household heads were aged 41 years and above, suggesting that older individuals are more involved in forest product extraction. Additionally, female-headed households (58.17%) outnumber male-headed households (41.83%)**,** indicating that women play a key role in resource extraction. Education levels varied, with 50.69% having secondary education**,** 32.41% with primary education**,** and only 14.40% attaining tertiary education**.** This suggests that education may influence dependency on forest resources. Furthermore, farming was the dominant livelihood (74.79%)**,** followed by salaried employment (16.62%), casual labor (3.88%), and unemployment (4.71%).

The study found that household size significantly influences forest extraction, with 46.48% of households having 5-8 members and 32.96% having more than 8 members. Larger households exhibit higher resource dependency. Most respondents (39.89%) earn between Ksh 5,000-10,000 per month, with 25.48% earning below Ksh 5,000, indicating that lower-income households are more likely to depend on forest resources. Additionally, 47.65% of respondents had lived in the area for more than 30 years, highlighting a long-standing dependency on forests.

Statistical analysis revealed that household size, age, and gender significantly influence forest product extraction. Education level and awareness of forest management practices showed a negative relationship, meaning that increased education and awareness reduce forest dependence. Economic factors such as income, land size, and occupation were also significant, with higher income levels and formal occupations decreasing reliance on forest resources. Environmental factors, including proximity to the forest ($p=0.0000$) and forest resource availability ($p=0.0020$), were found to strongly influence extraction behavior, with closer households engaging more in extraction activities.

The findings underscore the need for alternative livelihood programs, conservation awareness initiatives, and policy interventions to reduce over-reliance on forest resources and promote sustainable forest management.

5.2 Conclusions

The findings of this study highlight the significant dependence of rural households on forest resources for domestic and commercial use. This is driven by social, economic, and environmental factors. A substantial proportion (77%) of households rely on forest products, primarily for firewood collection, which serves as both an energy source and a means of income generation. The study further reveals that older individuals, women, and larger households exhibit higher dependency, often due to domestic responsibilities, high consumption needs and economic constraints.

Proximity to the forest is a crucial determinant of extraction rates, with households closer to the forest engaging in higher levels of resource use. This accessibility underscores the necessity for stringent forest management policies to mitigate overexploitation and reinforcing the need for regulated harvesting practices. Additionally, low-income households, particularly those earning below Ksh 10,000, are more reliant on forest resources, emphasizing the role of economic limitations in driving unsustainable extraction practices.

Education and awareness play a pivotal role in reducing forest dependency. Households with higher education levels demonstrate lower reliance on forest resources, highlighting the potential of educational initiatives in promoting conservation and alternative livelihoods. Additionally, forest resource availability (p=0.0020) is a critical determinant, as greater access to resources increases extraction rates, potentially contributing to degradation.

Encouragingly, a vast majority (86%) of respondents express a willingness to participate in conservation initiatives, indicating strong community potential for sustainable forest governance. However, the study confirms that economic constraints, limited employment opportunities, and land size restrictions drive unsustainable harvesting practices. The statistical significance of variables such as income, education, land size, and occupation further reinforces the need for targeted interventions that promote alternative livelihoods and energy sources.

Occupation of a household is a significant and negative factor. Furthermore, those who participate in extraction are basically farmers. This shows that the respondents need to be introduced to new occupations in order to diversify their roles. If respondents have better occupations, there is increased likelihood in reduction of extraction of forest products.

5.3 Recommendations

The first recommendation is to promote alternative livelihoods. This can be achieved by supporting income diversification through initiatives such as agroforestry, beekeeping, and ecotourism. Additionally, by providing skills training and microfinance opportunities to help households develop sustainable income sources, reducing reliance on forest extraction.

Secondly, the study recommends strengthening conservation awareness and education by implementing community sensitization programs through Community Forest Associations (CFAs) and deploying extension officers to train rural communities on sustainable forest use and alternative livelihoods. It also suggests enhancing environmental education in schools and promoting higher education and vocational training to reduce reliance on forest-based income sources.

Thirdly, the study recommends promoting sustainable harvesting methods such as Selective Harvesting, Rotational Harvesting, Agroforestry, Coppicing and Pollarding, Reduced-Impact Logging (RIL) to minimize environmental impact and ensure forest regeneration. Also, implementation of Reforestation and Afforestation programs to restore degraded areas and ensure sustainable wood supply. Finally, establish guidelines for responsible extraction to prevent overexploitation of forest resources.

Another recommendation is improving energy alternatives to reduce firewood dependency among households. The study suggests promoting the adoption of clean energy sources such as liquefied petroleum gas (LPG), biogas, and improved cook stoves. To ensure accessibility for low-income households, the study highlights the importance of providing subsidies or incentives for renewable energy solutions. It also emphasizes the need to encourage households living near forests to establish private woodlots, supporting sustainable firewood and timber production while reducing pressure on natural forests.

The study highlights the need to enhance forest management policies and enforcement for sustainable resource use. It recommends strengthening controlled harvesting regulations, promoting Community-Based Forest Management (CBFM), and establishing buffer zones to prevent overexploitation. Clear land tenure policies are advised to support sustainable land use and reduce encroachment, alongside improved monitoring and surveillance to prevent illegal extraction and ensure fair resource distribution.

The study recommends addressing household size and strengthening gender-sensitive conservation approaches. It highlights the need for family planning programs to manage household sizes and ease pressure on forest resources. Targeted financial and business support for female-headed households is also advised, recognizing their higher dependence on forest resources. Additionally, the study emphasizes the importance of involving women in conservation decision-making to ensure their needs and perspectives are reflected in policy formulation.

By implementing these recommendations, a balance between forest conservation and livelihood sustainability can be achieved, ensuring the long-term well-being of both communities and forest ecosystems.

5.4 Suggestions for Further Research

The study suggests the following areas for further research; First there is need for a panel data analysis on Forest Dependence specifically investigating how forest dependence evolves over time, considering economic growth, conservation policies, and population dynamics. Secondly, to determine the Effectiveness of Sustainable Harvesting Techniques one can Assess the adoption and impact of selective harvesting, agroforestry, and rotational logging in reducing forest degradation and also investigate barriers to implementing sustainable harvesting practices among rural communities.

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APPENDIX I: QUESTIONNAIRE

My name is Flora Mwangi, a postgraduate student of Moi University, in the Department of Agricultural Economics and Resource Management. I am carrying out a research on "Factors influencing rural household participation in extraction of forest products in Mt. Kenya forest Nyeri county". I humbly request for your cooperation and patience in responding to the questions to enable me achieve my study objectives. This research is purely for academic purposes towards a Master of Science degree in Agricultural Economics and Resource Management, Moi University.

All the information provided will be treated with utmost confidentiality. Thank you for your responses.

SECTION A: SOCIO-ECONOMIC FACTORS INFUENCING PARTICIPATION

1. Name of the respondent (optional) ---

   Gender (tick)

   a. Male [ ]
   b. Female [ ]
2. Age of respondents
   a. 18 – 30 Years [ ]
   b. 31-40 years [ ]
   c. 41-50 years [ ]
   d. Above 51 years [ ]
3. Primary occupation of the respondent.
   a. Unemployed. [ ]
   b. Farmer [ ]
   c. Casual labourer [ ]
   d. Salaried employee. [ ]
4. Highest level of education.
   a. No formal education [ ]
   b. Primary [ ]
   c. Secondary [ ]
   d. Higher Level [ ]

5. What is your average monthly income in Ksh from all your sources?
    a. Below 5000 [ ]
    b. Between 5000 and 10000 [ ]
    c. Between 10000 and 20000 [ ]
    d. Above 20000 [ ]
6. How many are you in the family?
    a. Below 2 people [ ]
    b. 3-5 people [ ]
    c. 5-8 people [ ]
    d. Above 8 people [ ]
7. Do you have land for cultivation?
    a. Yes [ ]
    b. No [ ]
8. If yes, what is the size of land ……………………………………. acres
9. For how long have your family been living in this area?
    a) 5-10 years [ ]
    b) 11-20 years [ ]
    c) 21-30 years [ ]
    d) Above 30 [ ]
10. What is the distance from your home to the forest? …………………. Km
11. Are you aware of forest management policies?
    a. Yes [ ]
    b. No [ ]
12. Would you be willing to participate in soil conservation and tree planting in Mt. Kenya forest without any pay?
    a. Yes [ ]
    b. No [ ]

SECTION B: PEOPLE –FOREST INTERACTIONS

1. Do you extract any forest products from the forest?
    a. Yes [ ]
    b. No [ ]

If yes,

2. What is the major forest activity?

   a. firewood collection [ ]
   b. Collection of Medicinal products [ ]
   c. Collection of herbs [ ]
   d. Subsistence Farming [ ]
   e. Lumbering/ Timber cutting [ ]
   f. Charcoal production [ ]
   g. Any other (specify)……… ……………….……………

3. What is the major purpose for carrying out these activities?

   a. Domestic use [ ]
   b. Commercial Use [ ]
   c. Both [ ]

4. Do you think any of these uses contribute to forest loss of cover?
   a. Yes [ ]
   b. No [ ]

That is all

Thank you for your time and cooperation