ROLE OF SMART VILLAGES IN PRESERVATION OF FARMLANDS AND RURAL LIVELIHOODS

A Case of Kimunyu Sub-Location, Gatundu South Sub-County, Kiambu County, Kenya

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DECLARATION

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This planning research thesis is my original work and has not been submitted or presented for examination in any other university, either in part or as a whole.

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DEDICATION

This research work is dedicated to all the people of Kimunyu sub location as well as the entire nation as a tool in our endeavor to eradicate poverty especially in the rural areas. I also dedicate it to all my loved ones especially my daughter for being a source of motivation and my mum for all her support to ensuring that I successfully finish this master's programme. God bless our land and nation.

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ACRONYMS

CBO	Community Based Organizations
EU	European Union
GIS	Geospatial Information System
GPS	Global Positioning System
FAO	Food and Agricultural Organization
ICT	Information and Communication Technologies
NGO	Non-Governmental Organizations
PPH	Physical Planning Handbook
SWOT	Strengths, Weaknesses, Opportunities, and Threats

ABSTRACT

In 1954, Kenya colonial government introduced the Swynnerton Plan aimed at intensifying agricultural practice with a focus on cash crops through improved markets, infrastructure, farm inputs and land amalgamation. The aim of the plan was to create family land holdings for resilience and self-sufficiency. Each family was targeted to have farming units of about ten acres. After independence, previously consolidated land holdings were subdivided among heirs which led to declining levels of cash crop production and household incomes as agricultural land was taken up by new homesteads. This study was carried out in Kimunyu sub-location to explore the human settlement pattern that could preserve agricultural land and sustain household income and livelihood. The study objectives were to: examine patterns of human settlement and the process of development in relation to farmlands; assess connectivity and accessibility of services by households; establish the main sources, levels and reliability of household income and; propose a smart village development model for securing sustainable land use and livelihoods. The study followed a survey research design. The target population included all households plus selected leaders in the sub-county and sub-location. A total of 80 households were sampled using the simple random method. Six key informants were sampled purposively based on relevance to the study. Face to face interviews were conducted with household heads/spouses/adults' children. Three focus group discussions were also held. Additional primary data were obtained through photography, mapping and observation. Secondary data was obtained through literature review. Data was analyzed spatially, qualitatively and quantitatively and presented in the form of charts, figures and tables. According to 85% of the respondents, human settlements had significantly reduced agricultural land. Linear settlement pattern was dominant within the sub location. Land subdivision was found to be high mainly for inheritance and real estate development. Cultivation was carried out on 56% of the land while 44% was built up area. The smallest farmland was 0.04 acres and the largest 53.17 acres with an average of 2.14 acres. The sub-location lacked standard infrastructure. Fifty three percent (53%) of the residents were positive to living in a nucleated settlement. Up to 93% of the respondents were self-employed in informal sector. Crop farming was the most common livelihood strategy. A total of 73% of the farmers practiced subsistence farming while only 5% were involved in commercial farming. Household income was low with 93% of the households earning less than Ksh. 50,000 and 7% earning over Ksh. 50,000 per month. Off-farm livelihoods were adopted to supplement the low-income levels. The study proposes a smart village model for optimal land

use towards household resilience and livelihood sustainability. It proposes intensification of maize production for food, bananas for cash crop, dairy and poultry for livestock enterprise and forestry on steep slopes. Financing should be organized for farmers to be able to purchase affordable housing against their crop and livestock enterprises. Value addition should be carried out for all agricultural enterprises to enhance incomes.

CHAPTER ONE: INTRODUCTION

1.0   Background Information

According to FAO (2015), most rural households in developing countries, Kenya included, live and work in small scale farms with land plots that are less than five acres. In addition to being food insecure, they lack access to markets and other services. Even though they are faced with poverty and lack freedom of choice, they farm and produce food for majority of people in the world especially those in urban areas. As a strategy to supplement their inadequate incomes, they carry out non-farm economic activities mostly in the informal sector. These smallholder farmers operate their farms as entrepreneurs with some household members as the human capital and take both risks and profits. They also make decisions on what to plant, the inputs to use and how, when to plow, seed and harvest; what to sell, to consume and to store. All these decisions are made in an economic environment that is subject to many risks, such as climate change and price surges as markets barely function well, if they at all do. This significantly affects their livelihood choices and the capacity to invest in themselves and their children on how to attain social and human capital objectives, such as health and education.

In 1952 during the State of Emergency in central Kenya, villagization programme which aimed at creating social organization was introduced. Families that previously lived in isolated homesteads had to move to villages which had an average of 1200 residents. The displaced and squatters were placed in villages and given plots of 500m^2. A total of 272 villages had been established in Kiambu district by 1956. In 1954, the colonial government introduced the Swynnerton Plan aimed at intensifying agricultural practice with a focus on cash crops through improved markets, infrastructure, farm inputs and land amalgamation. The aim of the plan was to create family land holdings for resilience and self-sufficiency in food and household income. Each family was targeted to have farming units of about ten acres. Villagization helped in relocating people and aided in the implementation of land consolidation exercise. The exercise was carried out between blocks of 800 to 1600 Ha, almost the size of a sub location. A portion of arable, cash-crop and grazing land was included in the consolidated holdings. After the consolidation, farm planning and boundary markings to create farm layouts for every farm was done. For the land with a slope less than 20 percent, the farmers were advised to cultivate food crops, permanent crops for slope between 20 to 35 percent, and grass and trees for slope greater than 35 percent. When Kenya gained independence, previously consolidated land holdings were subdivided among sons of the owners. The results were declining levels of cash crop production and household income as agricultural land was taken up by new homesteads.

In Kenya today, there is growing inequality between rural and urban areas. Villages have become less attractive to live in as most rural infrastructure is in poor condition. Education and other rural facilities are suffering from lack of attention. Agricultural production is being carried out in micro farms as very few large-scale farms exist. Competitive commercial family farms necessary for today's Kenyan economy are lacking. Potential entrepreneur farmers are reluctant to invest in agricultural production due to lack of assurance on improvement of their standard of living. Such individuals who could be successful commercial farmers are seeking different ventures that offer them a better quality of life. A lot needs to be done to encourage people capable of creating competitive farms to do so. Smart Villages Initiative mainly aim at engaging rural communities in understanding what they want to achieve and where to focus on as per their needs and potential. The initiative also provides a platform for working together with them as to find technological innovations that are appropriate for their region. Guiding the communities on where to settle and where to farm for maximum agricultural production and the general well-being of the society is part of the initiative (Ramachandra et al., 2015).

1.1 Research Problem Statement

The problem of land subdivision is currently being faced by most rural areas in Kenya especially those located on rural-urban fringes. Kimunyu sub location is no exception being part of the Nairobi Metropolitan Region. The expansion of the city has had direct and indirect impact on the residents as they are faced with new challenges and opportunities of urbanization. Some possible benefits of urbanization include increased work opportunities, better housing options, educational opportunities, the transfer of knowledge and technology, and ready markets for agricultural products. However, the sub location has not harnessed such benefits as the demand for land has resulted to huge strain on the infrastructure, social services, and natural resources

Subdivision of agricultural land to uneconomical sizes has affected the overall production and wellbeing of the sub location. Studies on how the un-economical subdivision of agricultural land can be halted to ensure resilience and self-sufficiency as food and household income are scarce. This study aimed to generate information on the potential of a smart village to achieve food and income sustainability and resilience in relation to land use and livelihood strategies within Kimunyu sub location.

1.2 Research Questions

The study was guided by the following research questions;

i.   How is the human settlement pattern and the process of development in relation to farmlands in Kimunyu sub-location?

ii.   How is connectivity and accessibility of services by households in the sub-location?

iii.   What are the main sources, levels and reliability of household income?

iv.   What role can a smart village play in preserving farmlands and achieving rural household food, income and livelihood security?

1.3 Objectives

1.3.1 Overall Objective

To gather data and information for the formulation of a Smart Village Development Model in Kimunyu sub location.

1.3.2 Specific Objectives

i.   To examine human settlement patterns and process of development in relation to use of farmlands.

ii.   To assess connectivity and accessibility of services by households in the sub-location

iii.   To establish the main sources, levels and reliability of household income.

iv.   To propose a smart village model of development for securing sustainable land use and livelihoods.

1.4 Scope of the Study

1.4.1 Spatial Scope

Kimunyu Sub location is an administrative division approximately 5.61 Sq. Kms located in in Kiganjo ward of Gatundu South sub county, Kiambu County. It is located on the south of the equator between latitudes E 36º 55' 30.72" and E 36º 57' 14.4" within Nairobi Metropolitan Region. It borders Kahunguini sub location to the south, Mutomo sub location to the west, Githunguchu sub location to the north and coffee farm to the west. This study was based in Kimunyu sub location as urgent intervention measures are needed because of the high rate of farmland subdivision and livelihood insecurity. The sub location is also in central Kenya where villagization programme was carried out during the emergency period.

1.4.2 Theoretical Scope

The Sinclair's theory based on Von Thunen model was reviewed. It aided in understanding of how metropolitan encroachment to rural areas can influence agricultural production. A review of rural development and land consolidation guidelines in relation to agricultural production was also done prior to exploring a smart village model appropriate for Kimunyu sub location. These included guidelines from policies, laws and regulations, and institutions part of planning framework in Kenya. The information provided the researcher with adequate insight on the best practices and planning interventions towards resilience and sustainability in Kimunyu sub location.

1.5 Justification of the Study

The smart village concept covers human settlement in rural areas and is strategic and region sensitive. It can only be implemented based on the development needs and potentials of a given rural community. This study aided in understanding the smart villages concept in the context of Kimunyu sub location as to provide practical solutions towards sustainable land use practices and livelihood strategies.

1.6 Significance of the Study

This study focused on realizing optimum utilization of locally available resources in Kimunyu sub location through appropriate technologies for sustainability and self-reliance. Having improved water availability, clean energy accessibility, agricultural production, livestock management, value addition and local employment prospects is a vision held by Kimunyu sub location residents. Provided in this study is data and information needed by various rural development stakeholders, that is, researchers, entrepreneurs, villagers, NGOs, financiers, regulators, policy makers, investors, and the government to help in realizing the vision.

1.7 Definition of Terms

Community Empowerment

The process of giving communities authority over the factors and choices that influence their life is known as community empowerment. (WHO, 2008)

Digital Technology

Any information used or transmitted by a computer is considered to be digital technology. It consists of computer software, websites, web pages, social media, data and databases, digital

music, and media, all of which promote increased creativity and information sharing.

Participatory Geographic Information System (PGIS)

This is a practice that came about as a result of participatory methods of spatial planning, information management, and communication. A variety of geographic information management techniques and tools, including sketch maps, interactive 3D models, aerial photos, satellite imagery, Global Positioning Systems (GPS), and GIS, are combined to make PGIS. (Rambaldi, 2006).

Land Consolidation

Enhancing the structure of agricultural holdings and farms to increase their economic and social efficiency through land consolidation is a significant land management tool. It also makes it easier to allocate non-agricultural land uses such as infrastructure, nature protection or restoration and these benefits are felt by both rights holders and the wider public. Instruments of land consolidation necessitates a comprehensive legal regulation that can be integrated into the national legal framework (FAO, 2020)

Livelihoods

The abilities, possessions (stores, resources, claims, and access), and activities required for survival make up a livelihood. When a way of life can survive strains and shocks while also preserving or enhancing its capacities and resources in the now and the future without endangering the natural resource base, it is said to be sustainable. (Chambers & Conway, 1988)

Smart Cities

the application of information and communication technology (ICT) to raise the standard and effectiveness of urban services including energy, transportation, and utilities in an effort to cut back on resource consumption, waste, and overall expenses. The concept focuses heavily on big data and the possibilities for using interconnected digital technology to revolutionize the way cities function. (source, Technopedia).

Smart Villages

A rural development idea that encourages local communities to participate in their own destiny by utilizing innovative local solutions to strengthen their resilience and capitalize on their local assets and possibilities. It uses a participative method to create and implement

plans to enhance the economic, social, and/or environmental situations of rural societies, utilizing digital technology solutions when appropriate. (Nieto E., 2019).

Rural Development

By creating more effective delivery systems for the public and private sectors to supply essential economic and social infrastructure and services, rural development aims to raise the standard of living for rural people. (World Bank, 2015).

Rural Settlements

Rural settlements refer to populated rural areas where the inhabitants are primarily engaged in agricultural production but could also be non-agricultural or mixed covering various economic sectors such as industrial, transport and construction (The Great Soviet Encyclopedia, 2010).

CHAPTER TWO: LITERATURE REVIEW

1.0 Introduction

This chapter looks at Sinclair's theory, guidelines of rural development and land consolidation in relation to agricultural production prior to exploring a smart village model appropriate for Kimunyu sub location.

1.1 Sinclair's Theory

The geographical pattern of agricultural land usage was highly regular and predictable, according to the Von Thunen model. Robert Sinclair (1967) observed that metropolitan expansion had an impact on production, particularly in a metropolitan region's innermost agricultural territory. Farmers knew that competing against the coming up much-higher location rents collected by urban land users was fruitless as urbanisation spread. Farmers' spatial behaviour revealed that metropolitan expansion was viewed as a danger in the rural inner zone. Those on the rural-urban fridge kept their agricultural investments minimal as they felt most threatened. The investments seemed to rise with increasing distance from the urban frontier. Sinclair suggested an alternative agricultural land use pattern for the rural zone affected by urban encroachment.

Sinclair proposed four types of farming: urban farming, which consists of small producing farm units scattered throughout the already subdivided outer suburban environment, and is best suited for poultry keeping, greenhouses, vegetables, and other building-oriented uses; vacant and temporary grazing, in which farmers leave target to sell their land for urban use when conditions are most favourable, and only use it on short leases; and transitory field crop and grazing, which is dominated by farm uses but can also be used for other purposes.. Sinclair's theory aids in explaining the scenario found within Kimunyu sub location and informs on what agricultural land use pattern to adopt especially before implementation of a smart village.

1.2 Rural Development

The Physical Planning Handbook (PPH) states that the goal of rural development is to raise the productivity of all land and land-based resources. The manual provides the following tactics for encouraging rural development: Increased opportunities for non-farm employment; Provision of supportive services, such as extension, market development, processing, education, farm training, and credit; Rural works and infrastructural development, such as roads, water supply, and electricity; Promotion of Self-help activities and small and micro enterprises; Improved administration of rural development programs. For optimal utilization of land, the handbook

advises that the above activities be concentrated at selected sites to generate a rural settlement. Concerning land subdivision, the handbook recommends a minimum land size of 2.5 Acres (1 Hectare) for farms on high potential agro-ecological zone. It also recommends that during property subdivision, 4% of the land be set aside for public utility uses in addition to the road reserve. Land owners are also advised to avoid haphazard type of land uses.

1.2.1 Rural Settlements

According to the PPH, human settlements comprise concentration of people and activities which can be commercial, agricultural, industrial, administrative, recreational, health and education as needed by the people. A rural center with a resident population of 2000–10,000 is advised to service a catchment population of 40 000 people. A secondary school with at least four streams is anticipated as well as a health center with a maternity facility, improved shopping options, markets, and banking services, a piped water supply and sewerage disposal systems, electricity, and telephone and postal services. Secondary highways must be planned for. A neighborhood is anticipated to have a socioeconomic identity, shared amenities like schools, leisure centers, and commercial malls, as well as to be a nearly self-contained unit when residential areas are planned. See Appendix A for the recommended percentage of developed area for the various land uses and Appendix B for the densities for residential development.

1.2.2 Rural Infrastructure

Development cannot occur in the absence of infrastructure services; hence it is critical for spatial planners to make sure that services are not only provided but also readily available to everyone at all times. The PPH divides infrastructure services into two groups: social infrastructure and physical infrastructure. Physical infrastructure includes things like roads, trains, airports, water supply, power lines, pipelines, and cables. Social infrastructure includes things like hospitals, schools, community centers, police stations, post offices, and administrative buildings. According to the manual, in order for human settlements policies to be effective, they must be supported by suitable transportation networks designed to promote equitable and balanced development. As a minimum, all designated rural centers are supposed to be connected by secondary roads. For more information on road classification and needed reserve areas, see Appendix C. The population of the catchment that needs to be supplied with water as well as per capita water consumption should be taken into consideration while building water supply facilities. A 100-meter buffer zone is required for groundwater reserves, and a 100-meter buffer

zone is also required for springs preservation. A 10-meter way leave is required for the main water pipeline.

Social facilities foster community, foster a sense of caring, and promote morality, creativity, and competition. Education facilities are encouraged to be built on storied buildings for economy. Nursery schools may be attached to primary schools and therefore follow the distribution of primary schools. They should be on a distance of 300-500metres and have 0.15 - 0.25 Hectares of land. Primary schools should have a minimum area of 3.9 Hectares of land. An additional 0.8 hectares are needed if housing for the teaching staff is to be constructed. They should service a population of 4000 people and be within a walking distance of 500 to 2 kilometers. Secondary schools should serve an 8000-person catchment area and have a minimum land area of 3.9 hectares. They should be within 500m to 3km of one another. Health facilities should be located in an area that is easily accessible by ambulance and should have minimum infrastructure. They should set aside land for future growth and public graves. According to PPH, recommendations for area coverage of health facilities can be found in Appendix D. A library/resource center, a social hall, a VCT center, a public telephone, and an amphitheater should all be included in every community center (cultural dances, cinema and others).

1.2.3   Rural Livelihood Strategies

This refers to the activities and decisions made by rural residents in order to achieve their economic objectives. Examples of such strategies include how they mix their revenue-generating activities, how they utilize their assets, how they invest in assets, and how they manage and safeguard their current assets and income. Individuals may rely on two or more income-generating occupations at the same time, resulting in a broad range of livelihoods. In addition, household members may choose to live and work in a variety of locations, either temporarily or permanently, and in a variety of economic activities (DFID, 2001). People can handle shocks and stress, recover from them, and keep or develop their skills and possessions, including the basis of natural resources, if their livelihood choices are robust and sustainable. (Chambers R., et al., 1997).

The general rural livelihood strategies include; agricultural production and all related activities, Trading, businesses, employment both in formal and informal sector, and light industries to mention but a few. According to the PPH, light industrial areas/estates serve industries that get along with residential districts. They are perfect for all intensive businesses, including factories that produce light assembly furniture, enormous laundries, dry cleaning depots, printing,

packing, and food processing. One of these estates can be found for every 30,000 individuals in residential districts. This ought to be placed on the main internal highways of the township, with access separated from residential feeder roads. To accommodate 1500–7500 people at a density of 60 workers per acre, each estate's total area should be between 10 and 50 hectares. a cluster of 10 to 20 small enterprises that doesn't congest neighborhoods. Large businesses can be located in an area of 50 hectares. Anything more than 50 hectares would cause serious disputes and incompatibility with the nearby residential neighborhoods.

1.3   Land Consolidation

In both the agricultural and non-agricultural sectors, rural circumstances have deteriorated, with less options to earn a fair livelihood. Efforts to improve the quality of life must include integrated rural development that considers the land tenure structure of a number of small and fragmented farms. In rural development, land consolidation is critical. By enabling them to have bigger, better-shaped farms, it can make it simpler for farmers to establish competitive agricultural production arrangements. Land consolidation is a crucial instrument for enhancing the quality of rural life through improved natural resource management and environmental conservation, given the rising demand for rural acreage for non-agricultural use. It also facilitates provision of better infrastructure and services, employment creation and amelioration of village conditions. As it addresses the issue of land fragmentation, tenure structure in support of rural development can also be improved on. A test area for land consolidation has been developed in Egri, North Macedonia, as seen in Figure 1.

Figure 1: land consolidation in Egri, North Macedonia) (FAO, 2020)

Land fragmentation might take the shape of a disjointed farm or a change in ownership. A farm could be made up of several lots that are separated by some distance. A farmer's holdings may

also include land held by the farmer as well as farmland leased from others, such as city dwellers. Consolidating dispersed farmlands enables for improved farming techniques to be introduced. During the consolidation of fragmented parcels, proper measures should be adopted to establish a land tenure structure that will support long-term rural development. The focus should be on offering practical answers to the difficulties that farmers and other rural communities face. It may take years to build medium-sized commercial farms, so supportive farming methods like Sinclair's should be considered. Part-time farming, which mixes market-oriented output with non-agricultural sources of income, and subsistence farming, which is used by those who have no other options, are examples. Land consolidation has the potential to dramatically alter land tenure systems and should only be carried out under the supervision of a government agency. It could also help to strengthen land consolidation systems by allowing for the clarification and updating of ownership information.

People's land rights should not be taken away by land consolidation initiatives. However, the rights can be transferred on a willing-seller/willing-buyer basis. During a land consolidation initiative, farmers and other rural residents must actively participate. Farmers who desire to expand their holdings may encounter a number of challenges. Land is mainly transferred through inheritance. Additionally, rural conditions are not favourable for farmers to sell their land. Money raised from selling a rural land may not be sufficient for exploring other investment opportunities due to low market values. Other owners have emotional attachment to their bought or inherited land. Those with no capacity to work have rural land holdings as their safety net providing economic independence. Rural farms also serve as retirement homes for most urban dwellers. Therefore, people prefer to keep it even if with or without returns. Most landowners would prefer to lease their property for a set amount of time rather than sell it.

The goal of land consolidation should not merely be to increase agricultural production, but also to enhance rural livelihoods. The long-term protection and management of natural resources, along with village revitalization through long-term economic and political development of the entire community, should be the ultimate goals. The consolidation process should be inclusive, democratic, and community-driven in both theory and practice. In order to help the community define new land uses for its resources and reorganize the spatial elements to reflect these new uses, the exercise aims to: It is suggested that components of rural and regional development, particularly rural-urban linkages, be incorporated using a holistic and cross-sectoral approach.

Institutional, financial, and legal challenges, as well as capacity building and international involvement, should all be addressed in the adopted land consolidation strategy.

1.4 Smart Villages

The smart villages concept encompasses both human settlements and the surrounding terrain, with a focus on institutional expansion, natural resources, value additions, and transparent service delivery. The European Union's (EU) effort aims to combat rural poverty while also improving community resilience and sustainability. It includes offering improved educational, employment, energy, clean water, health care, women's empowerment, transportation, and communication services to rural communities. The creation of smart villages requires clustering rural settlements based on their proximity and type of resources for integrated, long-term development. The goal of such development is to maximize resource usage inside the respective clusters while also using current strengths and assets to create new opportunities. The strategy is supported by new or existing territorial strategies and is territorially sensitive, based on the requirements and potentials of each region. (EU, 2018).

The main concept of smart villages is to pool community efforts and strengths from many sources and combine them with information technology to equip rural communities with the benefits of modern civilizations. The smart villages project, according to Mahatma Gandhi's ideology and beliefs, delivers "global means to local needs." For its essential daily needs, a hamlet should be a complete republic, independent of its neighbors. This means that each community produces enough food, milk, and vegetables to meet the needs of its residents. It is critical to have a school where no one is denied access to basic education. Playgrounds, sanitation, and drinking water should all be available at schools. Every activity in the community is carried out as cooperatively as possible, with no discrimination. (Somwanshi et al., 2016).

The smart village development model for an area is determined by the resources available, people's occupations, villagers' cooperation, and the region's societal acceptance. Understanding the socioeconomic factors of a community, as well as its geographical features and accessible resources, is critical. The ability to identify present skills and practices, as well as gaps in agricultural, energy, water resource, and livestock management, aids in the selection of the best model for the establishment of a smart village. To assure long-term intervention of technically possible, economically viable, user-pleasant, and environmentally benign technology, the model should incorporate local resources and competent manpower (Ramachandra et al, 2015).

1.5   Smart Village Case Studies

1.5.1   Rimbunan Kaseh, Malaysia

The 12-hectare (30-acre) model smart town outside of Kuala Lumpur has transformed how rural communities tackle issues of poverty by fostering environmental sustainability. At a 2012 GSIAC (Global Science and Innovation Advisory Council) gathering in San Jose, California, the concept was introduced. GSIAC is a collection of international leaders from various nations that have gathered to discuss ways to assist the Asian nation in building sustainability and a more robust economy.

Figure 2:   Rimbunan Kaseh, Smart Village in Malaysia (GSIAC, 2012)

A total of 100 cheap post-consumer material-built homes are available in the neighborhood, with prices ranging from $16,000 to $20,000. The energy-efficient homes, which measure about 100 square meters to 1,000 square feet, are built in ten days. The community is built around a closed-loop agriculture system in which everything is connected. It contributes to the hamlet residents' food and income. For instance, a four-level aquaculture system uses cascading water through a series of tanks to breed fish for a protein-rich food supply, including tilapia, guppies, and ultimately algae. The latter two products are used to feed the larger fish. Then, trees, grain fields, and crops like flowers and fresh fruit are watered with filtered fish tank effluent.

Individually cultivated fruit is grown in new hydroponic pots, which are three-piece plastic containers that sense soil moisture levels automatically. They assist in precisely watering plants as needed, avoiding the use of expensive fertilizers and pesticides as well as water. All of these systems work together to ensure a consistent food supply and increase residents' monthly income by $400 to $650. Composting organic waste encourages worms and other creatures, which free-range chickens eat alongside home-grown grains. The system for raising fish for vegetables is shown below, and it combines hydroponics (the practice of growing plants in water) with conventional aquaculture.

Figure 3: Vegetable Fish Farming System (GSIAC, 2012)

Long-term sustainability is ensured by the addition of biomass energy and small-scale hydroelectricity to the village's solar-generated electricity. The site is completed by a community center, resource center, places of worship, playgrounds, and educational facilities with 4G Internet access that enable both e-learning and e-health services. A more balanced development and economic activity between urban and rural areas has resulted from the initiative's promotion of rural growth through modern agricultural operations, as well as an improvement in the living standards and income levels of rural populations. Malaysia intends to replicate the Rimbunan Kaseh model in as many as 12 places as part of its short- to medium-term expansion of the smart

village initiative. This example has the potential to set a new standard for bringing about change for those living in poverty all around the world.

1.5.2 Rubaya Smart Village, Rwanda

In the north of Rwanda, the Rubaya smart green village project is located in Kabeza Village, Kageyo cell, Rubaya sector, Gicumbi District. The notion entails achieving sustainable development, in which local populations can live in a pleasant environment while being economically developed using natural resources that do not harm the environment (Maradan, 2017). Due to the adoption of relevant ICT capabilities and other technological developments for the green villages, the term 'Smart' has been added (Government of Rwanda, 2015). The initiative lasted three years (2009-2011) and was officially launched in June 2011 by His Excellency the President of the Republic of Rwanda, Paul Kagame.

Sensitization and awareness raising were carried out through onsite seminars, formal meetings, and research visits. Villagers and community leaders were also given training on how to manage and preserve the project's advantages. Roofed houses with three bedrooms, a kitchen, a shop, and a bathroom were built, each with a useable space of 100 square meters. Water collection gutters for rooftop water harvesting, as well as home water treatment and delivery facilities, were installed. There were also 15 runoff water collection and storage reservoirs installed for irrigation purposes. Water-borne, ventilated pit latrines, biogas digesters, communal cowsheds, and waste collection facilities (manure collection and storage) were built. Heifers of improved breed were also offered.

Energy and water self-sufficiency are two of the project's advantages. Biogas is often produced from consolidated household human and livestock waste for cooking and lighting. Rainwater collection provides home water as well as small-scale household irrigation for crop cultivation (Maradan, 2017). Terracing and tree planting have increased people's quality of life while also improving environmental sustainability. Due to the use of biogas leftovers as fertilizer, communities' food security has improved, and surplus has been sold to adjacent markets. Terracing has helped to reduce landslides on slopes, which used to inflict property damage and, in some cases, death. The cooperative in Rubaya earns an average of $26,000 per year from the selling of milk and fertilizer (Government of Rwanda, 2015).

The use of biogas for cooking has reduced reliance on firewood, lowering the rate of deforestation. A total of 14 hectares of woodland have been rescued. The residents now have a

clean, nontoxic supply of fuel thanks to the utilization of biogas plants, which has significantly decreased health risks associated with smoke from firewood. Women and children can spend their time doing more useful things because they don't have to trek vast distances to get water or firewood (Government of Rwanda, 2015). Schools are being built near the communities to promote school attendance and improve educational chances for young children, which is an important part of offering new options for future generations..

1.5.3   Karama Smart village, Rwanda

The four-story one-stop center village is furnished with everything you need, including food items, a contemporary market, a center for early childhood development, access to water and power, and a health post, among other things. There are 120 two-bedroom residences with a dining room, a toilet, a bathroom, and a kitchen in each of the two kinds of homes. The other homes are single-room dwellings with a dining area, bathroom, and kitchen.

Figure 4: Village Model in Rwanda Residential Houses (Ngabonziza, 2019)

To give kids who have finished elementary school access to further education, a portion of this community was built to house a secondary school with modern ICT labs. To advance science in the neighborhood, a division of mathematics, chemistry, and biology was created with a cutting-edge laboratory. In order to encourage students to discover their skills, sports facilities, such as basketball and volleyball courts, were installed as part of leisure facilities. From the

beginning of the 7.8 km road, fiber optic internet was installed to connect the village to the internet. Beneficiaries were grouped into cooperatives, with the exception of the six greenhouses in the community. It is common practice to raise 7500 chicks with the purpose of producing more than 7500 eggs every day. (Ngabonziza, 2019).

Figure 5: Karama Smart Village Model in Rwanda ECDE Center (Ngabonziza, 2019)

Figure 6: Water Harvesting Tanks (Ngabonziza, 2019)

1.6 The Planning Framework

1.6.1 Policy Guidelines

Kenya Rural Development Strategy (KRDS) 2002-2017

a long-term plan with numerous suggestions for rural Kenya's development over the following 15 years. The importance of food security is emphasized as the first step in rural development and the alleviation/reduction of poverty.

2003-2007 Economic Recovery Strategy (ERS) for wealth and job creation

Dedicated to attaining good governance, transparency, and accountability, as well as addressing hunger, poverty, and unemployment on a long-term basis.

Agriculture Revitalization Strategy (SRA 2004-2014)

It was developed in response to the ERS, and its primary objectives were to provide a framework for boosting agricultural productivity, encouraging investment, and encouraging private sector involvement in agriculture.

Kenya Vision 2030

It views science, technology, and innovation as fundamental enablers of competitiveness and comparative advantage. The policy was introduced in 2007 to continue the economic recovery momentum established by the ERS execution. Agriculture is identified as a crucial driver in growing Kenya's GDP to 100%. It also recommends decentralized money for high-poverty areas, unemployed youth, women, and other vulnerable populations, as well as investments in arid and semi-arid areas. Economic, social, and political pillars support it.

National Spatial Plan (NSP)

A flagship project under Kenya Vision 2030 aimed at dispersing the population and activities around the country in order to achieve long-term socioeconomic development. It establishes the general trend and direction of spatial development, creates the foundation for the implementation of national programs, and identifies a land and land use development strategy by giving a geographical representation of the projects.

Nairobi Metro 2030

Nairobi Metro 2030 is a component of Kenya's broad national development plan, which is encapsulated in Kenya Vision 2030. It attempts to ensure both the effective and efficient utilization of the region's resource endowments and the effective integration of the region into the fabric of the nation.

Big 4 Agenda

It is a plan that emphasizes four crucial areas: manufacturing, affordable housing, universal healthcare, and food security. The study will support the manufacturing pillar of the agenda by offering suggestions for enhancing the industrial sector in the study region. This will be accomplished by focusing on the dairy, horticulture, and construction materials businesses, as well as coffee, which is a major cash crop in the study region, which have also been highlighted by the national government. The study's food security pillar will be prominently featured in the development of activities aimed at enhancing agricultural and animal sector productivity. This research will focus on developing solutions for agricultural and value addiction techniques, as well as universal healthcare.

Sessional paper No. 3 of National Housing Policy 2004

Aims to make suitable shelter and a healthy living environment available to all socioeconomic levels in Kenya at a reasonable cost in order to encourage sustainable human settlements as envisioned in Vision 2030. Acknowledges the importance of land use planning in the housing industry. Promotes the design of human settlements, especially the rebuilding of areas with inadequate infrastructure and services.

Sessional Paper No. 2 of Integrated National Transport Policy 2012

The objective is to build a top-notch, seamlessly connected transportation system that can adapt to the needs of both the general public and business. Identifies the issues that Kenya's transportation sector is facing. The national transportation master plan aims to address local difficulties and possibilities while also providing critical regional connectivity to other markets.

National Land Policy (NLP)

Sets the goals and direction for land administration and management, as well as the measures and criteria that must be followed to ensure optimal land use and management.

Agricultural Sector Development Strategy 2009-2020

Acknowledges that the agricultural sector, particularly for those living in rural regions, serves as both the country's economic engine and the main source of income for the great majority of Kenyans. aims to strategically place the agricultural sector as a major contributor to the 10% annual economic growth rate anticipated under the economic pillar of Vision 2030.

ICT Policy

Ensures that Kenyans have access to efficient, dependable, and cheap ICT services in order to enhance their livelihoods. It envisions a vibrant Kenyan society based on ICT. Empowers

young people and marginalized groups, mainstreams gender in national development, encourages investment and innovation in ICT, and ensures that ICT is accessible to everyone.

National Tourism Strategy 2013-2018

By establishing, maintaining, and marketing sustainable tourism, the strategy targets to make Kenya the preferred destination of choice.

National Climate Change Response Strategy, 2010

Anticipates a Kenya that is rich and resilient to climate change. Its purpose is to strengthen and focus national efforts to adapt to climate change and reduce greenhouse gas emissions.

Sustainable Development Goals (SDGs)

Embody a generally held global vision of development toward a secure, equitable, and sustainable world in which all people can prosper. Reflect the moral ideals that no one or country should be forgotten. Goal 1: Eliminate poverty in all of its manifestations around the world. Goal 2: To eliminate hunger, improve food security and nutrition, and promote sustainable agriculture. Goal 3: Ensure that all people of all ages have healthy lifestyles and promote well-being; Goal 4: Ensure that all children receive a high-quality education that is inclusive and equitable, as well as encourage opportunities for lifelong learning. Goal 5: Ensure gender equality and the empowerment of all women and girls. Goal 6: Ensure universal access to water and sanitation, as well as long-term management of these resources. Goal 7: Provide everyone with affordable, reliable, sustainable, and contemporary energy; Goal 8: Encourage long-term, inclusive, and sustainable economic growth, as well as full and productive employment and decent work for all. Goal 9: Improve infrastructure, promote inclusive and sustainable industrialization, and encourage innovation. Goal 10: Reduce intra- and inter-country inequity; Goal 11: Make cities and human settlements more inclusive, secure, resilient, and long-lasting; Goal 12: Maintain long-term consumption and production trends. Goal 13: Take immediate action to address climate change and its consequences. Goal 14: Protect and responsibly exploit the oceans, seas, and marine resources for long-term development; Goal 15: Protect, restore, and promote the sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, and halt and reverse land degradation and biodiversity loss. Goal 16: For sustainable development, promote peaceful and inclusive societies, offer universal access to justice, and construct effective, responsible, and

inclusive institutions at all levels. Goal 17: Strengthen and revive the global partnership for sustainable development's implementation mechanisms.

1.6.2 Legal Guidelines

Every Kenyan's economic and social rights are outlined in Article 43 of the 2010 Kenyan Constitution. These rights include: access to the highest standard of health that is reasonably attainable, including the right to health care services, including reproductive health care; reasonable housing and sanitation standards; freedom from hunger with access to enough food of acceptable quality; clean and safe water in sufficient quantities; social security; and education.

County Government Act, 2012

Kenya's 2010 Constitution gives county administrations the power to select how the counties are run. (1) A county government is required to plan for the county, and no public funds may be appropriated until a planning framework has been created and approved by the County Executive Committee. This one is 107. (1). To direct, synchronize, and facilitate development within each County, the County Integrated Development Plan, County sectoral plans, County Spatial plan, and Cities and Urban Areas plans as permitted by the Urban Areas and Cities Act shall be used.

Physical Planning Act Cap 286

Guidelines for land use planning are provided. Within the geographical disciplines, it embeds stakeholder participation and institutional links. It basically entails the creation and implementation of physical development plans.

National Land Commission Act 2012

Gives effect to the goals and guiding principles of devolved governance in land management and administration, as well as for related reasons. The following list outlines the duties and responsibilities of the Lands Commission as well as those related to regional planning and management: For the benefit of the federal and local governments, manage public lands; carry out research on the exploitation of lands and natural resources; and provide suggestions to the appropriate decision-makers. Around the nation, land use planning is being monitored and supervised. Ensure that land maintained by certain state agencies and the general public is managed sustainably for the intended objectives and for future generations; Create and maintain a successful land information management system at the national and local levels; Manage and administer all unregistered trust and community land on behalf of the county government.

The Environmental Management and Coordination Act, EMCA 1999

It creates the institutional and legal framework for environmental management. Its guiding principles include the notions that everyone in Kenya has a right to a clean and healthy environment and that everyone has a duty to preserve and develop it. The right to a clean and healthy environment includes access to the various public areas or portions of the environment for recreational, educational, health, spiritual, and cultural purposes. It also has provisions for audits, social environmental impact evaluations, and environmental assessments.

Water Act, 2002

Focuses on the acquisition and control of water rights as well as the management, conservation, use, and control of water resources. Additionally, it addresses the administration and regulation of water and sewage services. It also includes guidelines for setting up and running institutions that deal with providing services and managing water.

Public Health Act, Cap 242

Provides for the protection and maintenance of public health. It establishes principles and criteria for a clean atmosphere, efficient ventilation, and livable developments in a certain region. These provisions govern the issuance of occupational licenses.

Survey Act, Cap 299

Makes provisions for surveys, geographical designations, and land surveyor license, as well as other related matters. Under the direction of the Director, the Department of Surveys creates and maintains property boundary plans in support of Land Registration across the country. Existing survey data was used to prepare the plans for this strategy.

Land Registration Act (No. 3 of 2012)

Explains the procedure for registering land for different types of land. It describes how to set up land registries and land registration units.

Agriculture, Fisheries and Food Authority Act, (2013)

Provides a framework within which to make ideas on agriculture promotion and soil and fertility conservation for sustainable agriculture and land use optimization.

Forests Act, No. 7 of 2005

Provides for the establishment, development, and long-term management of forest resources, including conservation and sensible use, for the country's socioeconomic development. It acknowledges that forests have an important role in the stabilization of soils and groundwater, allowing for stable agricultural activities, as well as in conserving Kenya's water catchments and regulating climate by absorbing greenhouse gas emissions. It also acknowledges that Kenya's woods are a vital source of biodiversity and wildlife habitat.

Community Land Act, 2016

Outlines requirements for community land's preservation, registration, upkeep, conversion to either public or private land, and the county government's accountability for unregistered community land. Phase II 5. (5) Subject to the provisions of section 46 of this Act, any person who held a preexisting customary right to keep or occupy land immediately before the commencement of this Act will continue to do so. 6. (1) County governments hold all unregistered community land in trust on behalf of the communities for whom it is held. 13. (2) Land is deemed to be public land vested if it has been used communally for a public purpose before the start of this Act.

1.6.3 Institutional Guidelines

National Government

Has a number of ministries working in regional development around the country. Among them are the Ministries of Health, Water, and Lands, as well as the Ministries of Infrastructure, Housing, and Urban Development.

County Government

Has the duty to plan for the county, and no public funds can be appropriated until a planning framework has been developed and approved by the county legislature and the county executive committee. declares that the county's planning authority are its departments, cities and other urban regions, sub-counties, and Wards. Coordinating integrated development planning within the county, ensuring integrated planning within the county, ensuring links between county plans and the national planning framework, and coordinating integrated development planning within the county are all tasks that fall under the purview of the county planning unit. Make sure that the public participates in the planning process. Ensure that scarce land, water, and other resources are

used effectively for economic, social, ecological, and other goals across a county to promote the development of a well-balanced settlement system.
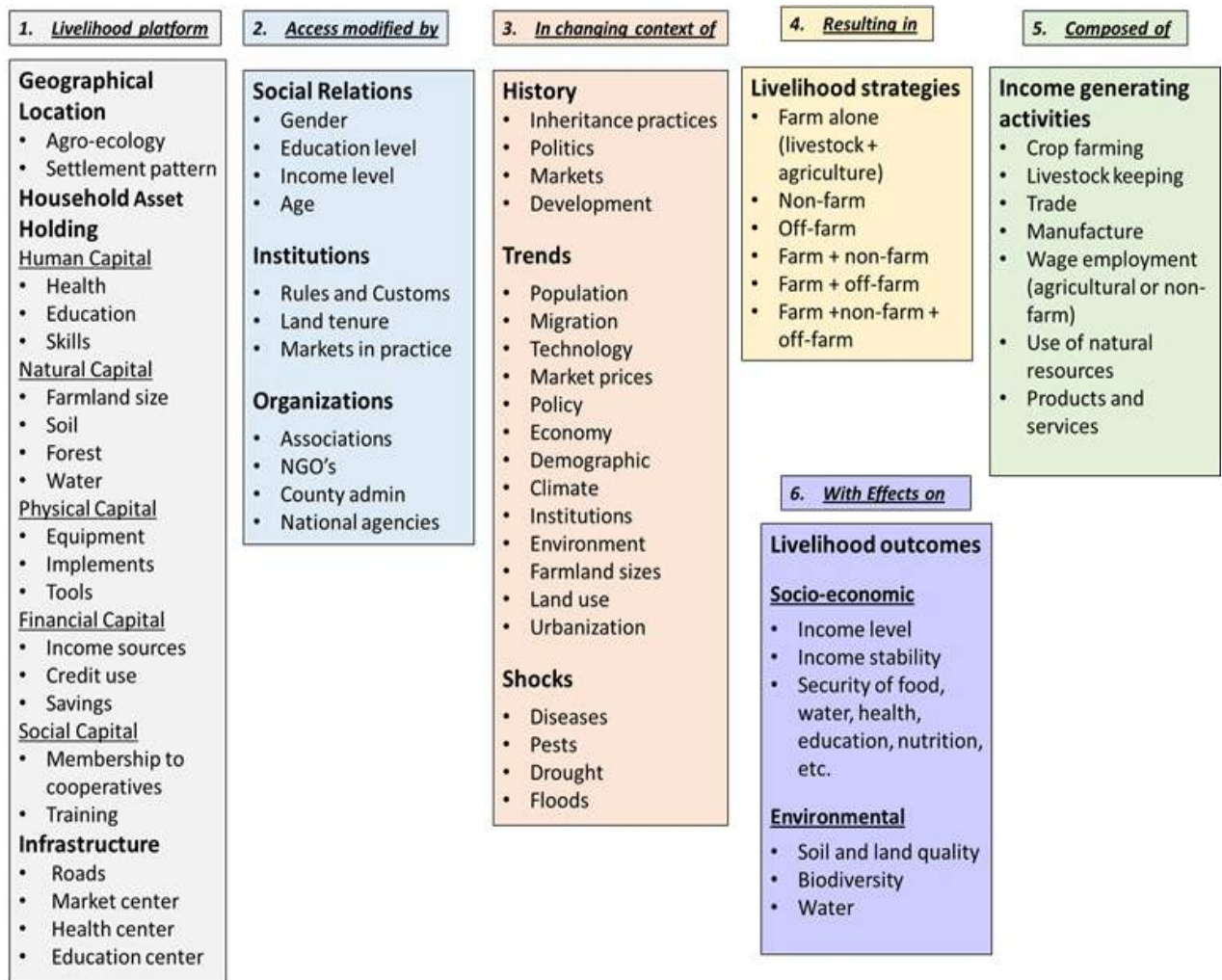
1.7 Overall information gap

The fundamental problem in Kenya today is converting policy goals into concrete actions and results in the shape of improved livelihoods, equitable economic growth, and social transformation. In order to translate policy goals into local tangible achievements, practical information on how to promote pro-poor ecologically sustainable development at the village level and beyond is critical. Farmers and other community-based groups tend to believe what they can see, and with such evidence, skeptical decision-makers might be persuaded and motivated to allocate resources to such interventions. Our type of practical information is scarce, so this study seeks to fill the void.

1.8 Conceptual Framework

A livelihood, in the words of Chambers and Conway (1991, p. 6), is comprised of the skills, possessions, and activities necessary to support oneself. It is sustainable if it can withstand shocks and stress and bounce back, if it can maintain or enhance its capacities and resources, and if it can provide opportunities for future generations to lead respectable lives. In the short and long term, the net advantages will be achieved on a local, national, and global level. This strategy focuses on households and how they use their assets to carry out economic activities in order to create decent living conditions. (Frankenberger, 1996).

Figure 7: Conceptual Framework (Author, 2019)

1. Livelihood platform

Geographical Location
- Agro-ecology
- Settlement pattern

Household Asset Holding

Human Capital
- Health
- Education
- Skills

Natural Capital
- Farmland size
- Soil
- Forest
- Water

Physical Capital
- Equipment
- Implements
- Tools

Financial Capital
- Income sources
- Credit use
- Savings

Social Capital
- Membership to cooperatives
- Training

Infrastructure
- Roads
- Market center
- Health center
- Education center

2. Access modified by

Social Relations
- Gender
- Education level
- Income level
- Age

Institutions
- Rules and Customs
- Land tenure
- Markets in practice

Organizations
- Associations
- NGO's
- County admin
- National agencies

3. In changing context of

History
- Inheritance practices
- Politics
- Markets
- Development

Trends
- Population
- Migration
- Technology
- Market prices
- Policy
- Economy
- Demographic
- Climate
- Institutions
- Environment
- Farmland sizes
- Land use
- Urbanization

Shocks
- Diseases
- Pests
- Drought
- Floods

4. Resulting in

Livelihood strategies
- Farm alone (livestock + agriculture)
- Non-farm
- Off-farm
- Farm + non-farm
- Farm + off-farm
- Farm + non-farm + off-farm

5. Composed of

Income generating activities
- Crop farming
- Livestock keeping
- Trade
- Manufacture
- Wage employment (agricultural or non-farm)
- Use of natural resources
- Products and services

6. With Effects on

Livelihood outcomes

Socio-economic
- Income level
- Income stability
- Security of food, water, health, education, nutrition, etc.

Environmental
- Soil and land quality
- Biodiversity
- Water

CHAPTER THREE: RESEARCH METHODOLOGY

2.0   Introduction

This chapter discusses the study's target population, sampling strategy, and research design. Additionally, it emphasizes the study's data analysis, data gathering, and ethical issues. The chapter concludes with a data needs matrix that explains the source, analysis and presentation of data for different objectives of the study.

2.1   Research design

A survey (cross sectional) research design was adopted for the study. This involved visiting the sub-location and collecting data from the different sub-groups of the target population only once using different approaches. Mapping of the different social and physical facilities including other unique features in the sub-location were undertaken during the field visits. A detailed illustration of the methodology for formulating a smart village model of development is in appendix E.

2.2   Target population

The target population of the study included all households and key informants from different sub-sectors. Table 1 below shows a summary of the target population and the projections up-to year 2030. Spectrum was used to generate the population projection. The parameters used in the projection included; increasing county fertility rates among youth, increasing urban rural migration, rate of urban sprawl and growth trend of urban centers in Nairobi Metropolitan Region.

Table 1: Kimunyu Sub Location Population Dynamics (Census data, 2009)

Year	Total	Male	Female	Households
2009 Census	4,350	2,094	2,256	1,134
2019 Census	7,907	3,958	3,949	1,865
2020 Projection	8,263	4,144	4,119	2,054
2025 Projection	10,042	5,076	4,966	3,957
2030 Projection	11,821	6,008	5,813	4,863

2.3 Sampling Plan

Multistage sampling approach was used in getting the sample. Kimunyu sublocation has six villages. Each village was treated as a cluster. The sub-location had about 1,865 households as indicated in Table 1. According to Mugenda & Mugenda (2003), in descriptive research, a sample size of 10-50% is acceptable. The target population was a total of 1,865 households. The minimum which is ten percent of this population was 187 households. However, due to lack of sufficient financial resources, only 80 households were sampled. The list of all households in a given village formed the sample frame. Thirteen households were sampled from each village using simple random method. If no one was found in a sampled household, the next household was visited and the head/spouse/adult child interviewed. One research assistant was hired for each village. For security, the village headman guided the research assistant in locating the sampled homes. The researcher was also assisted by a community leader to carry out mapping.

2.4 Data collection

2.4.1 Primary Data

A total of 80 households and six key informants were interviewed through face-to-face interviews. Three focus group discussions were also held. Additional primary data was obtained through photography and observation.

2.4.2 Secondary Data

Secondary data was obtained through literature review of published books and journals, online data and resources, government reports and records from the relevant offices. Unpublished data sources such as assessment reports, theses, policy briefs and discussion papers were also reviewed. The desktop review of all these materials was carried out during the entire period of this study. It also involved an extensive analysis of issues relating to rural development strategies through policies and programs in Kenya and the extent to which they have involved the citizens and utilized data. This data was critical in complementing primary data and providing the study background.

2.5 Data Analysis

Data was examined using descriptive, statistical, and geographical methods. The accuracy and consistency of the data entered into the household questionnaires, which included both open-ended and closed-ended questions, were verified. The responses were numerically coded and stored in a database template using SPSS for further analysis. The spatial data collected was analyzed using ArcGIS software.

2.6   Data presentation

Analysis results were presented in the form of charts, tables and figures. These were all systematically compiled in the current report.

2.7   Ethical considerations

The following ethical guidelines were put into consideration during the entire research period: All the research assistants and respondents were made part of the research only through informed consent. What the research was about, what it involved, and what their part in it would be, was all clearly communicated; Prior to the research itself, discussions were held with the research supervisors to help obtain ethical consent on all the sensitive issues; The data collection instruments were first approved by the research supervisors before using them; Any personal details, information or data relating to anyone was referenced to them.

2.8   Data needs matrix

Table 2: Data Needs Matrix (Author, 2019)

Research objectives	Data Sources	Data analysis	Results presentation
To examine human settlement patterns and process of development in relation to farmlands	Literature review Google earth images Field survey Household interviews Observations and photography	Descriptive analysis SPSS & MS Excel Spatial analysis with ArcGIS	Photographs Maps Tables Figures
To assess connectivity and accessibility of services by households.	Literature review Google earth images Field survey Household interviews	Descriptive analysis SPSS & MS Excel Spatial analysis with ArcGIS	Photographs Maps Tables Figures
To establish the main sources, levels and reliability of household income.	Google earth image Field survey	Descriptive analysis SPSS & MS Excel	Tables Charts

Research objectives	Data Sources	Data analysis	Results presentation
	Synthesis of findings

Household Interviews | | |
| **To propose a Smart Village Model of development for securing sustainable land use and livelihoods.** | Literature review

Google earth image

Field survey

Interviews

Synthesis of findings

Mapping | Descriptive analysis

SPSS & MS Excel

ArcGIS-Spatial analyst | Maps

Descriptive and analytical Report |

CHAPTER FOUR: KIMUNYU SUB LOCATION

3.0 Introduction

If effectively utilized, both renewable and non-renewable natural resources form the foundation of a region's economy. The number and quality of available natural resources, as well as the intensity and efficiency with which they are used, define the level and rate of economic growth in Kimunyu sublocation to a large extent. Maheshwari (1985) believes that rural areas have their own natural resources, and that science may suggest ways to use these in order to provide more and better jobs for the local population. Natural resources, human resources, and land are the three basic categories of resources according to Singh (1988). For a balanced use of local resources, integrated development planning is critical. The resources and assets of the Kimunyu sublocation are discussed in this chapter.

3.1 Geographical Location and Size

Kimunyu Sub-Location is an administrative division and is located in Central, Kenya. It is located in Kiganjo ward of Gatundu south sub-County, Kiambu County which is part of the Nairobi Metropolitan Region. The sublocation is located on the south of the equator between latitudes E 36º 55' 30.72" and E36º 57' 14.4". It borders Kahunguini sub location to the south, Mutomo sub location to the west, Githunguchu sub location to the north and on the western side it is surrounded by coffee estates located in Juja sub county. The sub location covers an approximate area of 5.61 Sq. Kms. The sub location is comprised of six villages as shown in the figure and on the table below;

Table 3:Kimunyu Sub Location Villages Information (Author, 2019)

No.	Village	Area (Square Kilometers)
1	Kimunyu	2.23
2	Gachoka	1.11
3	Gechure	0.71
4	Thangari	0.56
5	Thiririka	0.51
6	Gathigia	0.47

3.1.1 National Context

*Figure 8: Location of Kiambu County in Kenya(Author 2019)*
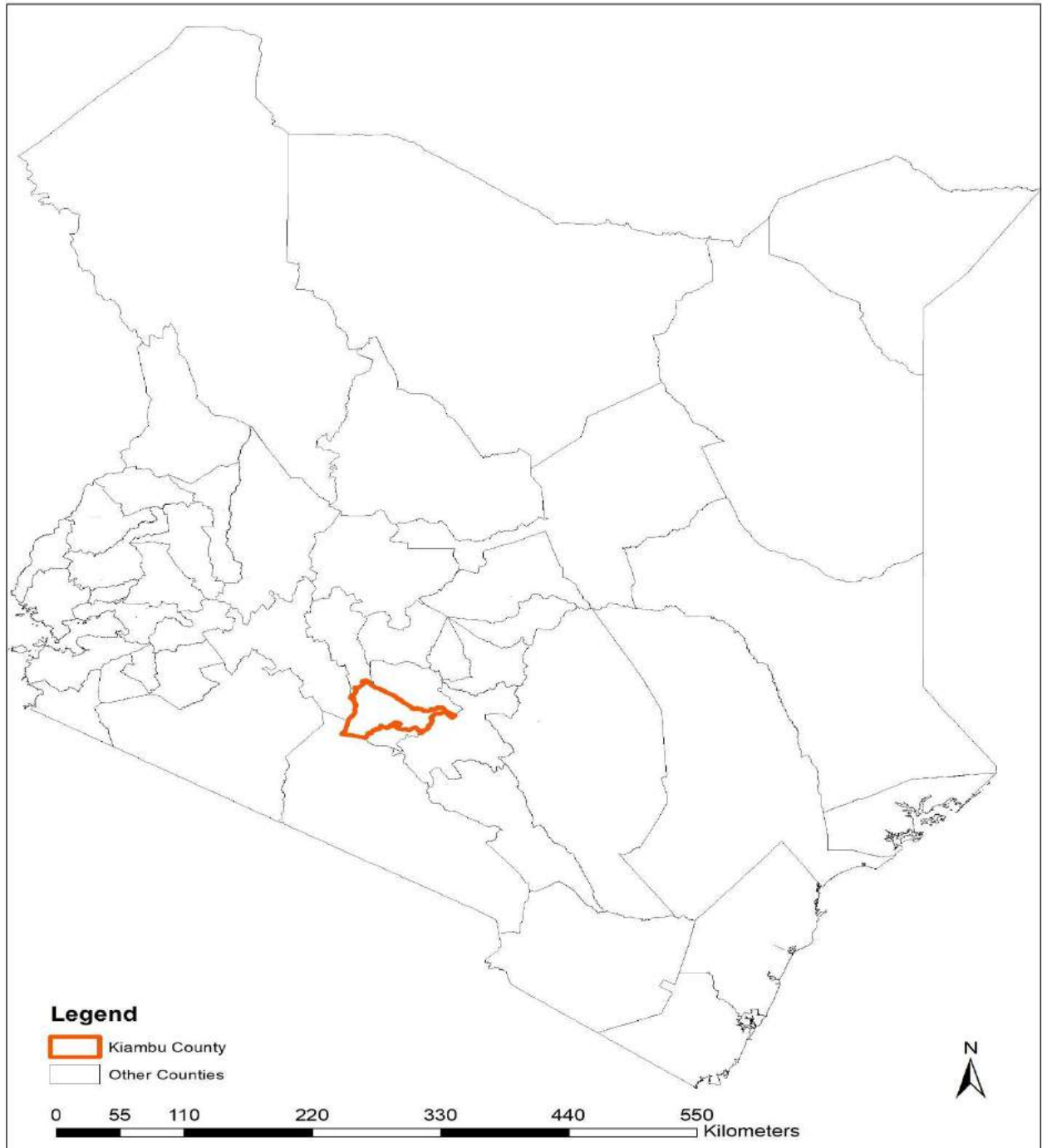
The location of Kiambu County in Kenya inside the Nairobi Metropolitan Area is depicted in Figure 8 above. Kiambu County is surrounded by the counties of Nairobi and Kajiado on the south, Machakos on the east, Murang'a on the north and east, Nyandarua on the north and east, and Nakuru on the west.County Context

Figure 9: Location of Gatundu South Sub- County in Kiambu County (Author 2019)
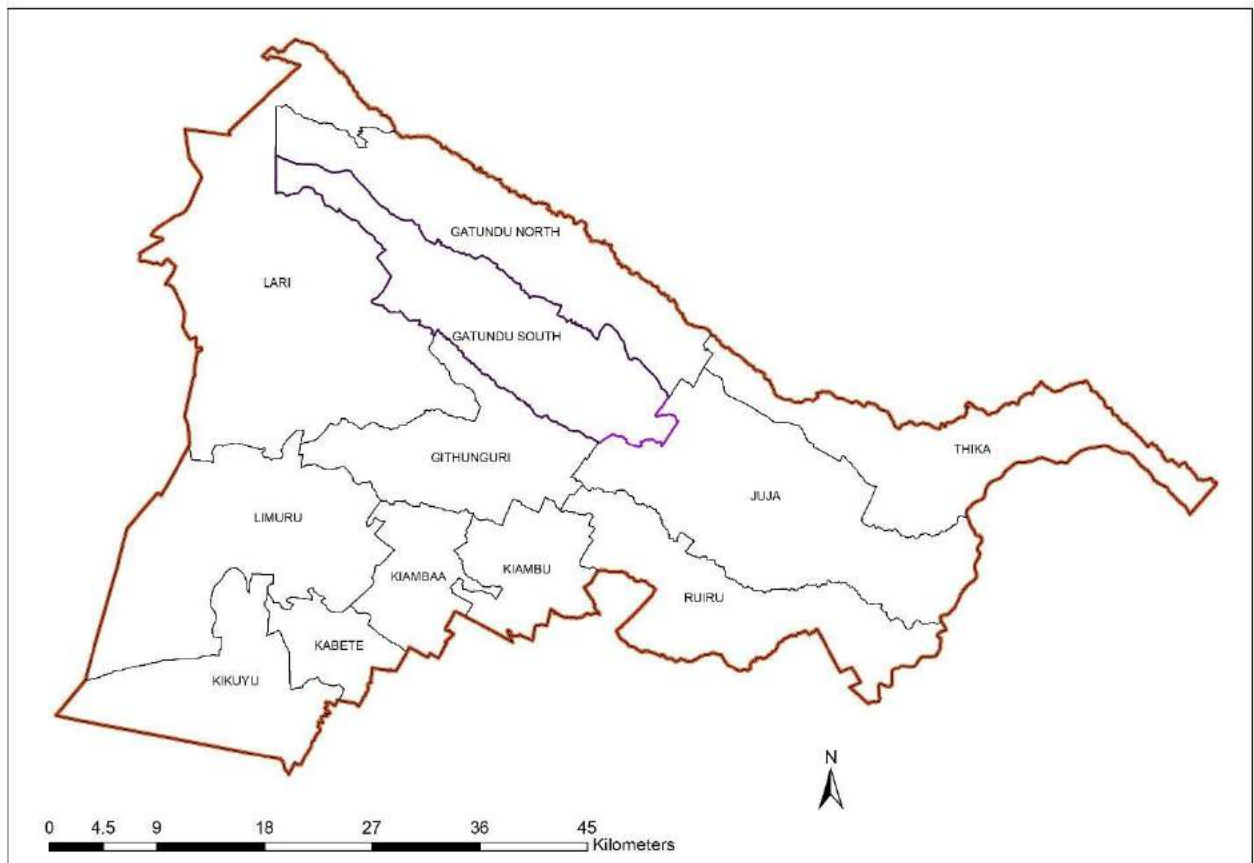
3.1.2 Sub County Context

Figure 10: Location of Kimunyu Sub-location in Gatundu South Sub-County (Author 2019)
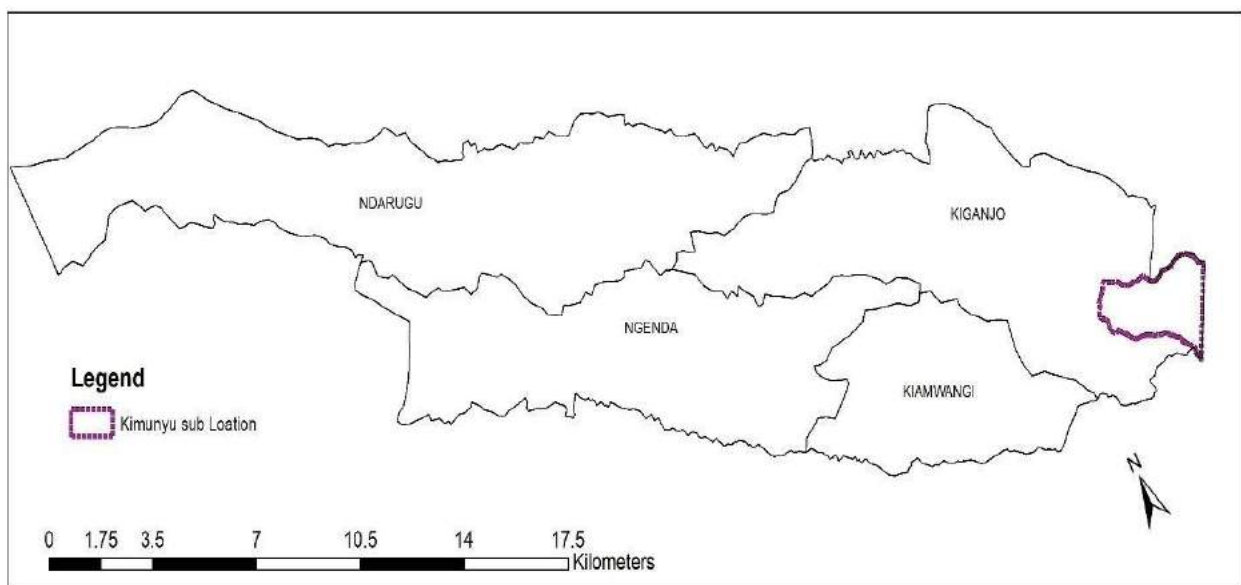
3.1.3 The Base Map

Figure 11: Kimunyu Sub Location Base Map (Author 2019)
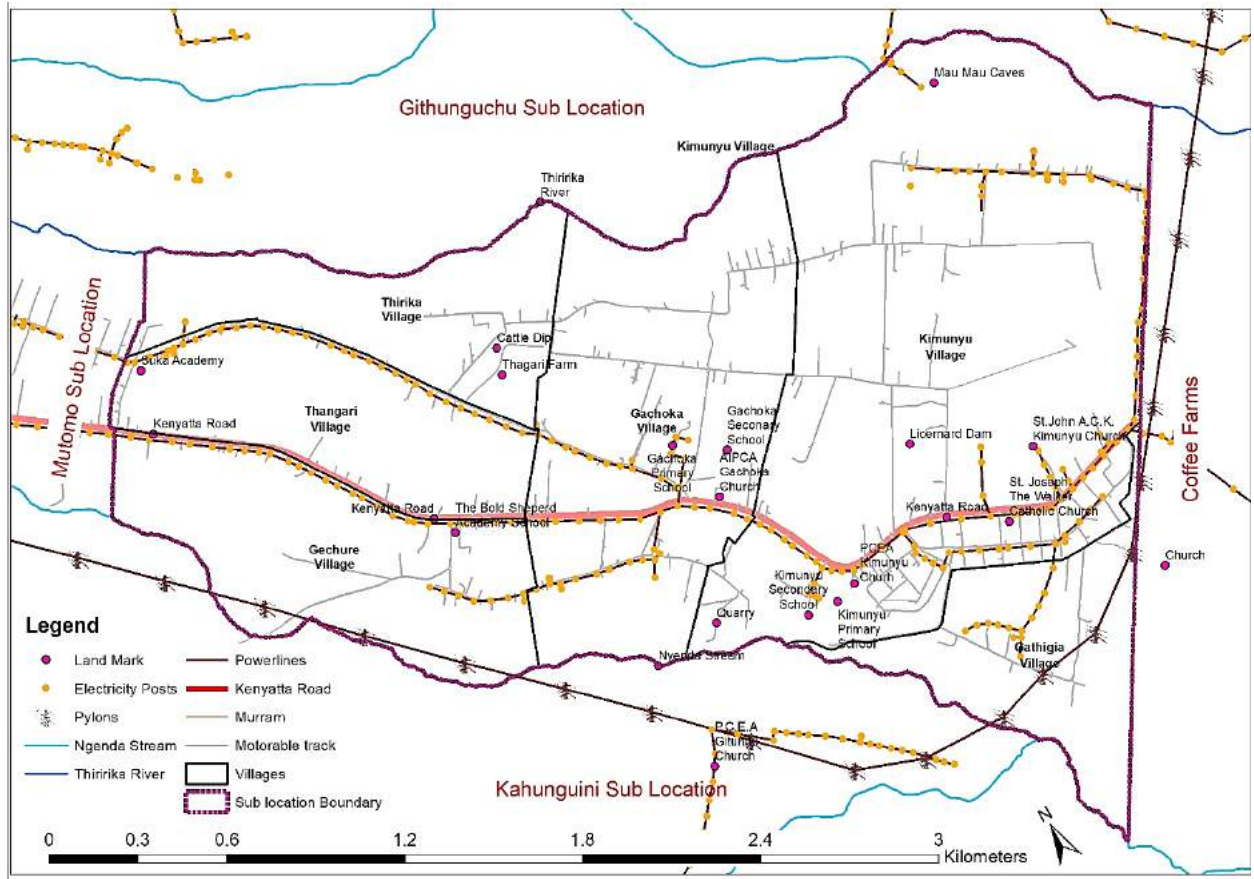
Figure 11 above illustrates the base information that aided in the successful collection of additional data in the study area.

3.2   Physiographic and Natural Conditions

3.2.1   Physical and Topographic Features

Kimunyu sub location is found in the lower highland topographical zone. The area is characterized by hills, plateaus and high elevation plains. The area lies between 1,525 and 1,659 metres above sea level as shown in the contour map and the Digital Elevation Model (DEM). Although it is mostly a coffee and dairy zone, there are other practices for growing maize, bananas, horticulture crops, poultry, and goats, to name a few. On the northern side lies river Thiririka and Ng'enda stream on the southern side which also represent the location borders respectively.

Figure 12: Kimunyu Sub Location Contour Map (Author, 2019
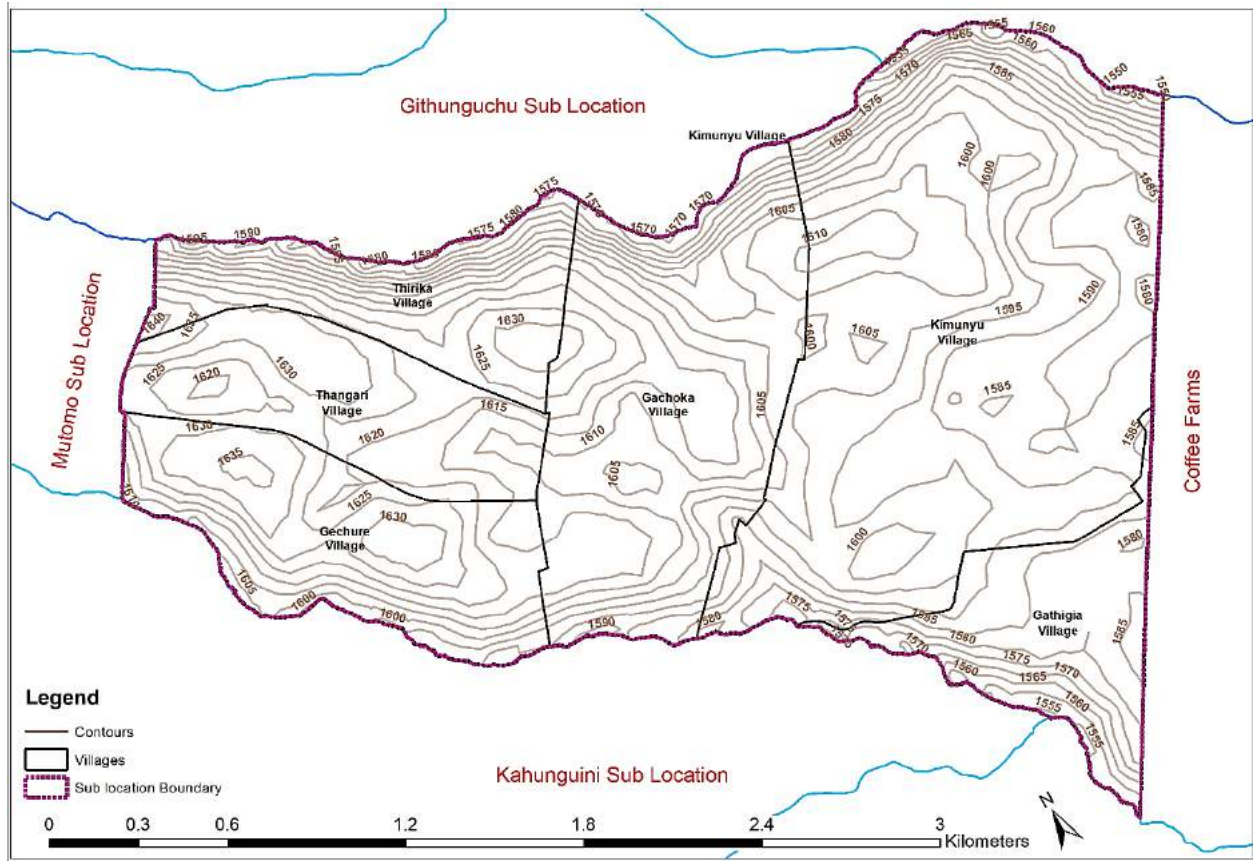
Figure 13: Kimunyu Sub Location Digital Elevation Model (DEM) (Author, 2019)
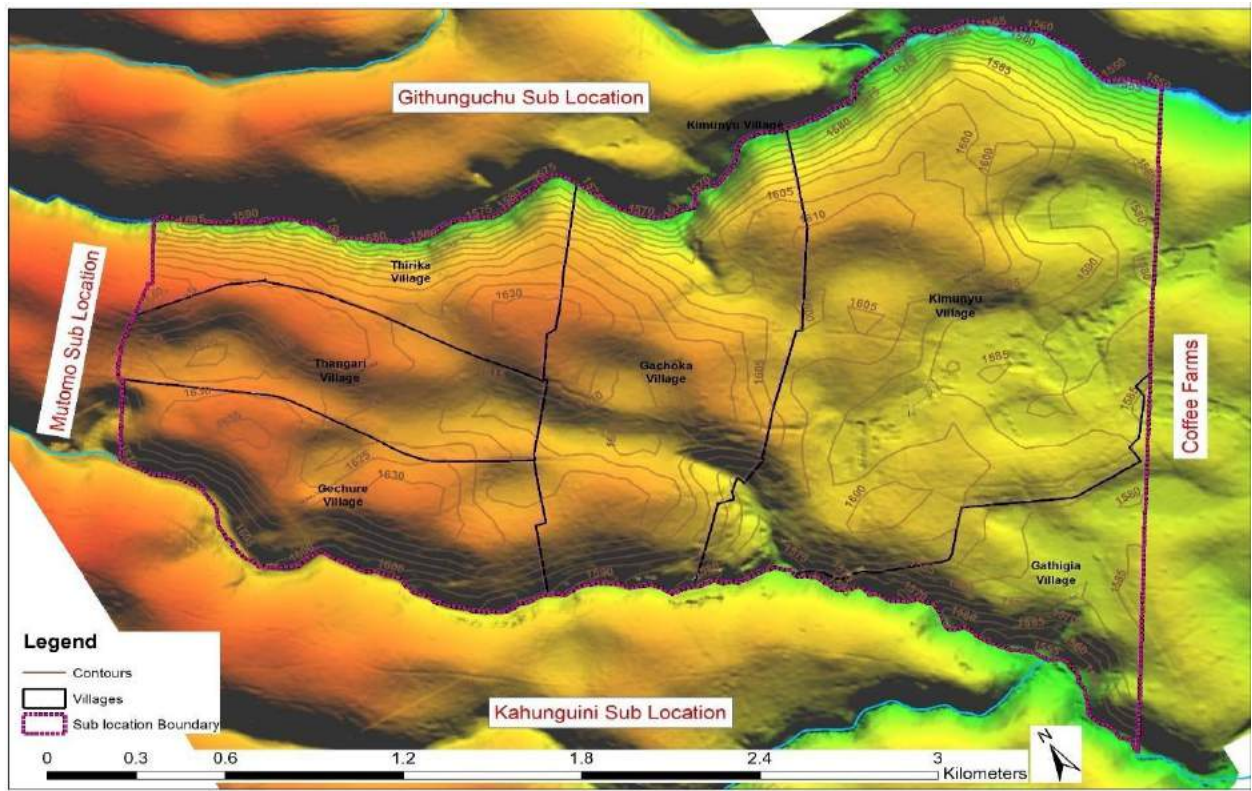
3.2.2 Water Resources

Water in the sub location is from two principal sources-surface and sub-surface. The sub location lies in Thiririka river sub-catchment area which originates from the Aberdare plateau. River Thiririka and Ng'enda stream are the two major sources of surface water. The area has one natural dam and several wetland areas mostly within Kimunyu village.

Figure 14: Licernard Dam (Field Survey, 2019)

Figure 15: River Thiririka (Field Survey, 2019)

Figure 16: Ng'enda Stream on the right (Field Survey, 2019)

3.2.3   Soil Conditions

The region is distinguished by high-level volcanic rock soils with high fertility levels that are ideal for growing a variety of food and cash crops, including potatoes, coffee, horticultural goods, vegetables, maize, beans, bananas, pyrethrum, and beans.

3.3   Physical and Social Infrastructure

Productivity and sustained economic growth depend heavily on infrastructure. It makes a substantial contribution to human development, poverty alleviation, and achieving a nation's development objectives. The table below lists all the infrastructure developments in Kimunyu sub location. They have been divided into two categories; the physical infrastructure and the social infrastructure.

3.3.1   Transportation

Road network in Kimunyu comprise of a tarmacked primary route which is Kenyatta Road, secondary routes and foot paths see figure 19 for more information on sub location the road network.

Figure 18: Internal Road Section (Field Survey, 2019)

Figure 19: Kimunyu Sub Location Road Network (Author, 2019)
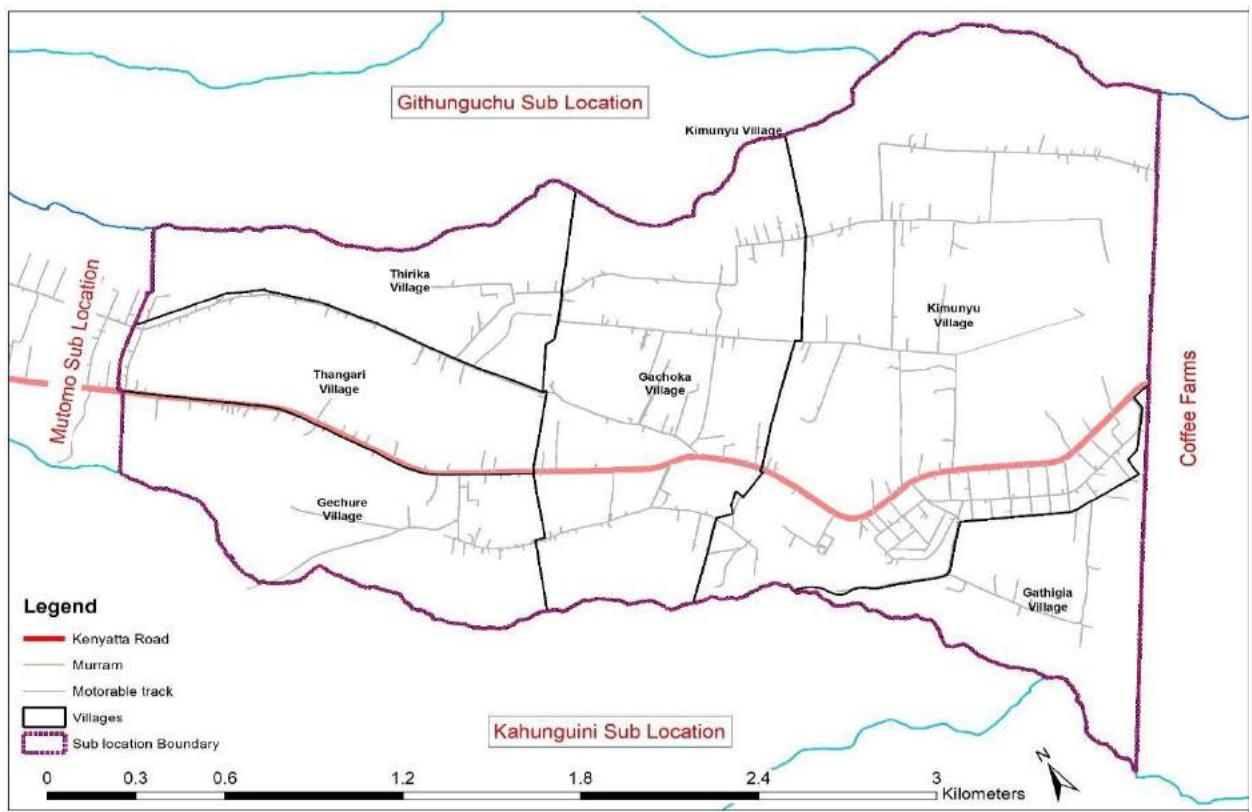
3.3.2   Energy

Electric grids are well distributed within the sub location (see map 4-7) though not all households have power connection. Sustainable energy sources such as solar panels, hydro and wind energy as well as waste energy sources like biogas have not been realized.

Figure 20: Illustration of Electricity Grids (Field Survey, 2019)

3.3.3 ICT

Information, Communication and Technology infrastructure needs major improvement in the area. Below is a photo of communication mast near Gachoka primary school.

Figure 21: Communication Mast near Gachoka Primary School (Field Survey, 2019)

Figure 22: Kimunyu Sub Location Energy and ICT Infrastructure (Author, 2019)
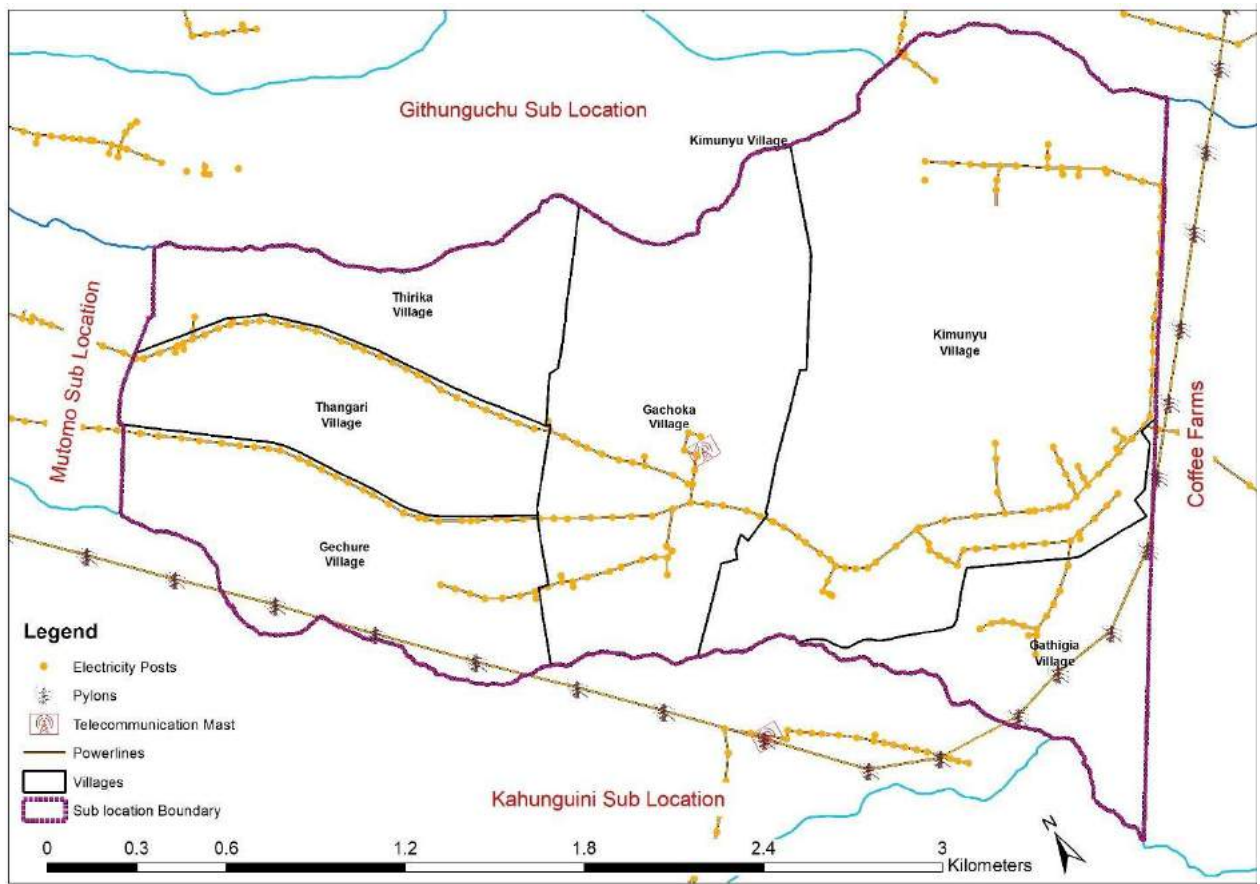
3.3.4 Water and Sanitation

Supply of clean water is by Gatundu Water and Sanitation Company. Most households have water tanks. A few manholes are present.

Figure 23: Water and Sanitation (Author, 2019)
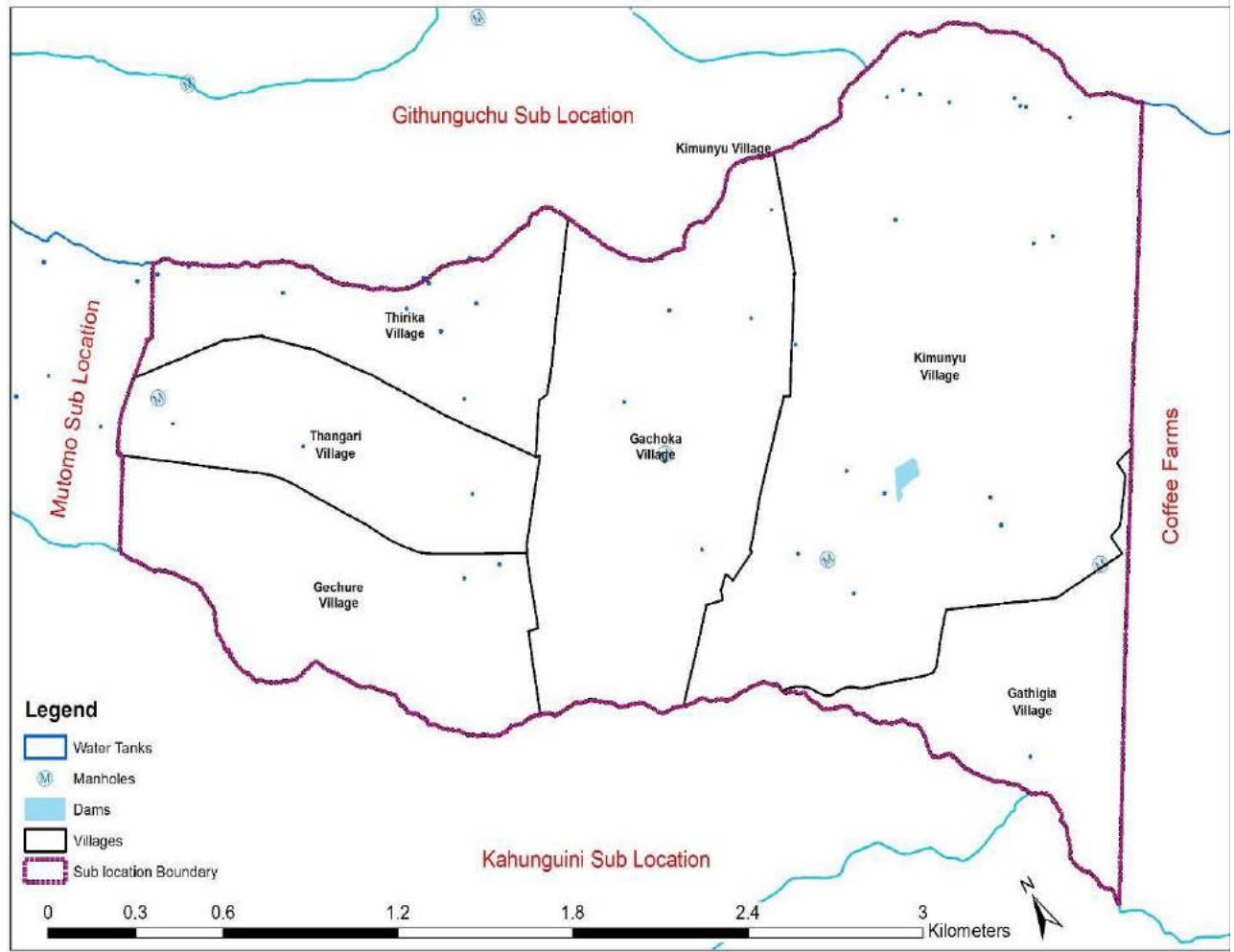
3.3.5 Financial Services

Financial markets and services that support fundamental economic functions including capital formation, investment, payment processing, and risk management also require significant upgrades. Some that are present include; KICODEP SACCO.

Figure 24: Financial Markets and Savings, KICODEP SACCO (Field Survey, 2019

3.3.6 Education, Skills and Literacy

There are four (two public and other two private) primary schools and two public secondary schools within the sub location. These are Kimunyu primary and secondary schools, and Gachoka primary and secondary schools. Both Gachoka primary and secondary schools are on 9.43 acres of land while both Kimunyu primary and secondary schools are on 10.34 acres of land.

Figure 25: Kimunyu Primary and Secondary School Play Ground (Field Survey, 2019)

Figure 26: Gachoka Primary and Secondary School Play Ground (Field Survey, 2019)

The private schools are the Bold Shepherd school and Suka academy. They are located on small parcels of land and lack essential facilities such as playgrounds.

Figure 27: The Bold Shepherd School (Field Survey, 2019)

Figure 28: Suka Academy Hostels (Field Survey, 2019)

Suka academy is a boarding school where the hostels are on a different compound with the classes. A university college is being constructed in Mutomo sub location just adjacent to its border with Kimunyu sub location. It's a branch of Kenyatta university as shown below

Figure 29: Kenyatta University On -going Project (Field Survey, 2019)

3.3.7 Safety and Resilience

Organizations and processes that give a region the ability to withstand stress from disasters like natural disasters while also providing a reliable source of local food.

3.3.8 Public Space

There is a lack of public space that draws economic activity like tourists and business offices, as well as parks and nature reserves.

3.3.9 *Culture, Sports and Creative Arts*

Institutions such as museum that attracts tourist have not been established. Same for those that promote talents such as creative arts. As for sports ground, major improvements are needed. Below is an illustration of the Kimunyu play field which has a stone wall all around it and floods during the rainy seasons.

Figure 30: Kimunyu Sub Location Play Ground (Field Survey, 2019)

3.3.10 Environment and Climate Change

There are no systems in place to improve environmental conditions. Environmental degradation has accelerated over time due to resource depletion, ecosystem devastation, habitat destruction, and wildlife extinction. Farmlands and rivers are the most deteriorated locations in the Kimunyu sublocation. Increased population, which has caused a high need for shelter, is one of the key drivers to environmental degradation. Furthermore, due to the release of numerous

agrochemicals into water sources, farming has resulted in pollution. Temporal rainfall variability is also experienced within the sub location and there are no solid waste management facilities established.

3.3.11 Irrigation

Irrigation infrastructure and schemes needs major investments in the area. There is high irrigation potential within the area but the residents claim to lack water sufficient water for agricultural purposes.

3.3.12 Security, Law and Order

The sublocation has a chief's office and a police post.

Figure 31: The Chief's Office (Field Survey, 2019)

3.3.13 Religious Facilities

There are several religious facilities within the sub location. These include; St. John Kimunyu, P.C.E.A Kimunyu, A.I.P.A Gachoka, and Kimunyu catholic church.

Figure 33: P.C.E.A Kimunyu (Field Survey, 2019)

3.4   Land and Land Use

The sub location has a total area of 5.61 Sq. Km. The total number of land parcels were 636 which comprised 1 414 .10 Acres of land. The smallest land parcel was 0.04 Acres while the largest was 21.95 Acres excluding the Government Land which was 53.17 Acres. The average parcel size was 2.14 acres excluding the GL and 2.22 acres including the GL.

Figure 34: Kimunyu Sub Location Cadastral Map (Author, 2019)
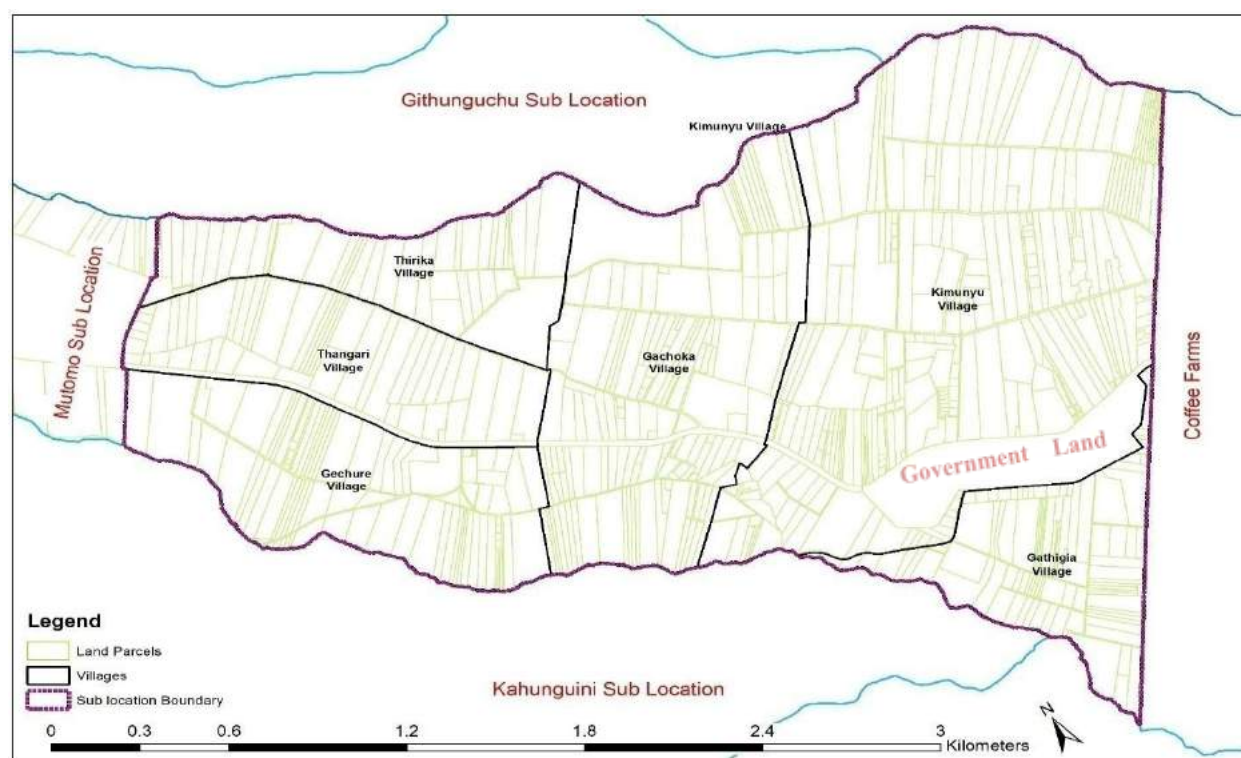
The following is an analysis summary of the generated cadastral attributes as per the six villages.

Table 4: Summary of the Land Parcel Sizes as per the Survey Plans (Author, 2019

Village	Total Area (Sq. Km)	Total No. of Parcels	Total Land Size (Acres)	Smallest Parcel (Acres)	Largest Parcel (Acres)	Average Parcel Size (Acres)	parcels below 2.5 acres
Gechure Village	0.71	66	178.32	0.05	13.72	2.70	47(71%)
Thangari Village	0.56	50	157.93	0.25	12.06	3.16	24(48%)
Thiririka Village	0.51	40	145.40	0.35	21.95	3.63	18(45%)
Gachoka Village	1.11	130	263.26	0.17	21.72	2.03	106(81%)
Kimunyu Village	2.23	257	537.03	0.04	53.17	2.06	195(75%)
Gathigia Village	0.49	93	132.16	0.11	10.34	1.42	79(84%)

The recommended minimum size for parcels of land in high potential agricultural areas like Kimunyu sub location as per the PPA is 2.5 acres. Generally, 73% of the parcels in Kimunyu sub location are below the recommended size. Looking at the specific villages, only Thangari and

Thiririka villages have more than half of their total parcels above the minimum. Gathigia village which is the smallest coincidentally records the smallest parcel sizes with 84% of them being below 2.5 acres. Looking at this table, it is clear that urgent interventions are required to help restore the farmlands to economical sizes.

Chart 1: Land Parcel Sizes as per the Six Villages (Author, 2019)
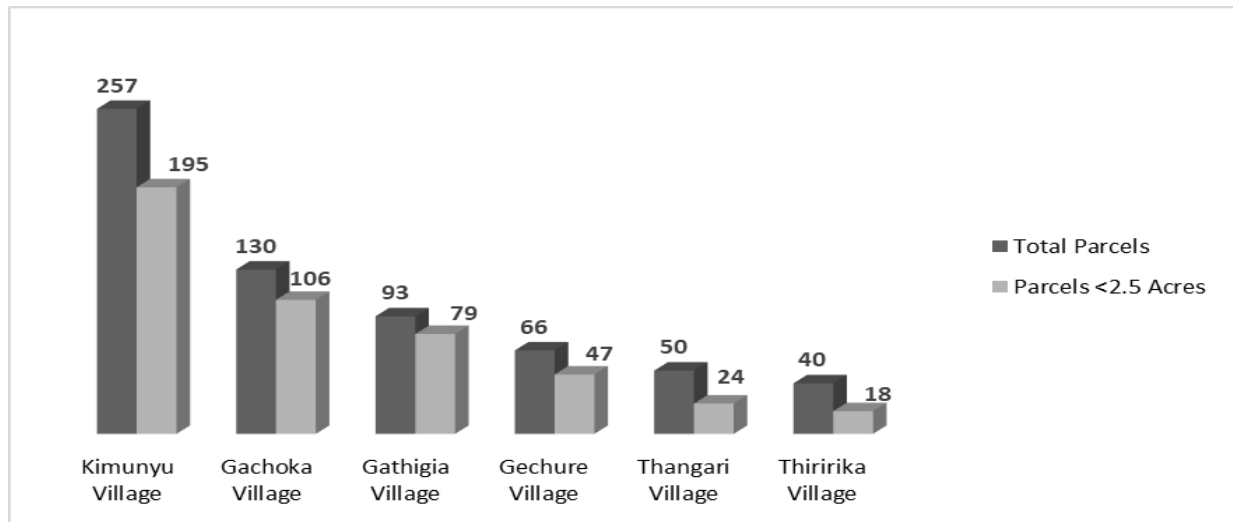
Land in Kimunyu is put under diverse uses including residential, agricultural, commercial, wetland forest and public land where we have public utilities and amenities.

Figure 35: Kimunyu Sub Location Existing Land Use Map (Author, 2019)
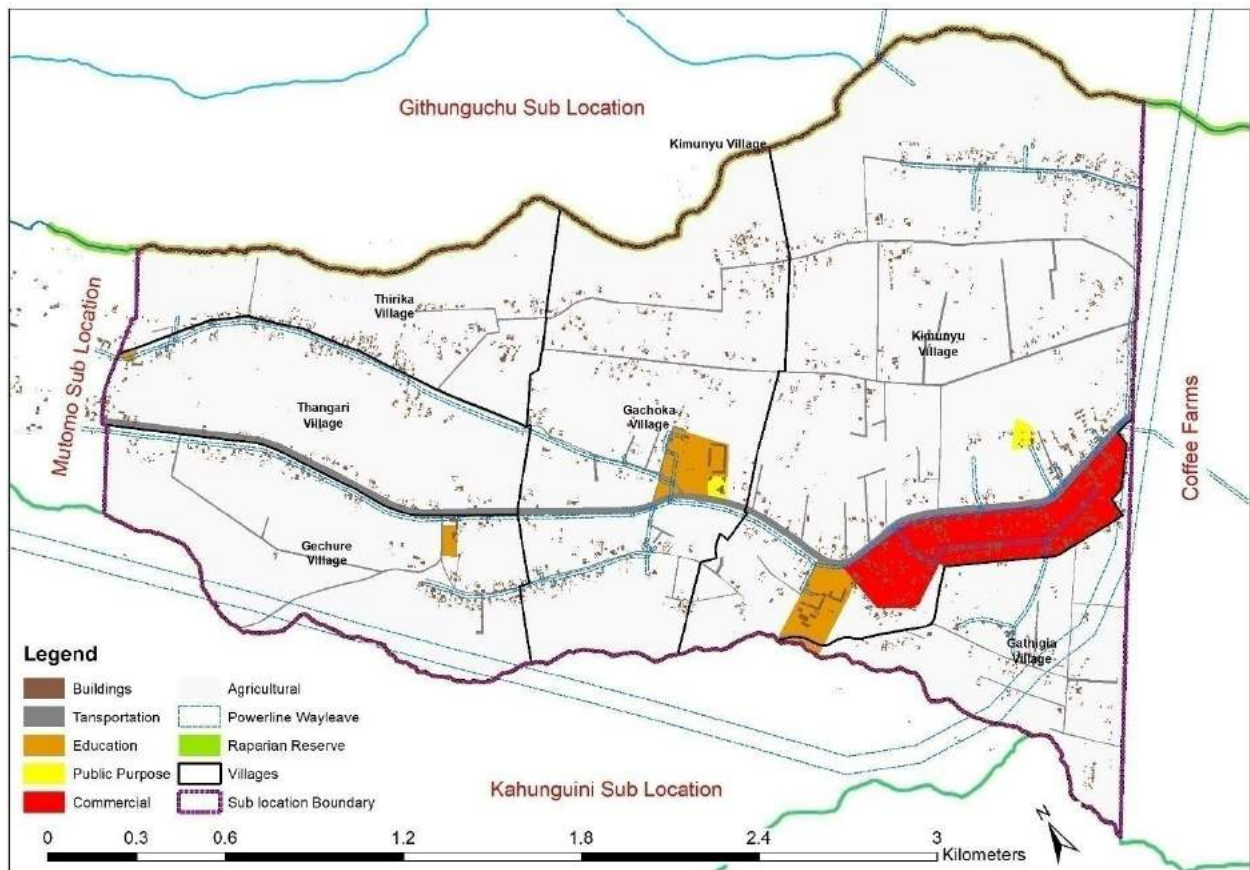
3.4.1 Land Ownership Category/Classification

There are two categories of land; public land is approximately 3.76%, whereas private land is approximately 96.24%.

3.4.2 Mean Holding Size

The average mean holding size of land is approximately 2.22 acres including the Government Land and 2.14 excluding the GL. Most of the minor landholdings are located in the villages of Gathigia, Kimunyu, and Gachoka. The registered land regime did in fact allow for more land fragmentation than was economically feasible, which led to the majority of farmers turning their fields into residential plots to supplement their minimal farm income. The communities of Thangari, Thiririka, and Gechure possess sizable landholdings. The smallest holding is 0.04 acres while the largest is 21.95 acres excluding the government land which is 53.17 acres. There is a total of 636 registered land parcels where 73.7% of them are below 2.5 acres while the remaining 26.3% are more than 2.5 acres as shown below;

Figure 36: Uneconomical Land Sub Division (Author, 2019)
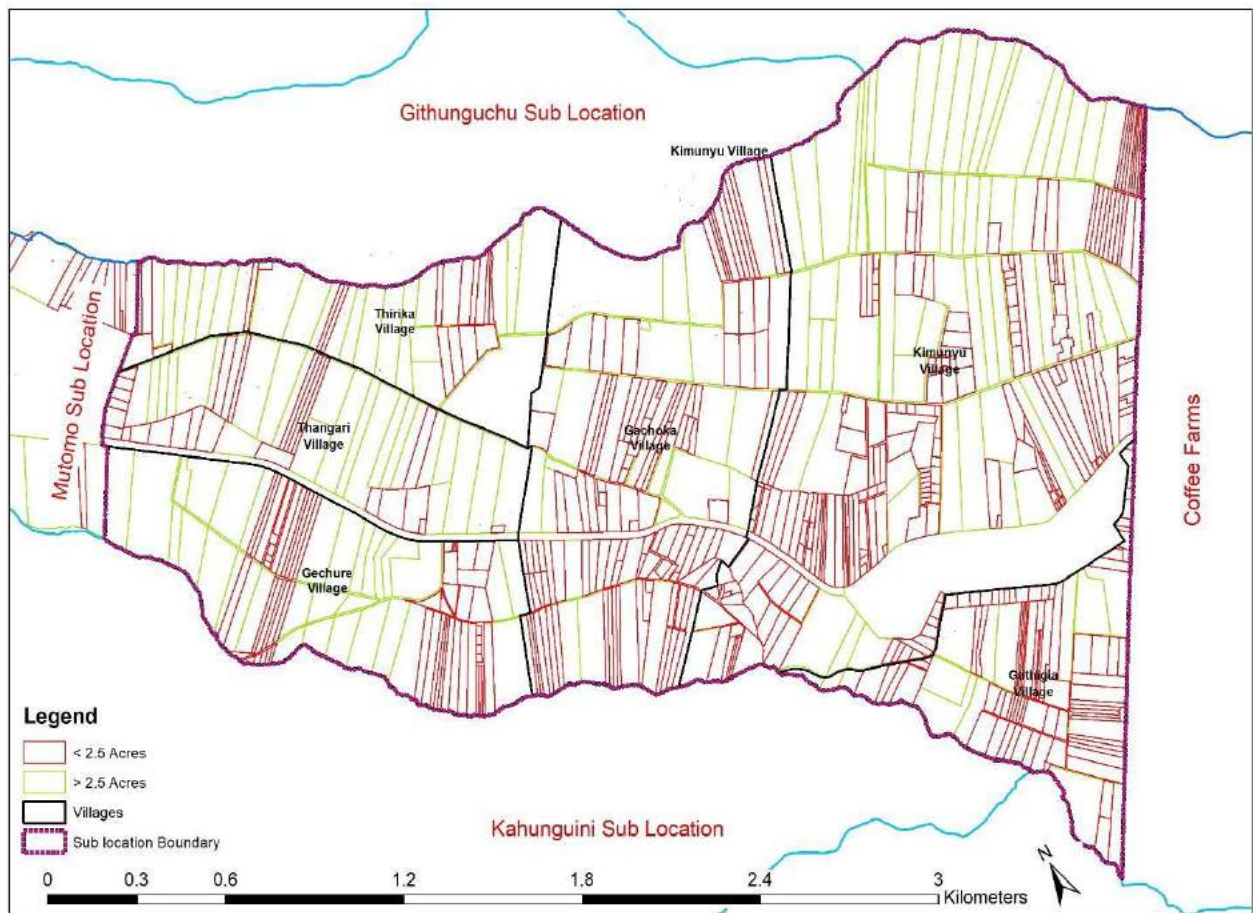
3.4.3   Settlement Patterns

Human settlement studies help to clarify where, why, and how people settle as well as the effects of both intended and erroneous settlements. It is easier to decide where to site and deploy new or extra facilities when there is a greater understanding of the modernisation requirements of expanding communities and their behavior. Planning for an improved quality of life in relation to housing, sanitation, and the environment also benefits from knowledge of socio-cultural values and ethical standards of the populace. Last but not least, the studies promote the development of industries and other amenities for the communities (Balasubramanian A., 2015).

Linear communities are small to medium-sized towns that grow in a straight line. Road transit networks are reported to be followed by linear settlements, which predominate in the sublocation. Settlements that are dispersed are often referred to as scattered settlements. These are sparsely populated settlements that lack a clear settlement pattern and are spread across a large area of occupancy. Although the study area is small, scattered settlements are evident. Isolated settlements are also evident within the area. This is where one settlement is located very

far from the other settlement(s). Nucleated settlements can be seen especially on the government land in Kimunyu village. These settlements are normally clustered on a particular location. Figure 37 illustrates the settlement pattern in the study area. The settlement pattern in Kimunyu sub location is mostly linear followed by dispersed then nucleated and finally isolated in that order.

Figure 37: Human Settlement Patterns (Author, 2019)
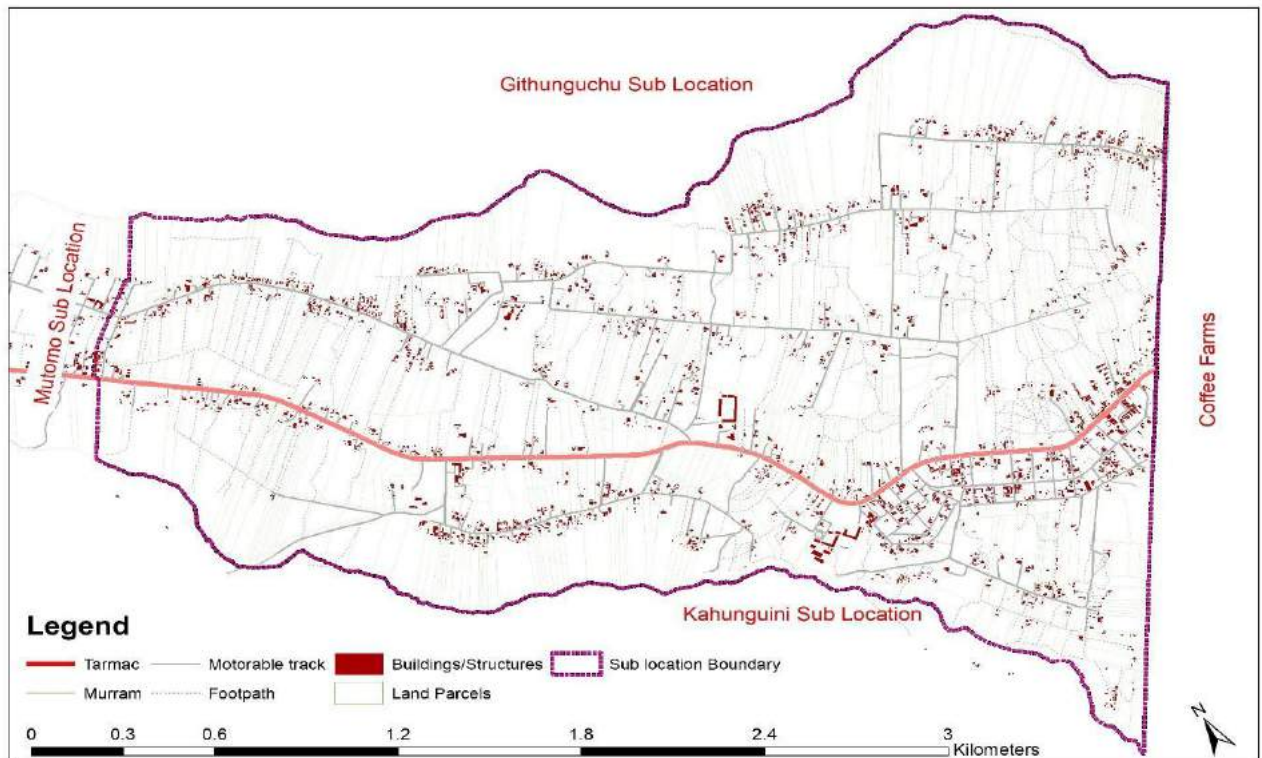
The following three sets of satellite images shows major changes in the settlement pattern in Kimunyu village in the year 2008, 2018 and 2019. In 2008 less homesteads with large farmlands can be seen. In 2018 subdivision can be clearly seen especially on the coffee farms and in 2019 several real estates had been put up. This greatly affected farming in the region and the wage jobs as some these developments can be noted in the coffee farms where most households used to earn their wages. Even though some of the residents secured jobs within the construction industries, employment prospects were discouraging.

Figure 38: 2008 Satellite Image covering Kimunyu Village

Figure 39: 2018 Satellite Image covering Kimunyu Village

Figure 40: 2019 Satellite Image covering Kimunyu Village

Some of the newly developed estates included Banda home, Summergreen estate, Airwaves park estate, Cornerstone estate to mention but a few.

Figure 41: Cornerstone Estate (Field Survey, 2019)

Figure 42: Airwaves Estate (Field Survey, 2019)

Figure 43: Summergreen Estate (Field Survey, 2019)

3.5 Crop, Livestock, Fish Production and Value Addition

3.5.1 Main Crops Produced

The main food crops grown in the area were maize, beans, Irish potatoes, bananas, and vegetables. Although though maize is the staple meal, the sublocation cannot produce enough of it or beans to feed the population, requiring them to buy cereals and grains from other sublocations. Although most of the farmers had removed their coffee trees, coffee is the principal cash crop in the area.

Figure 44: Crop Farming -Bananas (Field Survey 2019)

Figure 45: Crop Farming -Maize and Beans (Field Survey, 2019)

3.5.2 Storage Facilities

Due to the partition of land into small units, farming in the Kimunyu sublocation is primarily small-scale, therefore the majority of the food crop produced is for immediate use, with surplus held in on-farm storages, granaries, and in-house storage..

3.5.3 Agricultural extension, training, research and information services

These services are barely available probably because most households do not carry out farming on a serious note.

3.5.4 Main livestock breeds and facilities

Dairy, poultry and goat keeping are mainly found in this area.

Figure 46: Cattle Dip (Field Survey, 2019)

3.5.5 Fisheries

The sub location has a fish pond that is not functional.

Figure 47: Fish Pond (Field Survey, 2019)

3.6   Mineral Resources

3.6.1   Mining and Extraction Activities

Mining is the process of extracting minerals from the ground or earth. Ballast, hardcore, gravel, murram, sand, and construction stones are among the most often mined materials.

Figure 48: Quarry (Field Survey, 2019)

3.7   Tourism

3.7.1   Main tourist attractions and activities

The sub location has at least one tourist attraction site that is barely visited. This is the Mau-Mau caves in Kimunyu village along Thririka river. The guide did explain that a few locals do go to the site now and then but mostly it's used for religious purposes where people go to pray and even camp there for nights.

Figure 49: Mau-Mau Caves (Field Survey, 2019)

3.7.2   Hotels

There is are no large hotels within the sub location except for the Gatundu gardens resort and stop over along Kenyatta road as shown below.

Figure 50: Gatundu Gardens Resort (Field Survey, 2019)

3.8   Industry and Trade

3.8.1   Markets

There is lack of a market with the proper infrastructure.

3.8.2   Industrial Parks

There are no industrial parks within the sub location.

3.8.3   Major Industries and Factories

No major industries are found with in Kimunyu sub location.

Figure 51: Water Bottling Company (Field Survey, 2019)

Figure 52: Steel Welding Light Industry (Field Survey, 2019)

There is only a simple coffee collection centre within the sub location as illustrated below.

Figure 53: Coffee Collection Centre (Field Survey 2019)

3.8.4 Type of Businesses

The type of businesses found in the area include; a mini supermarket, butcheries and hotels, retail shops with a variety of goods, mobile money agents, sale of cereals as well as animal feeds just to mention but a few. Below is a representation of a few of them;

Figure 54: Retail Shops and Businesses-1 (Field Survey, 2019)

Figure 55: Retail Shops and Businesses -2 (Field Survey, 2019)

Figure 56: Retail Shops and Businesses-3 (Field Survey, 2019)

3.9   Forestry, Agro-forestry and Value Addition

Within the sublocation, there is no gazetted forest. Although tree coverage is adequate, there is room for improvement. Private forestry plays a critical role in supplanting government domination in obtaining essential forest products and services from designated forests. On the farm, small-scale woodland establishment is noticeable, with farmers focusing on: -Fruit tree production. Other activities that can be included on a wide scale include the production of timber, fodder, medicinal herbs, riparian restoration, apiculture, and aquaculture. The tree farming industry is growing in popularity, and it plays an important role in both livelihood empowerment and finance resource mobilization. The interaction between the forest and the neighborhood is advantageous. if those further downstream can rely on the water supply found

in forests where sustainable abstraction is used. This could lead to a rise in farm productivity, boosting food security levels in Kimunyu and nearby sub-locations. It can also improve residents' health, resulting in improved production.

3.9.1 Value Addition

Marketing and value chain development are two of the most problematic aspects of forestry growth in the sub location. This is especially visible on private farms, where there is little coordination and guidance between farmers and market data. This encourages middlemen to take advantage of farmers and foresters by offering extremely low rates for farm forestry products.

3.10 Emerging Issues

Land sub division to uneconomical sizes as well poor infrastructure due to lack of attention are the major issues of development in notable.

<center>**CHAPTER FIVE: DATA ANALYSIS AND DISCUSSION**</center>

4.0   Household Demographic Characteristics.

Age and sex are important demographic variables in the study of fertility, mortality and nuptiality. These variables are the primary basis of demographic classification.

4.0.1   Gender of the Respondents

There were 80 respondents in total but only data form 78 of them was analyzed. 55% of the respondents were females and the remaining 45% males. Out of the total respondents 42 were household heads, 20 their wives and the rest were their adult sons and daughters.

4.0.2   Age of the Respondents

A respondent had to be 18 years of age and above. The youngest interviewed was 20 years old while the oldest was 88 years old. The average age was 52 years. Below is an illustration of the respondents' age;

Chart 2: Age of Respondents (Author, 2019)
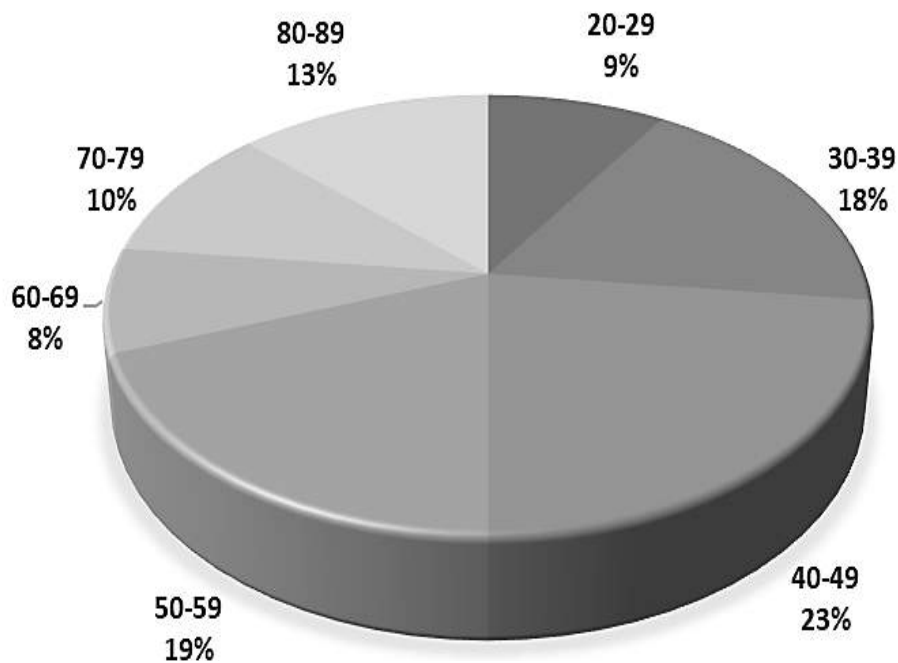
4.0.3   Marital Status

Considering marital status, 51% of the respondents were married, 34% were single, 10% widowed, and 5% divorced.

4.0.4 Household composition

Generally female-headed households tend to be poorer than male-headed households. Also, poor health conditions and economic hardships are found in large, crowded households. There were 119 adults of above 18 years and 79 school going children of 18 years and below. Up to 58 of the 119 adults were males and 61 females. The average age of the school going children was 12 years. Below is a detailed illustration.

Chart 3: School Going Children Under 18 years (Author, 2019)
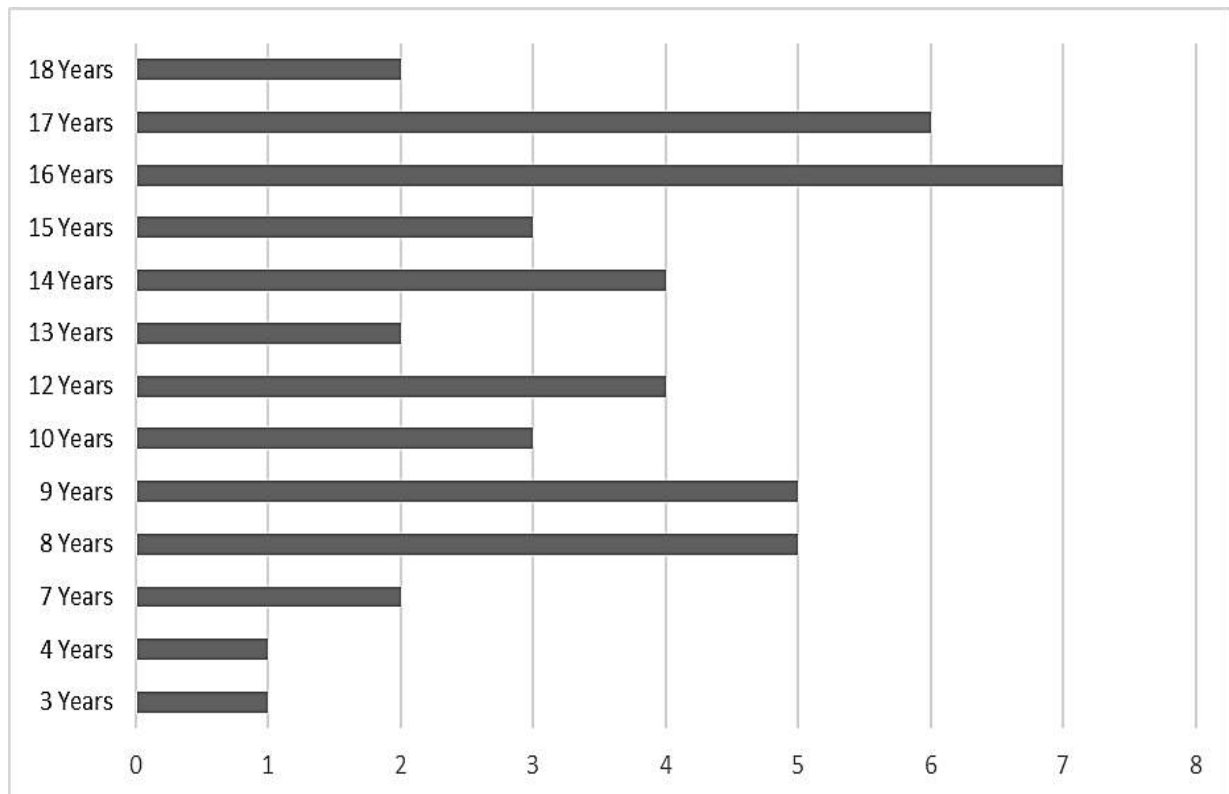
The average household size was 3 members.

4.0.5 Education Details

Human capital accumulation is one of the important drivers of economic growth. A high school dropout rate can impede growth. According to the survey, 47% of the respondents had some primary school education, 17% of them had some secondary education, while only 11% and 15% had completed primary and secondary levels respectively. A proportion of 9% had attended college and only 1% had advanced education at university level. This showed low completion rates of both primary and secondary education. The education details of the children were as illustrated where majority were in class 8.

Chart 4: Class Distribution of the School Going Children (Author, 2019)
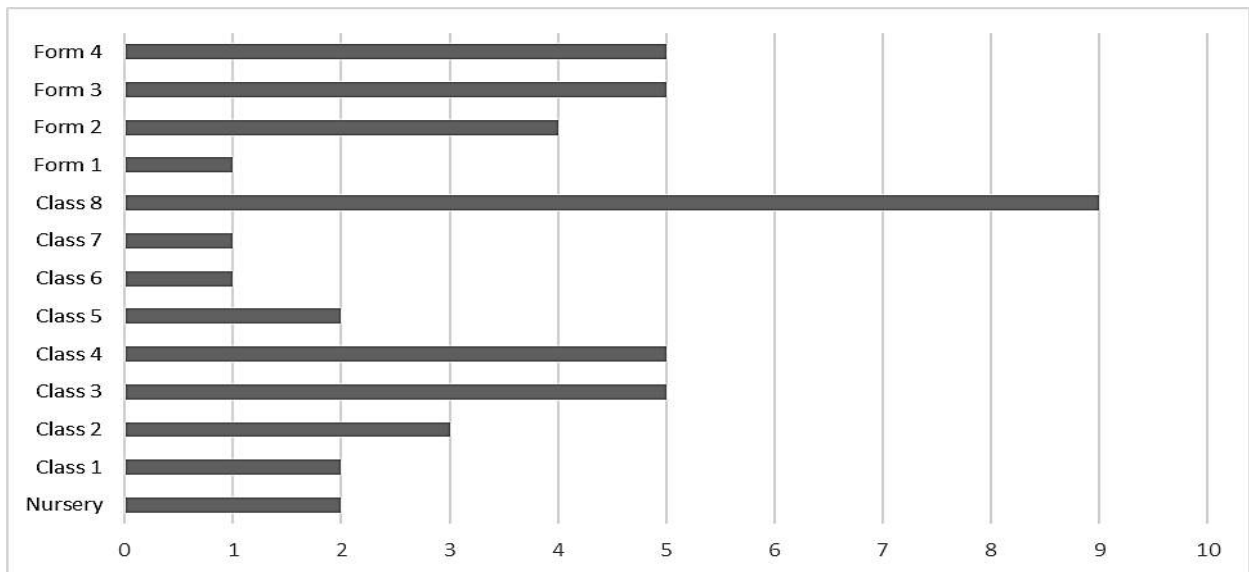
From the above, 61% of the children were in primary school, 29% in secondary school, 9% in pre-school and 1% in special school.

4.1 Human Settlement Patterns

The main goal of human settlement is to make everyone's living and working conditions better in terms of social, economic, and environmental factors. Misuse of farmlands can alter the overall wellbeing of settlements. The settlement pattern in the study area was mainly linear and dispersed. Up to 53% of the respondents would consider living in nucleated settlements. Those who were against nucleated settlements had the following reasons;

Chart 5: Reasons why not in Support of Nucleated Settlements (Author, 2019)
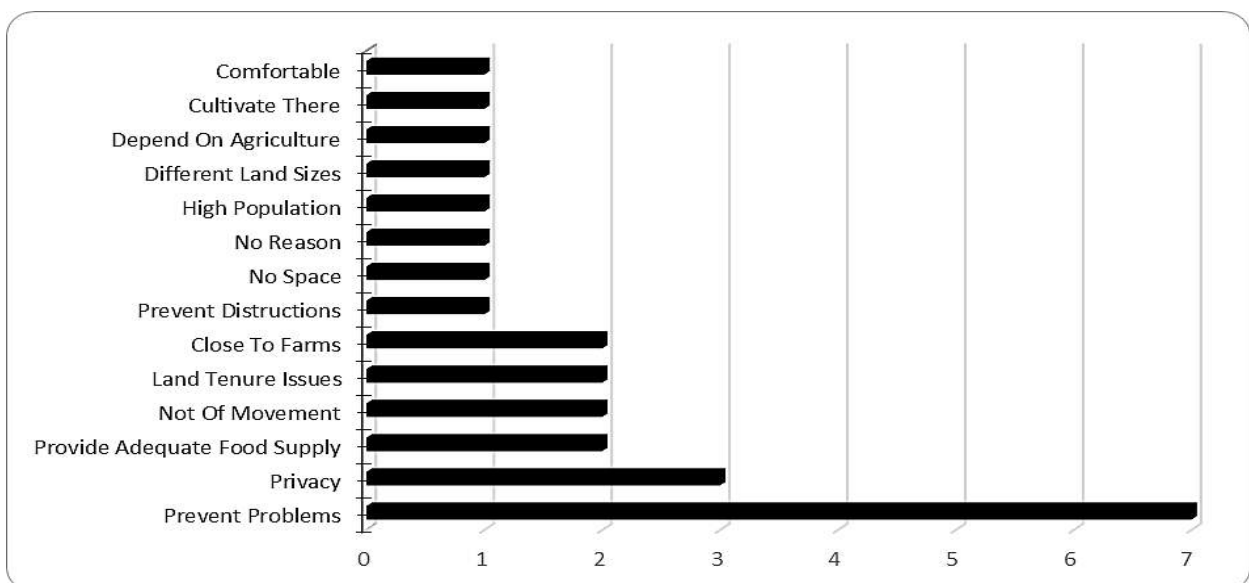
Majority felt that problems would arise while others had privacy concerns. Others all they wanted was adequate food supply. Among the problems feared for was land tenure issues. Some wanted to be close to their farms while others felt that there was no adequate space for nucleated settlements. While some had no particular reason, others felt that due to high population, this would be impossible. Others did not see how this could be accomplished with the different sizes of land present in the sub location. Lastly, some said that they were dependent on agriculture and wanted to keep cultivating their land and just be comfortable.

Those in support of nucleated settlement wanted the government to: Educate the farmers; Provide essential infrastructure; Provide farm inputs; Ensure sustainable transport to and from the farms; Introduce development controls in the built-up areas; Create non-farm employment opportunities and Construct affordable houses. Among the six villages, 95% of those in favor of nucleated settlements preferred to settle in Kimunyu village. They claimed that the village was flat compared to others. Also, they said that the village got swampy especially during rainy seasons and this made it not fit for farming. 3% mentioned Kiganjo which is outside the study area and 2% Thiririka village.

4.1.1 Impact on Farmlands

The organization of structures and buildings within a farmland is key to sustaining the agricultural productivity of the land. If not well planned, structures can take up more agricultural land than intended. The total farmland size recorded by all 78 respondents was 71.74 acres where 40.34 acres of the total was under cultivation (56%) while 31.4 acres of the total was built up area (44%). Average farmland size was found to be 0.92 Acres. A total of 78% of the respondents acquired their land through inheritance, 21% bought their land and only 1% had leased. For the land ownership documents, 86% of the respondents had their title deeds, 6% had allotment letters and 8% had no documentation at all. See Appendix F for more information on household farmland details.

The largest farmland size recorded was 7 acres and the smallest size was 0.1 acres. Majority of the respondents, that is, 29 of them had 0.25 acres. The largest farmland under cultivation was 5 acres and majority of the respondents, that is, 22 of them did not cultivate their land at all. The largest farmland built up area was 2 acres and the smallest size was 0.01 acres. Majority of the respondents, that is, 17 of them had built up on 0.5 acres. The average total household farmland size under cultivation was 0.52 acres and that built up was 0.4 acres. A proportion of 74% of the respondents had 2 to 3 structures, 8% had 4 to 7 structures and the remaining 18% had a single

structure on their farms. Up to 50% of the respondents felt that houses or structures had taken up so much of their agricultural land while 85% of the respondents said that their farmlands had reduced incredibly due to construction of structures. Another 4% of the respondents felt that construction of buildings had led to uneconomical subdivision of agricultural land and the remaining 11% had encountered reduced farm output. Table 5 shows the average farmland size occupied by food crops, cash crops and the average number of dairy cows kept. Households allocated about one third (33%) of their land to food crops.

Table 5: Average Farmland Sizes Utilized for Crop and Livestock Production (Author, 2019)

Agricultural land use	Average land size (Acres)	No. of farmers out of 78 respondents	Proportion of the Respondents
Food crop	0.6	39	50.0%
Cash crop	1.83	8	10.3%
-	**Average no. of animals**	-	-
Dairy farming	1	19	24.4%

About 80% of the food crops grown on household farms was maize, 10% vegetables and 10% beans. The cash crops grown were as illustrated in Figure 6;

Chart 6: Cash Crops Grown in Kimunyu Sub Location (Author, 2019)
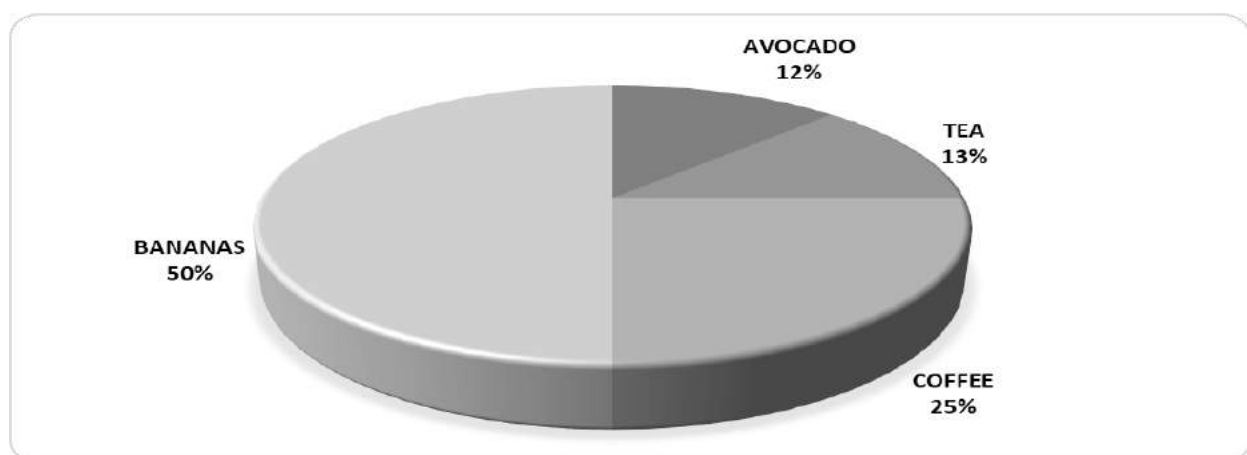
Bananas followed by coffee, tea and finally avocadoes were the crops grown mainly for selling and not just household consumption. Among the livestock kept by the respondents, 53% were poultry, 42% dairy cows and 5% meat goat See Appendices G, H and I for more details onfood crop, cash crop and and livestock production respectively.

When asked on whether they intended to further subdivide their land, 77% of the respondents said no since the parcels were too small. Some said that they would give their land to the children who would practice farming without subdividing it. Others said their children will have to buy land somewhere else and added that the best they could give them was education. For the 23% who showed intention of further land subdivision, their reason was for inheritance purposes. They claimed if this got overlooked, conflicts would arise among their children. The smallest anticipated sub-plot was 0.1 acres and the largest 2.5 acres all with an average of 0.65 acres. Among 78% of the respondents who acquired their land through inheritance, they recorded an average size of 2.35 acres for their parent's land. The smallest size recorded was 0.13 acres and the largest size was 7.5 acres. Table 6 shows a summary of the generational changes in land sizes.

Table 6: Summary of the generational changes in land sizes (Author, 2019)

Generation	Average sizes (Acres)	Largest (Acres)	Smallest (Acres)
Grandparents	2.35	7.5	0.13
Parents	0.92 (73.6% reduction)	7.0	0.10
Grand children	0.65 (41.5% reduction)	2.5	0.10

Small farmland sizes were the major factor that hindered high agricultural production in Kimunyu sublocation followed by poor weather and climatic conditions. Other factors are as illustrated in Figure 7 below;

Chart 7: Factors that Hinder High Agricultural Production (Author, 2019)
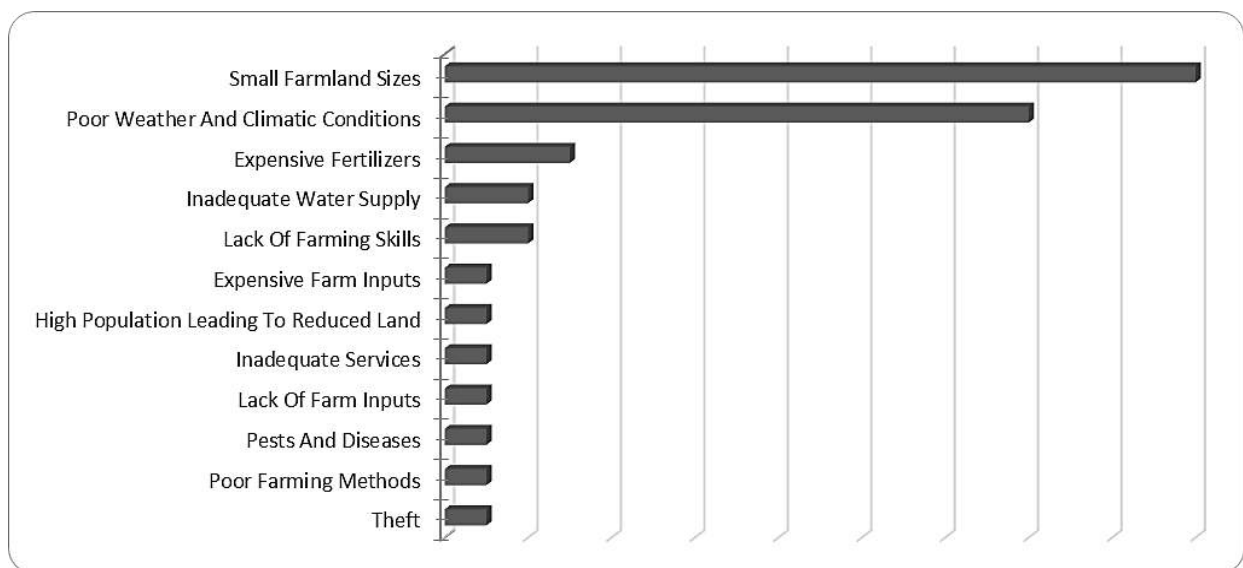
To resolve the issue of land subdivision due to human settlements, respondents had the following suggestions;

Chart 8: Suggested Solutions to Reducing Farmland Sizes (Author, 2019)
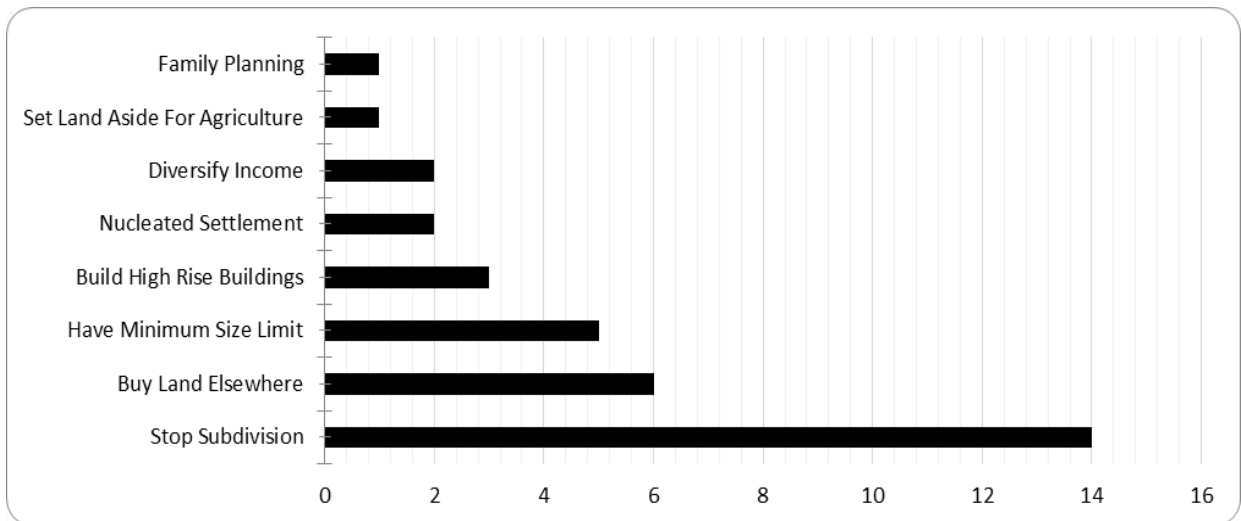
Most of them felt that for starters, no more land subdivision should be allowed and this meant acquiring of more land outside of Kimunyu sublocation through purchase. They also suggested that a minimum land size should be set. Construction of high-rise buildings was also mentioned so as to utilize the vertical and not just the horizontal space. The respondents also suggested the development of nucleated settlements and to have land for agriculture set aside. Other suggestions included the diversification of income sources as not to rely on mostly agriculture and family planning due to the growing population.

4.1.2   Impact on the Environment

The organization of human settlements affected solid and liquid waste management in the following ways;

Chart 9: Impact of Human Settlement on Waste Management (Author, 2019)
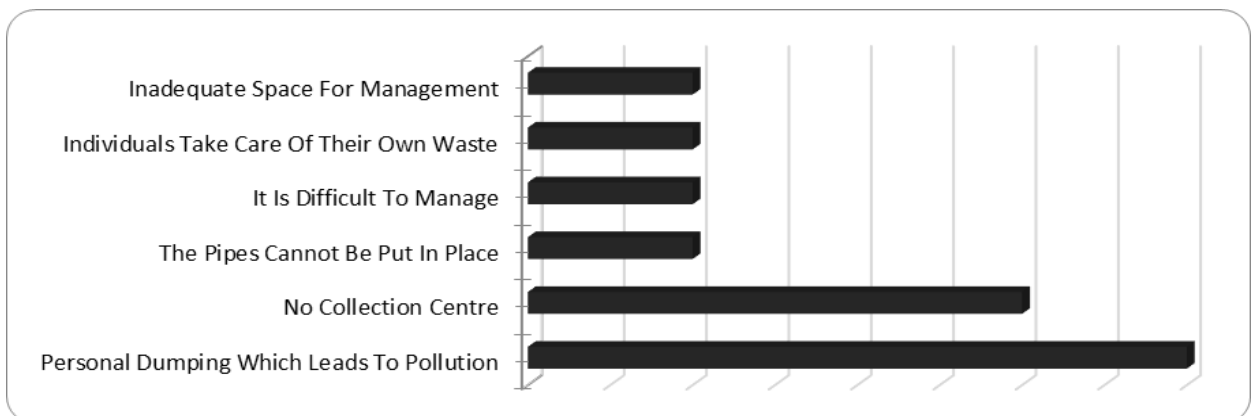
From the above figure it's clear that majority took care of their own waste which they disposed mostly by dumping hence causing environmental pollution. Also, the issue of lack of space for proper waste management was mentioned as drainage pipes could not even be put in place.

4.2 Connectivity and Accessibility of Services

Human settlements play an important role when it comes to provision of services. Up to 84% of the respondents agreed that a nucleated settlement attracts the provision of services which in return leads to the growth of the settlement and ultimately justifying the need for the provision of more services. A proportion of 98% of the respondents were also in agreement that compared to dispersed settlements, the cost of providing services to nucleated settlements is lower. Seventy six percent (76%) of the residents felt that the general cost of service provision within the sub location was affordable while 24% of them said that it was expensive. Corruption was given as the major reason for the expensive services followed by both dispersed settlements and lack of accessibility to services. Other reasons are as listed below;

Chart 10: Reasons for Expensive Services (Author, 2019)
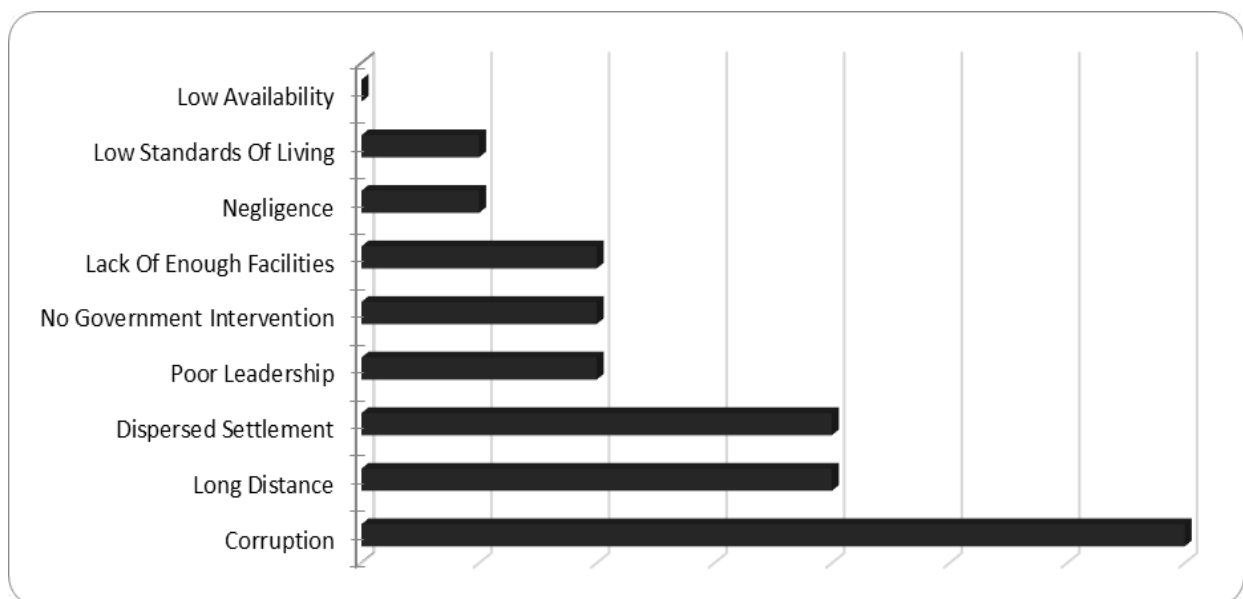
4.2.1 Cooking and Lighting Energy Sources

Fifty-seven (57%) of the respondents utilized wood fuel as the main source of cooking energy, 15% utilized biogas, 11% charcoal and 7% kerosene. Electricity and LPG were each utilized by 5% of the respondents. For lighting energy, 88% of the respondents utilized electricity, 10% kerosene while only 1% utilized charcoal and solar. Demand for wood fuel had caused high rate of deforestation with no clear strategy for sustainable supply, a scenario that needed urgent measures considering the global issue of climate change. Electricity was well connected in the

area considering the number of respondents who had access to the energy source. Only a few respondents (12%) had no electricity connection in their houses due to lack of capital for installation.

4.2.2 Source of Household Water

Piped water was the main source of household water at 63%, borehole water followed at 19% while river/stream and protected well were the least utilized each at 9%. Table 7 below contains the challenges faced in accessing water.

Table 7: Challenges faced in Accessing Water (Author, 2019)

Water Source	Challenges
Piped water	Poor supply of water, Water rationing, Breakage of pipes, Expensive, Unreliable, Quality not clean.
Borehole	Salty water, Quality not clean.
River/stream	Long distance, Dirty water, Inadequate rainfall
Protected well	Salty water, Drying of well

When asked about the reliability of the water supply channels in the sub location, 51% said that they were very reliable, 36% said they were fairly reliable and 13% said that they were not reliable. The table below gives the reasons to the answers given on water supply reliability.

Table 8: Water Supply Reliability (Author, 2019)

Answer	Reasons
Very reliable	Always available, Mostly available and Portable, Very effective
Fairly reliable	Far source, Not always available, Poor pipe connection, Water rationing
Not reliable	Dry seasons, Due to vast population

4.2.3 Solid Waste Management and Sanitation Services

When asked whether they had a set location for disposing their solid waste, 75% of the respondents said no while 25% of them said yes. Again, when asked about having garbage

collection services, 88% of the respondents said no and only 12% of the respondents said yes. This is clear that out of the 25% who said yes to having designated location for waste disposal, 13% of them were individual locations. When asked about their solid waste disposal methods, only 1% of the respondents used garbage collection services out of the 12% who claimed to have access to the services. Sixty two percent (62%) of the respondents burnt their waste, 21% practiced composting, 13% disposed their waste by burning, and 3% by burying. Only 1% of the respondents disposed their grey water via drainage, the rest just poured either into their gardens, onto roads or pavements and also into their latrines.

4.2.4 Health Services

Malaria and respiratory tract infections were the most common diseases mentioned. Eighty-three (83%) of the respondents rarely got sick and 4% never got ill. Only 13% of them frequently got sick. Other infections mentioned by the residents included; pneumonia, typhoid, tuberculosis, HIV/AIDs, diarrhea, STDs and eye infections.

On getting sick, 49% of the respondents claimed to visit a public hospital, use of off-counter medicine and public dispensary followed at 22% each. Use of private clinics and hospitals as well as traditional medicine was not common. They were at 2% and 1% respectively. Below is an illustration of the most reliable health facilities that the respondents visited on getting ill.

Chart 11: The Most Reliable Health Facility (Author, 2019)
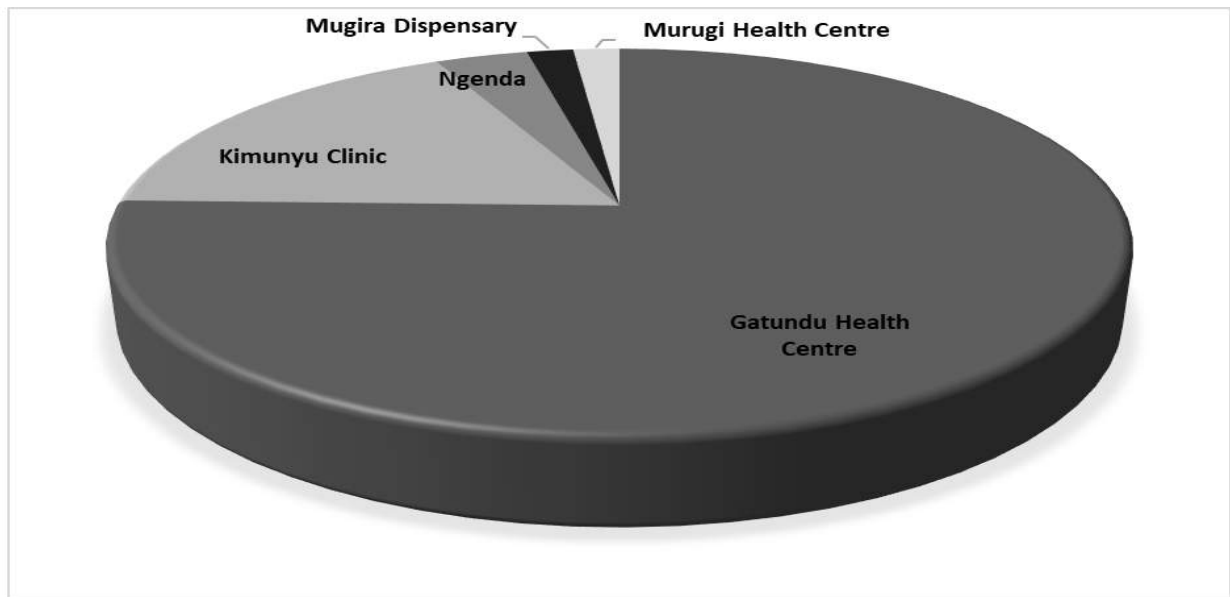
Gatundu level 4 hospital which is located at Gatundu town was leading at 75% followed by Kimunyu medical clinic at 18%. Below is a photograph of the Kimunyu medical clinic which is within Kimunyu village. It is a private health facility.

Figure 57: Kimunyu Medical Clinic (Field Survey, 2019)

4.2.5 Transport Services

Transport services are very essential for efficient movement of goods and people. When asked about their major mode of transport 48% of the households said walking, 44% matatu's, 7% motorcycles and only 1% used private means. The following is a graphical illustration of the problems the household members faced with their available means of transport.

Chart 12: Problems Faced in Transportation (Author, 2019)
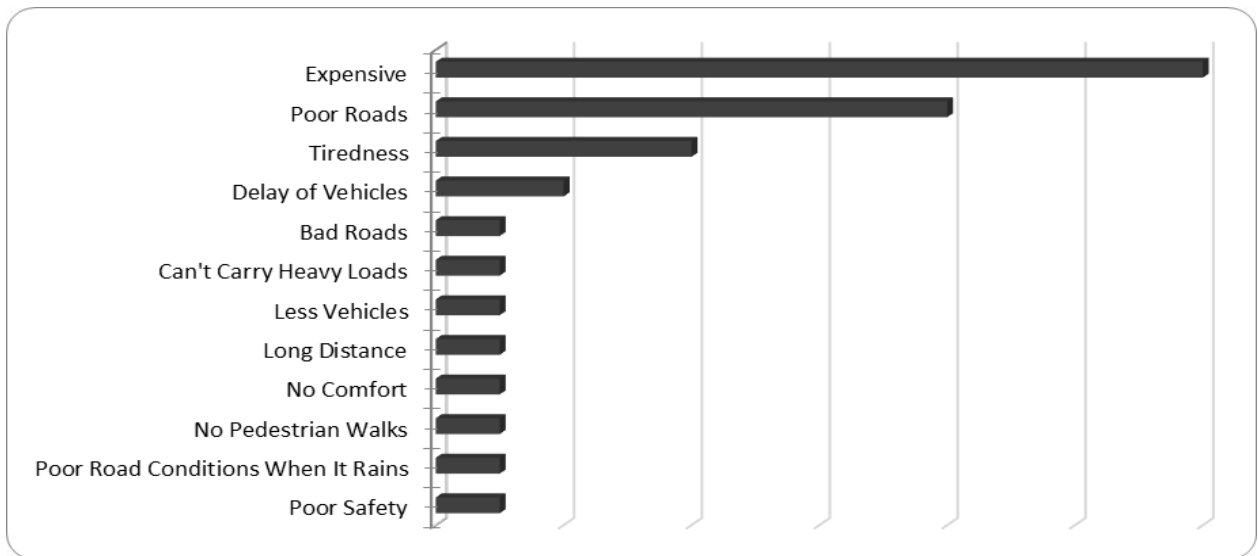
Majority said that transportation in the area was expensive in addition to having less vehicles and experiencing of delays explaining why they mostly opted to walk. Even though they are faced with the challenges of having no pedestrian walks hence their safety is not guaranteed. They walk for long distances which results to tiredness and cannot carry heavy loads. The road conditions were also said to be poor and got worse when it rained. They gave the following suggestions to aid in the improvement of their transport infrastructure. Majority of the suggestions were responses to the problems they faced with the construction of railway line being unique.

Chart 13: Suggestions for Improvement of the Transportation Services (Author, 2019)
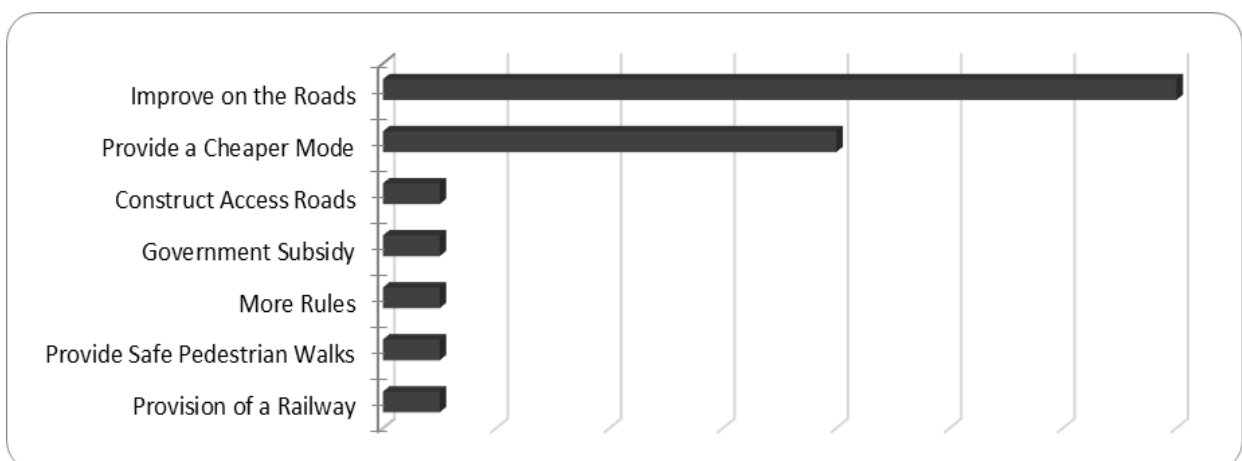
According to the respondents, connectivity level of Kimunyu to other markets and urban centers was fairly and well done both at 47% with only 6% of the respondents rating the connectivity as poor.

4.2.6 Education services

Table 9 below indicates the learning institutions in which the respondents received their education services. Gachoka primary and Kimunyu secondary schools were the most attended.

Table 9: Education Facilities Most Attended by Respondents (Author, 2019)

Education Level	Education Facility
Primary	Gachoka Primary School, Kimunyu Primary School, Isaciri Primary School, Kahati Primary School, Kamwangi Primary School, Kehara Primary School, Kyaume Primary School, Mutuna Primary School, Ngecha Primary School, Nyangata Primary School, Ruera Primary School
Secondary	Kimunyu Secondary School, Gatumu Secondary School, Ituru High School, Joy Town Secondary School, Kajiado High School, Kambui Girls Secondary School, Karingi Secondary School, Ruiru Secondary School, St Francis Girls Mangu, Teresa Njeri Secondary School
Tertiary	Kabete Technical Institute, Kisumu Institute, TIBS, Kijabe Technical Institute, Kisii Technical Institute
University level	● JKUAT

Among the education institutions mentioned, only Kimunyu primary and secondary schools as well as Gachoka primary school are within Kimunyu sub location. Thirty seven percent (37%) of the respondents got their education from within Kimunyu sub location which was mostly primary and secondary education. Below is an illustration of the distance the respondents travelled to get education services;

Chart 14: Distance of Education Facility from Home (Author, 2019)
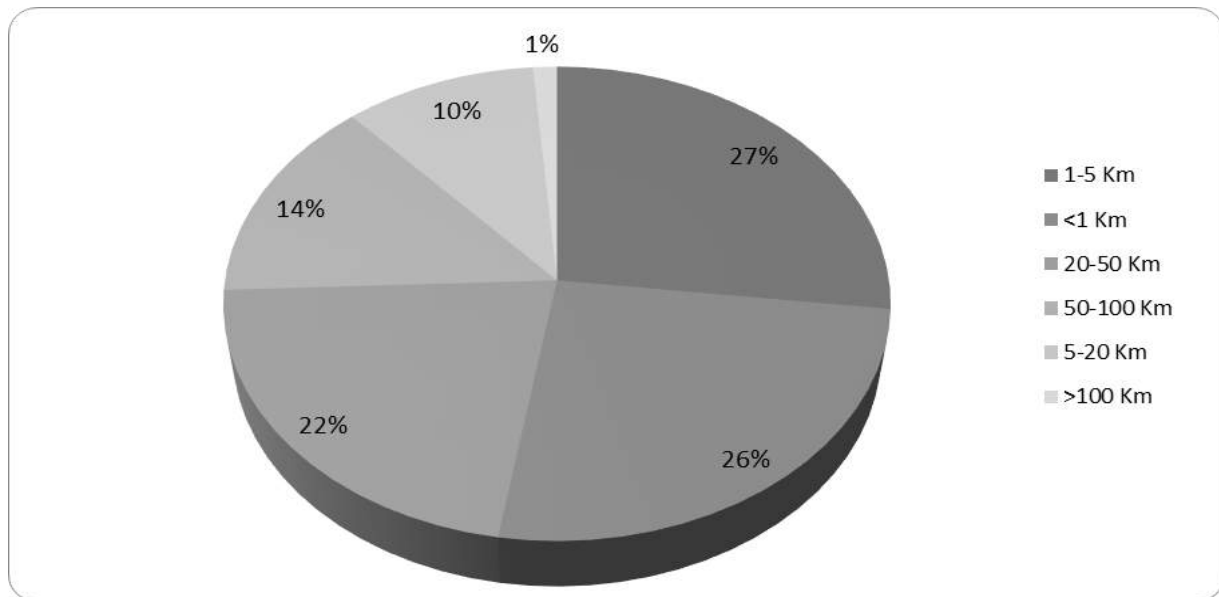
Fifty-three (53%) of the respondents indicated that they had to travel a distance of less than 1 Km to 5 Kms to receive their education. This comprised of primary and secondary education.

For the current school going children, those in preschool and primary mostly attended Gachoka and Kimunyu primary schools and those in secondary mostly went to Gachoka secondary school as shown below. This shows a difference as most of the respondents went to Kimunyu secondary school and none among them had attended Gachoka secondary school. Other schools mentioned include; Ikuma secondary school, Chogoria secondary school, Ilazin secondary school, Kariga high school, Kihuyu primary school, Kiruguya secondary school, Machakos secondary school, Mbooni secondary school, Mutomo primary school, Sunshine academy, Kangema secondary school, Kerigiti Secondary school, and St. Dominic secondary.

About 72% of the children travelled a distance of less than 2 Kms since both Kimunyu and Gachoka schools are within Kimunyu sub location. Ninety percent (90%) of the schools were government schools and only 10% were private. See Appendix K for a status summary of selected social and physical infrastructure within Kimunyu sub-location according to the respondents.

4.2.7 Agricultural Extension Services

Ninety five percent (95%) of the respondents claimed not to have received agricultural extension services in the last one year with only 5% having benefited from the services.

Chart 15: Agricultural Extension Services in the Last One Year (Author, 2019)
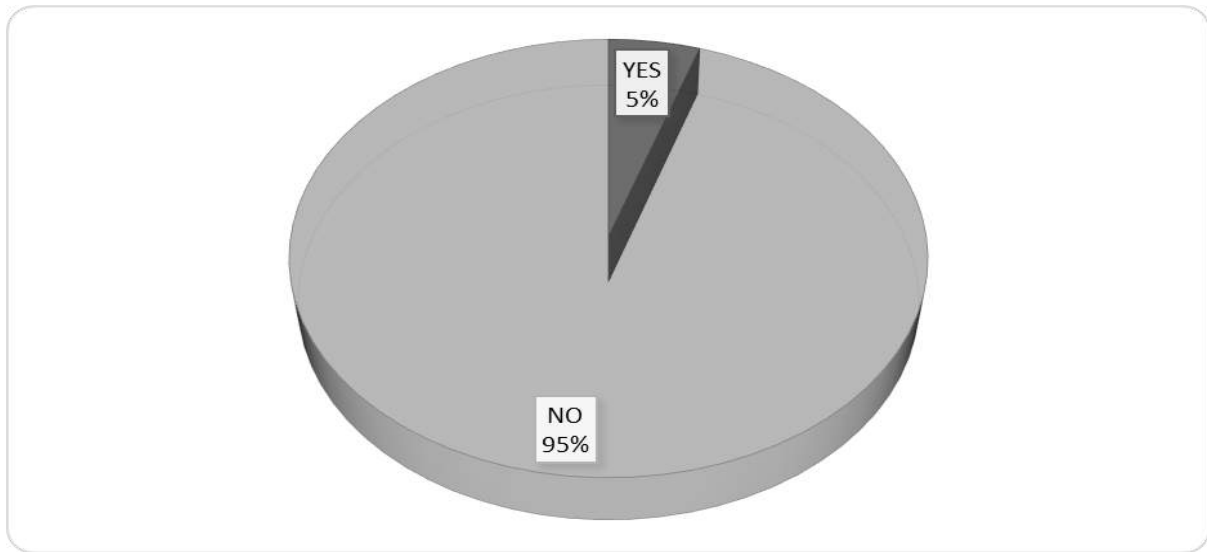
4.2.8 Markets and Marketing Services

Sixty-nine (69%) of the farmers sold their agricultural produce at Kimunyu Market, 25% at Gatundu town and the remaining 6% at Juja town.

Chart 16: Market Centers where Farm Produce is Sold (Author, 2019)
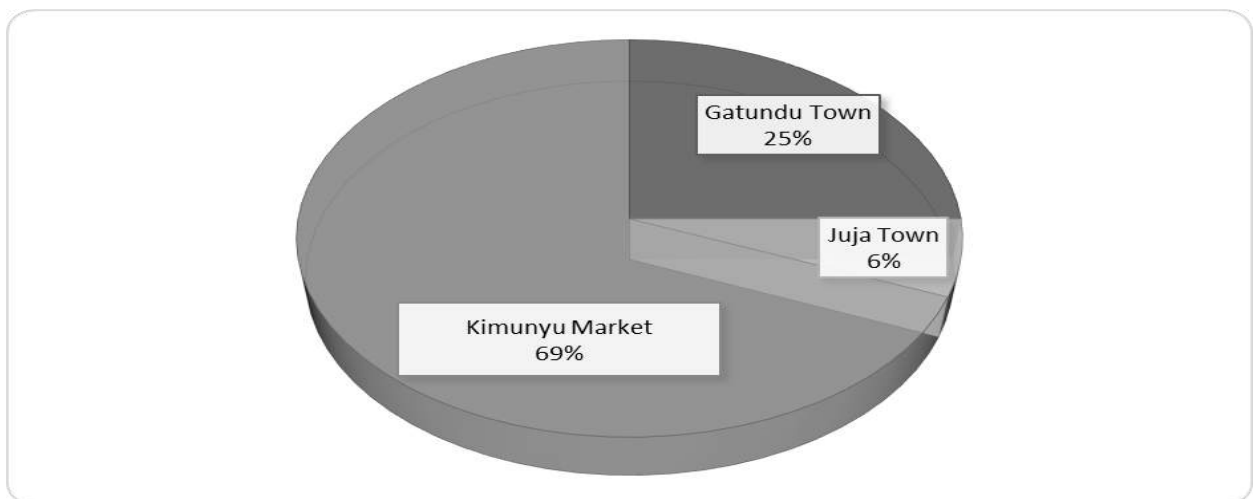
Kimunyu open air market however needed major improvements. Essential market facilities were lacking with the market being characterized by just a bare open ground. Up to 83% of the respondents sold their crop produce individually, 11% through the middlemen and 6% through cooperatives as indicated below. Those who sold their produce individually said that they made more profits and were not exploited. As for the group that sold through middlemen, the benefits they had included; ready market and easy accessibility probably because the middlemen went for the produce directly from the farms. The challenges that the farmers faced during sale of

agricultural produce included; lack of reliable markets, poor market conditions, low selling prices at the market, middlemen also bought farm produce at very low prices, delay in transportation which caused perishable goods to spoil as there were no proper storage facilities.

As for the sale of livestock produce, 86% of the respondents sold individually while 14% utilized cooperative services. Those who sold individually claimed to make more profit. The farmers who sold via cooperatives said that they benefited from readily available market and marketing services. The farmers experienced difficulties in the transportation of poultry products especially for those who did individual marketing. The farmers who sold via cooperative experienced delays in payments. The respondents mentioned that payments by the cooperatives were never on time and that caused them major inconveniences. Additionally, transporting of the poultry and products to the market was a major challenge to them.

4.2.9 Institutional Organization for Planning

In planning it's important to take into account local institutions, approaches and traditions of planning. More formal and informal community organizations and governance mechanisms need to be established in the study area. The following table comprises of institutions that contributed to the wellbeing of various sectors through the provision of essential services and the impact this had on development.

Table 10: Institutions Supporting Development in Kimunyu Sub Location (Author, 2019)

Sector	Institution	Service Given	Impact on Development
Crop farming and Livestock farming	Ministry of Agriculture, NGOs, SACCOs, AFC	Capacity building, Treating of Animals, Loans	Healthy animals hence more products, More profits, Farm development
Health	Ministry of Health	Free medical examination, Vaccination	Healthy people, Prevention of infections
Education	Ministry of Education	Free primary education, Providing teachers	Improved education system, More educated people
Social Services	County Development Fund	Building schools	Good reading environment
Finance	KFWT, Micro-Finances	Loans	Capital

From the above table, institutions in support of agriculture. Health, education, social and financial services were present but there was still room for more especially among the farmers when it came to marketing of their farm produce.

4.3 Main Sources, Levels and Reliability of Income

4.3.1 Main Sources of Household Income

Most of the respondents claimed to have an income earning job in the informal sector. 60% of the respondents were self-employed in the informal sector while 33% were employed still in the informal sector. This means that 93% of the respondents sort their livelihood in the informal sector. Only 1% of the respondents had a formal job in the National Government at Juja offering cleaning services and earning Kshs 10 000-20 000 per month. The main livelihood strategies comprised of; crop farming, dairy farming, trading, transport services and jua kali. These economic activities were mostly located in Kimunyu sub location with a few in Juja, Kawangware, and Toron. Figure 17 shows the location of the economic activities in distance;

Chart 17: Location of the Economic Activities (Author, 2019)
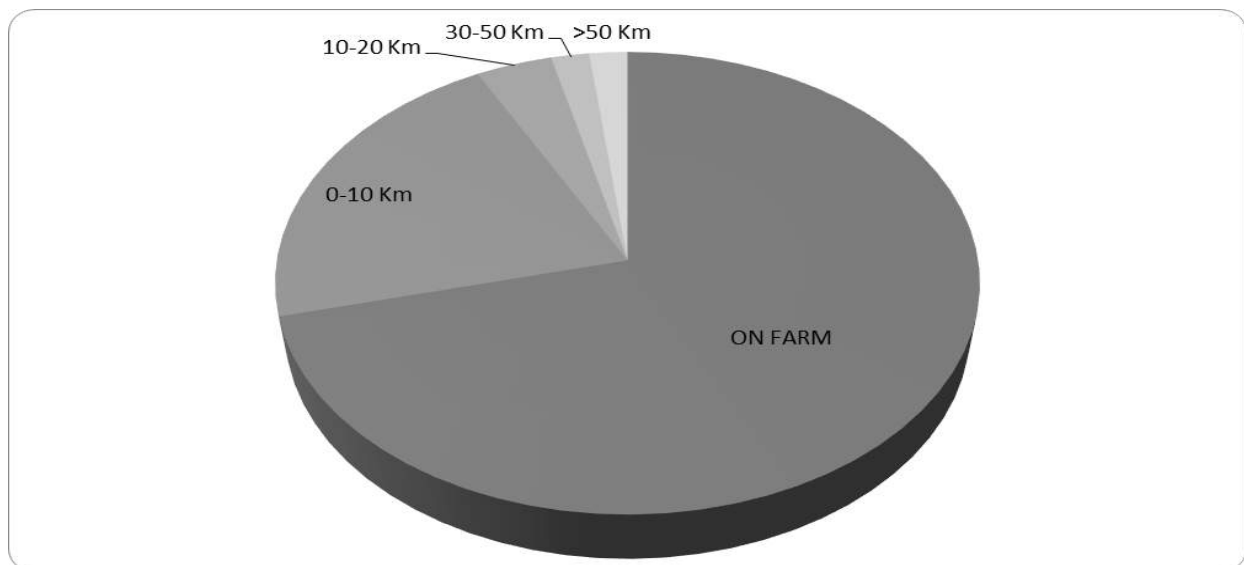
Crop Farming was the most common livelihood strategy at 52% followed by trading at 21%, jua kali at 13%, dairy farming at 8% and transport services at 6%. 73% of the respondents practiced subsistence farming, 5% commercial farming, 9% both commercial and subsistence farming, while 13% never practiced farming.

The residents were directly or indirectly dependent on agriculture as their main source of income. The following is an illustration of the challenges faced by the households in crop production;

Chart 18: Challenges by Households on Crop Production (Author, 2019)
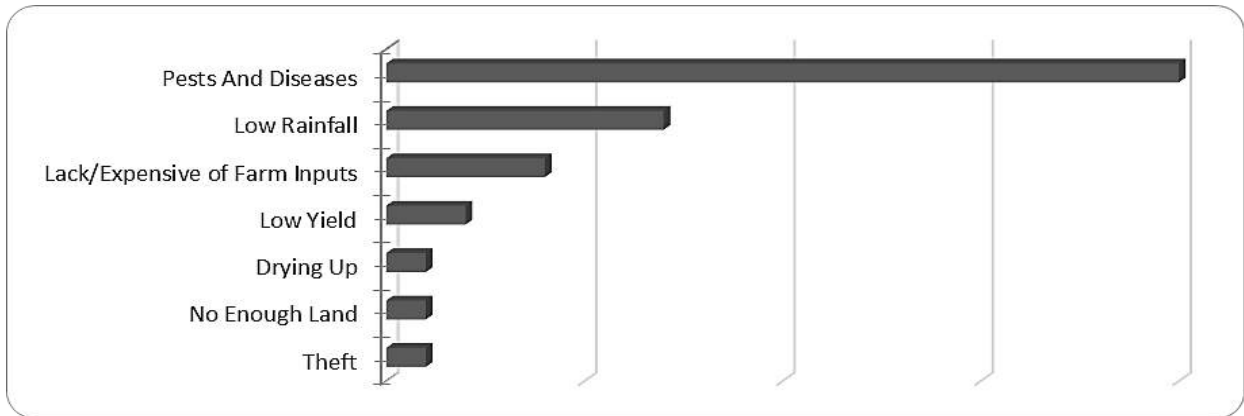
Pests and diseases were on top of the list followed by low rainfall which was linked to the global issue of climate change. Expensive farm inputs discouraged them from practicing crop farming as cost of the inputs was higher than returns. Other challenges mentioned was low crop yield, drying up of crops due to lack of irrigation water, lack of sufficient land for crop farming and theft of crops while still on their farms. The respondents listed the following mitigation measures that they employed to the above challenges;

Chart 19: Current Mitigation Measures on Crop Production Issues (Author, 2019)
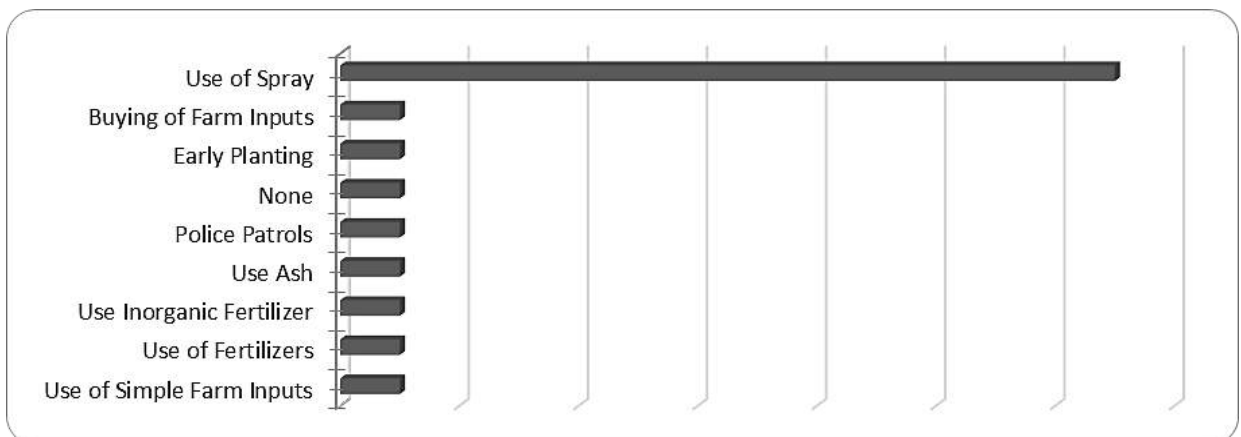
To control pests and diseases most farmers considered the use of sprays and others ash. Use of fertilizers including organic fertilizers was done in effort to increase the low crop yield. To cope

with the issue of low rainfall, early planting of crops was done. Despite the expensive farm inputs some farmers had no choice but to buy them while others opted for simple and affordable farm inputs. Police patrols were used to curb the theft of crops from the farmlands. Some farmers did nothing about the issues. The following are mitigation measures that respondents proposed to help in addressing crop production challenges.

Chart 20: Proposed Mitigation Measures on Crop Production Issues (Author, 2019)
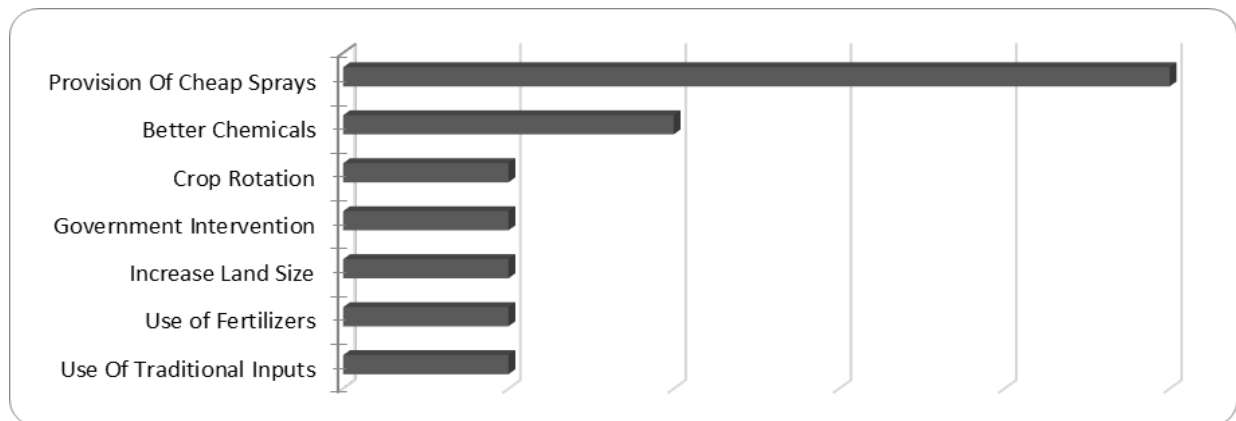
In addition to the mentioned crop production challenges the farmers did experience losses in their crop production which are as illustrated in table 11.

Table 11: Problematic Stages in Crop Production (Author, 2019)

Problematic Stage	Problems Experienced
While still on the Farm and During harvest (44%)	Affected by pests and diseases, Brokers buy at low prices, Lack of agricultural inputs, Theft of produce, Inadequate rainfall, Insufficient water supply
In storage (36%)	Lack of good storage facilities, Inadequate market
At the market (18%)	Poor prices
During transportation (2%)	Delay during transportation

Top five crops that grew well in Kimunyu sub location according to t respondents were maize, beans, bananas, potatoes and coffee in that order. Others mentioned included; cassava, avocadoes, vegetables, tomatoes, sweet potatoes, yams, and sugarcanes. Table 12 shows

recommended type of farming within Kimunyu sub location according to the respondents. Maize and beans were the most recommended reason being they provided both food and income. Others are as listed below indicating that, most farmers preferred crop production more than livestock production.

Table 12: Most Proffered Type of Farming by Households (Author, 2019)

Farming Type	Reason
Banana	Assured production
Commercial / subsistence farming	Can sell and still consume some
Cash crop	Easier to cultivate
Commercial farming	To have more income
Crop farming	Fertile land
Dairy and subsistence farming	Food for family
Green houses	Good climate
Horticulture	High income
Livestock keeping	Market availability
Maize and beans	Provide food and income
Mixed farming	Small sizes of land
Rotational farming	To regain the soil fertility
Zero grazing	Requires less space

The challenges encountered in livestock production were as follows. Pests and disease seemed to be an all-round challenge to both crop and livestock production. Lack of grass during drought and little production were the biggest challenges.

Chart 21: Challenges in Livestock Production (Author, 2019)
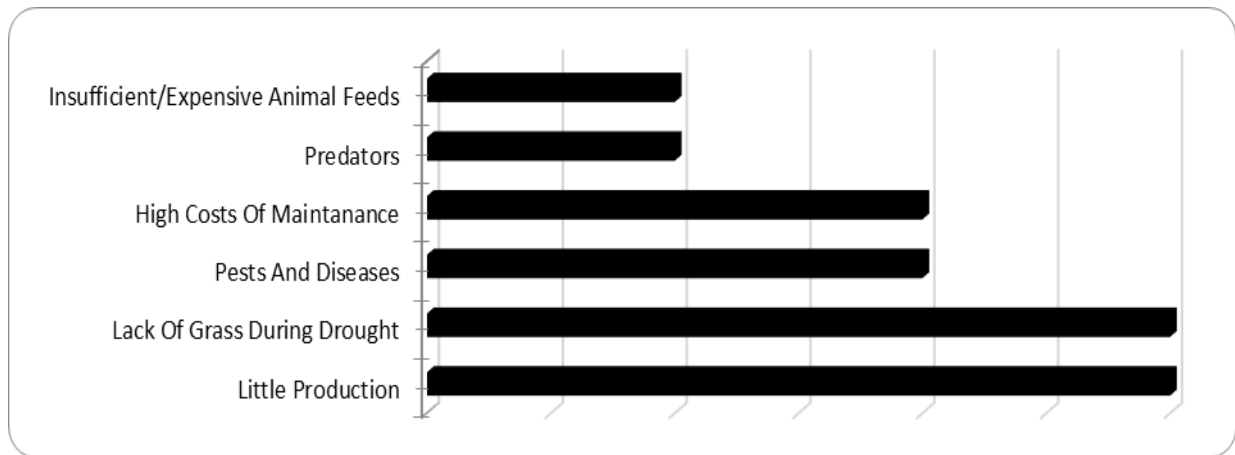
The following are the mitigation measures that they applied for the above-mentioned challenges. Some had no measures at all. Preserving stock of silos was the most applied as to address food scarcity during drought periods. The farmers coped with the challenges by preserving stock of silos, visiting the vet for vaccination services, borrowing of loans to meet the high maintenance cost and in some instances no measures were employed. They proposed three measures to help address the livestock production challenges as follows; increase of land for livestock production, the government to intervene and utilization of animal waste as fertilizer to grow needed feed.

Very few people were formally employed in the study area with the informal sector having dominance. There were no agriculturally based industries and only a few non-farm-based industries were present as shown below;

Table 13: Existing Non-Agricultural Industries in Kimunyu Sub Location (Author, 2019)

Non-agricultural industry/factory within Kimunyu Sub location	Product
Devki Steel	Steel
Kimunyu Wire Mesh	Wire mesh
Water packaging	Water

When asked about the non-farm employment opportunities in area, construction and casual laborer jobs were leading. The development of the residential estates within Kimunyu sub location explains why construction industry was leading. Other opportunities mentioned included; welding, retail shops, industries, boda-boda rider, water packaging, jua kali, flowers growing, and business person. When asked about the non-farm economic activities that needed

to be introduced withing the sub location for livelihood diversification, the respondents gave the following;

Chart 22: Economic Activities that need a Boost in the Study Area (Author, 2019)
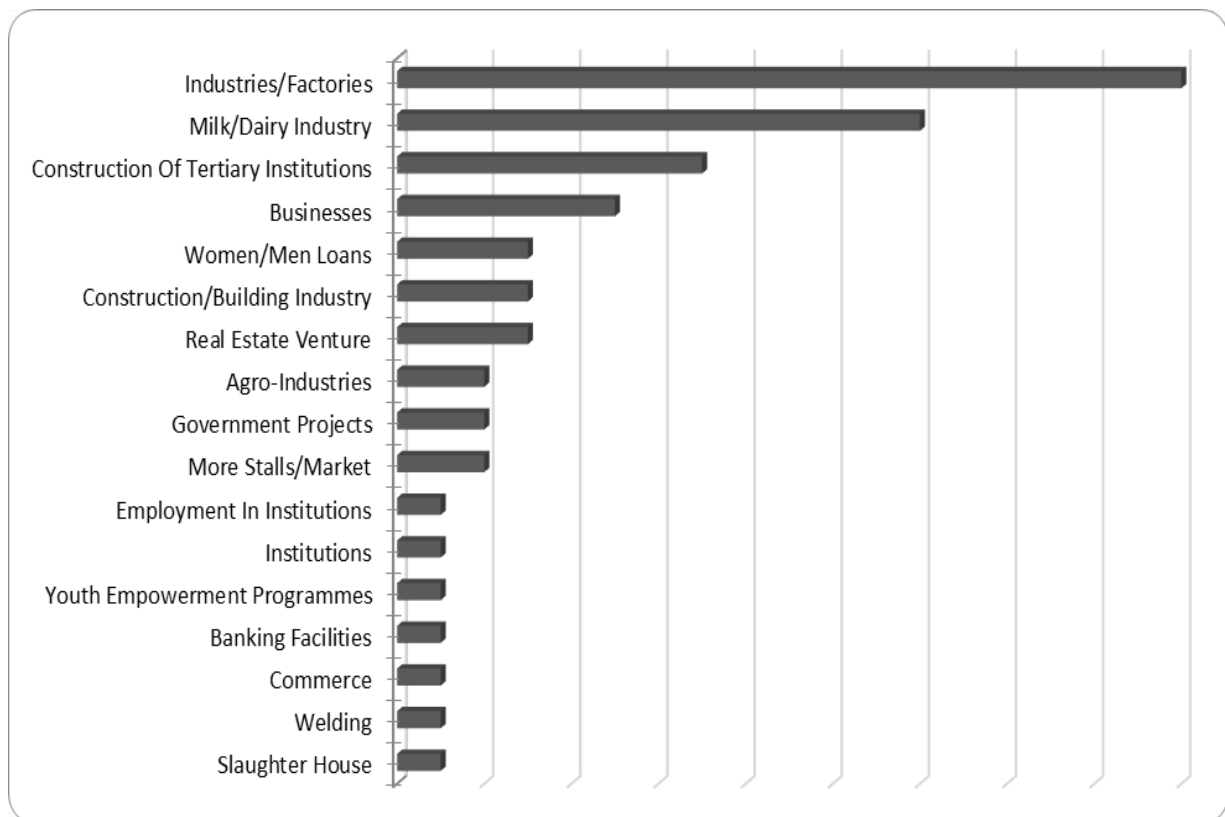
4.3.2   Household Income Levels

The following is an illustration of the main household income levels.

Chart 23: Household Main Income Levels (Author, 2019)
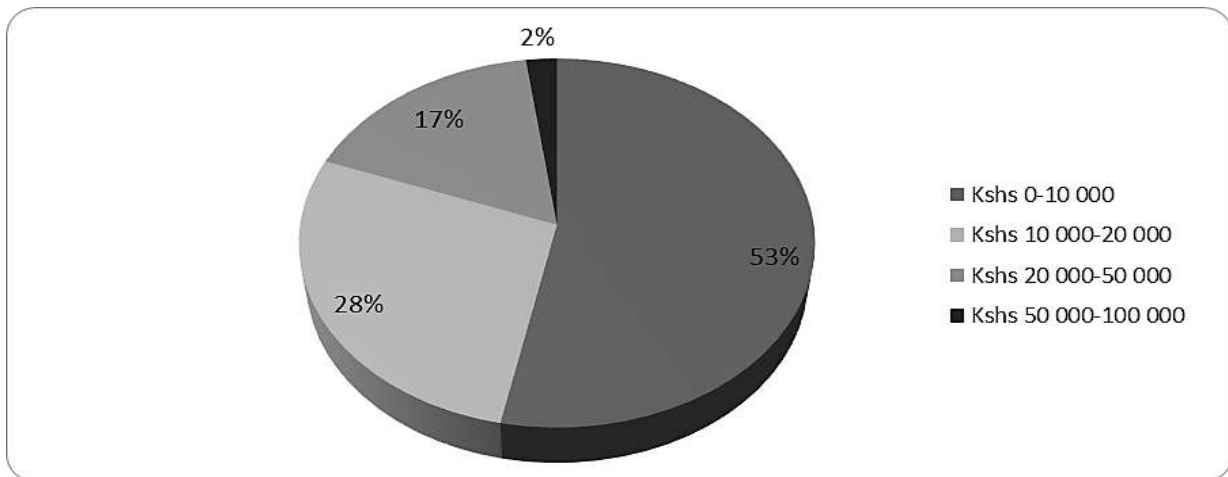
Majority (53%) of the respondents earned up to Kshs. 10,000 per month while only a few (2%) earned more than Kshs 50 000 per month. The total household income inclusive of earnings from other income generating activities other than farming was as illustrated below.

Chart 24: Total Household Income per Month (Author, 2019)
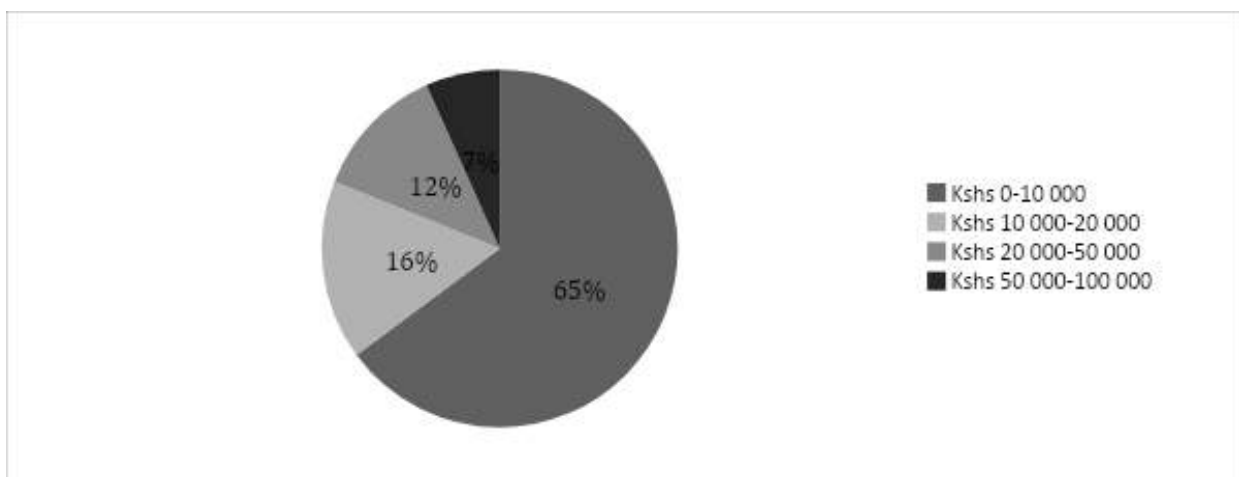
The percentage of those who earned up to Kshs. 10 000 per month increased to 65%. Also, the number of those who earned more that Kshs. 50 000 per month increased to 7%. There was a fall in the other two categories and what comes out clear here is that majority of the households had farming as their major economic activity but wasn't bearing much returns. Up to 75% of the respondents said that their income levels were decreasing with the remaining 25% experiencing an increase. The reasons to the changing income levels were as shown below;

Chart 25: Reasons for Increasing Income Levels (Author, 2019)

Non-farm Investments were leading in causing the income levels to rise though only a few households were able to invest. Also having children married off reduced the household size and so the expenditure which aided in increased investing.

Chart 26: Reasons for Decreasing Income Levels (Author, 2019)
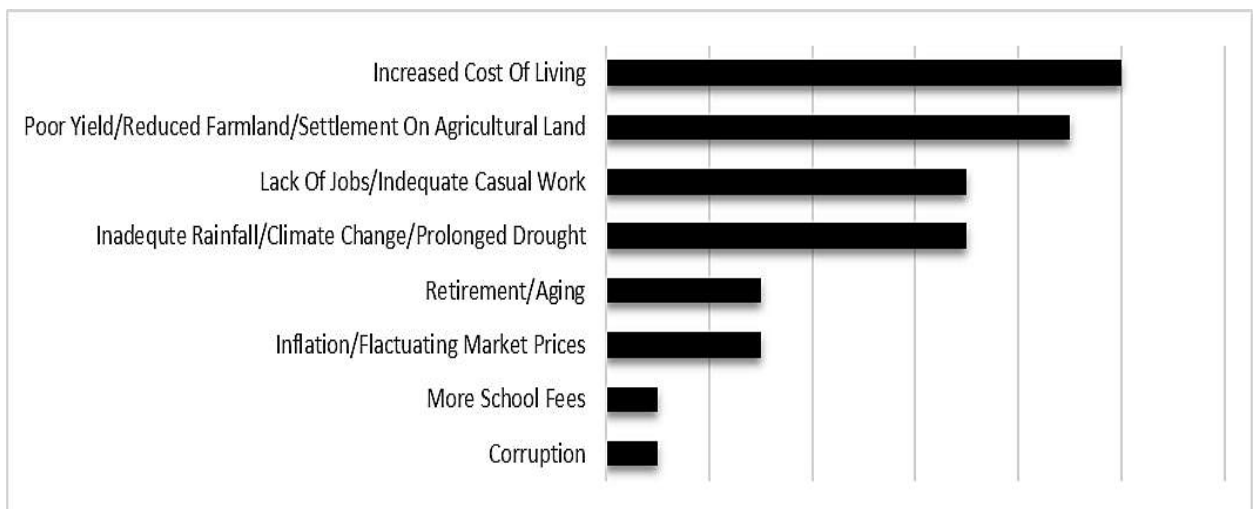
Increased cost of living was a major cause of the decreasing state as majority of households could not afford to make any investments and at the same time provide for their needs. With agriculture being the major economic activity for most of the households, their income levels were decreasing due to the misuse of farm-lands and the experienced climate change which all negatively affected agricultural production. Low job opportunities, fluctuating market prices as well as retirement/aging also contributed to decreasing income levels among other reasons as illustrated above.

4.3.3   Reliability of Household Income

Eighty one percent (81%) of the respondents were not able to make any non-farm investments with only 19% of them being able to. This validates the information from the previous section

that the income levels of most of the respondents have been on the decline and not many had been able to make non-farm investments. The following table shows the types of non-farm investments the few respondents were able to make though only one was able to give the returns made from the investment in Kshs per month.

Table 14: Non-Farm Investments Details (Author, 2019)

Investment/Enterprise	Location	Income (Kshs per month)	No. of Employees
Banana dealer	Gatundu town	Could not estimate	0
Hotel and butchery	Kawangware, Nairobi	10, 000	2
Mpesa	Kimunyu	Could not estimate	1
Timber seller	Kimunyu	Could not estimate	1

Information on expenditure of three selected goods, that is, food, clothing and farm inputs by the respondents was obtained as follows. Fifty-six (56) of the respondents helped identify the centers from where they acquired their supplementary food. Up to 98% of them bought from Kimunyu market while only 2% sourced from Gatundu town. Out of the 56 respondents, 46 of them were able to give the amount in Kshs that they spent on food per month. This ranged from as much as Ksh 20 000 to Kshs 1 000 per month with majority spending Kshs 6 000 per month. The average amount spent on food per month was Kshs 7 800. Up to 49 respondents identified centers from where they bought clothes. Gatundu town was leading at 47% followed by Kimunyu market at 31%, Ruiru at 12%, Thika at 6%, Nairobi and Juja both at 2% each. Out of the 49 respondents, 26 were able to give the amount in Kshs spent on clothing per month. The amount ranged from Kshs 10 000 to Kshs 200. The average amount spent on clothing per month was Kshs 2 700. As for the farm inputs, 47 households responded with 57% of them sourcing their farm inputs from Gatundu town and the remaining 43% from Kimunyu market. A total of 29 of the households were able to quantify the amount they spent on farm inputs per month in Kshs. This amount ranged from Kshs 20 0000 to Kshs 200 with an average of Kshs 4 100 per month.

Expenditure information on health, education and administration services was also obtained. 45 households responded that they mostly got their health services from Gatundu town verifying the response that Gatundu level 4 hospital was the most visited health facility. Kimunyu followed and Nairobi came last. Only 13 of the 45 respondents were able to quantify the amount they spent on health services per month in Kshs. Most of them spent Kshs 5 000 while the highest and lowest amounts spent were Kshs. 10 000 and Kshs. 400 respectively, per month. The average amount was found to be Kshs 2 200 per month. Up to 46 households responded that they got their education services all in Kimunyu. This is both primary and secondary education. Only 15 of the households were able to quantify the amount they spent on education in Kshs per month. The amount was as high as Kshs 30 000 to as low as Kshs 500. The average was found to be Kshs 5 580 per month. Forty-nine (49) respondents said that they acquired their administration services only from Kimunyu at no cost.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0   Summary and Conclusions of Findings

Settlement pattern: Majority of households were in linear and dispersed settlements. Up to 53% of households were willing to live in nucleated settlements. Up to 56% of the total land of the sub-location was under cultivation while 44% was built up area. The built-up area is increasing because of households converting the agricultural land to rental houses. This is a threat to food and livelihood security and needs to be addressed.

Connectivity and accessibility to services: Many households are connected to social and physical infrastructure but they complained of high cost which they indicated can be reduced if they were in nucleated settlements. Corruption was identified as a major factor in the challenges of connectivity and access to services. This also needs to be addressed.

Sources, levels and stability of income: Up to 81% of households depend wholly on farm-based income while 19% have additional income from non-farm sources. Considering total income, those earning below Ksh. 50,000 were 93% and those earning above Ksh. 50,000 were 7%. Maize was the key food crop covering 80% of the land under food, 10% vegetables and 10% beans while cash crops consisted of bananas 50%, coffee 25%, Tea 13% and Avocado 12% of the land area under cash crops. Dairy and poultry farming were the major livestock enterprises in the study area. The income from agriculture is stable but very low while income from non-farm sources in significant and can be enhanced. The minimum land size that can sustain a household given the farming system needs to be worked out.

Potential in the Smart Village Model: High- Smart villages play an important role in the preservation of farmlands and rural livelihoods. They inevitably point towards the notion of density-control and promotes the densification of non-farm settlements in order to free up agricultural land. They also facilitate implementation of local innovations for effective and efficient utilization of natural resources to realize socio-economic and environmental sustainability. The development of a smart village in Kimunyu sub location was found to be economically feasible and technologically viable. The residents were positive to the idea of living in a nucleated settlement but needed the government to intervene.

Rise nucleated settlements can reduce the proportion of land under built up area, and avail more land for agriculture. The same type of settlements can enhance connectivity and access to services by increasing efficiency and reducing per capita costs. The level of income can also be

increased by enlarging the household land holding and practicing planned commercial agriculture. Fewer enterprises optimally farmed could generate higher quantities of food and income. The main candidates appear to be maize for food, bananas for cash crop and either dairy or poultry for a livestock enterprise. Forestry could be considered for areas with steep slopes.

5.0.1 Development Needs and Potentials

Kimunyu sub location found in the lower-highland agroecological zone, is a high-potential agricultural area. Linear settlement pattern following the road transportation routes was dominant. With regard to the household assets including; human, natural, technological, financial and social capital, a lot needed to be done. The education level of the residents was generally low. A high rate of school dropout was noted as only a few household members had completed secondary level of education. The old and retired were not as many as compared to the working group who however were mostly jobless and lacked essential skills.

The sub location being in the rural-urban fringes of Nairobi Metropolitan Region was faced with the challenges and benefits of urbanization. A major challenge was decline in agricultural production due to high demand of land for non-agricultural use. Potential commercial farmers could no longer compete with the high prices of urban land uses. Coffee farmers went to the extent of uprooting their coffee bushes and putting up real estates. Despite having potential ready markets for their agricultural produce, farmers opted for other income generating economic activities. Markets and marketing services for agricultural produce were unreliable as well.

In addition to the small farmland sizes, the soil quality had deteriorated such that the farm yields were so low to even meet the dietary needs of the households. The sub location is located between two permanent rivers but water for irrigation was lacking. The high rate of deforestation to meet the demand for wood fuel had worsened water shortage problems. A platform for local technological innovations was lacking and farmers barely invested in farm inputs due to unreliable income. Infrastructure within the sub location had also deteriorated and could barely meet the needs of the growing and changing community. Community empowerment through training activity, use of credits and savings, and membership to cooperatives needed a major boost.

Farm, non-farm and off-farm livelihood strategies which comprised of mainly crop farming, livestock keeping, trading and wage employment, were all present in Kimunyu sub location.

However, urgent intervention measures were needed for resilience and sustainability. Droughts, diseases and pests had affected agricultural production. Farmers were lacked the capacity to withstand shocks related to price surges and climate change. Strategic and integrated rural development was lacking within Kimunyu sub location. The cooperation of institutions and organizations responsible for essential development services was needed for improved socio-economic and environmental livelihood outcomes.

5.1 Recommendations

To achieve land use and livelihood sustainability as well as resilience in Kimunyu sub location, this study recommends: Strategic and integrated development of the sub location as a whole in terms of culture, society, economy, technology and health; Community development and empowerment especially among the youth and women in terms of their psychology, skill, knowledge, attitude and other abilities.; The improvement of the living standards of the people through new training in farming, extension, non-agricultural, and vocational sectors to mention but a few so as to increase income and employment prospects; The development of standard physical and social facilities within the sub location including ICT infrastructure; The establishment of development-oriented and financial institutions like multi-purpose community cooperatives, banking, credit and saving to mention but a few; The development of light industries such as village value-addition industries, jua kali sheds, rural crafts, cottage industries/factories and other related economic operations in the rural sector as to achieve diversified livelihood strategies; The development of modern and commercial agriculture, animal husbandry and other agricultural related activities as to realize increased and reliable income levels; The provision of quality services in terms of drinking water, education, transport, energy, health and communication; The restoration of uncultivated land, provision of irrigation facilities and motivation of the farmers to adopt improved seed, fertilizers, practices of crop cultivation and soil conservation methods as well as the rehabilitation of the fish pond in Kimunyu village; Close coordination of all local development projects in the sub location and the involvement of the local people and institutions to a large extent as to promote local action. Integrated resource management will help reduce vulnerability, enhance socio-economic and environmental sustainability, and empower the residents while improving their quality of life. The following section comprise of detailed information on the proposed smart village model of development for Kimunyu sub location.

5.1.1 Proposed Smart Village Model

As depicted in figure 59 below, the proposed smart village concept included six dimensions: governance, resources, village services, technology, living, and tourism.

Figure 58: Proposed Smart Village Model (Author, 2019)

The first dimension of governance in the proposed Kimunyu sublocation smart village model is to achieve effective, efficient, communicative, and innovative government. It is divided into three sections: public services, openness, and policy. Internal and inter-village good governance are critical, and the government plays an important role in this area because it provides public services. Electronic services and social media should be incorporated to promote community empowerment and involvement in public management, as well as openness in decision-making processes. The use of information and communication technology (ICT) in the delivery of public services should be encouraged. E-government raises the quality and quantity of government services. Transparency in finances and information is also a part of good governance. Village resources, budget, potential, agenda, output, and tourism, to name a few, should all be open to the public. Interactions with the community should be manifested at the village level through public engagement in policy decision-making.

ICT and other technologies fit for rural regions make up the technological dimension. ICT should be used to aid local economic development by facilitating infrastructure investments, business development, human resource development, and overall community development. To

ensure long-term viability, technology must be efficient, long-lasting, low-cost, and simple to use and maintain. The technology used in the smart village should be in line with the Kimunyu sublocation's development needs and possibilities.

Information on the state or quality of existing local resources is crucial for constructing a smart village. Natural, human, and economic resources are among them. Human capital is an important component of smart village development because a settlement's social outlook is determined by its personality, talents, creativity, and social interactions. All actions that promote community empowerment and education should be encouraged. Transparency of information should also help to connect the community to the outside world. Economic resources should be developed in order to generate revenue. The resources of the Kimunyu sublocation should be developed into an economy that includes capital generation, village-owned businesses, value addition, and prosperity.

In the Kimunyu sublocation, the dimension of living refers to each individual's life. Smart living is essential for ensuring a high quality of life in terms of health, housing, education, and social cohesion. The living environment should encourage civility and social inclusion. All of these things, including safety and comfort, as well as access to public facilities, should be achieved. The goal should be to create a community that is decent, comfortable, and efficient. Village branding through local tourism marketing should be considered on a national and worldwide scale. To make the sublocation more livable, village marketing through tourism should attempt to provide new job opportunities, infrastructural development, and social connections. The caves of Mau-Mau offer tourism potential, and the proposed smart village development model includes accommodations and support services. The dimensions, characteristics, and indicators of the proposed smart village development model are summarized in Table 15.

Table 15: Dimensions, Aspects and Indications of the Smart Village Model (Author, 2019)

No.	Dimension	Aspects	Indicators
1	Governance	Services provided by the government	Administration services
			Use of ICT in community service provision
		Transparency	Transparency of government and financial information
		Policy	Leadership
			Public participation

No.	Dimension	Aspects	Indicators
2	Technology	ICT	Internet availability
			IT infrastructure
		Appropriate Rural Technologies	Sensors
			Cloud computing
3	Resources	Natural Resources	Land condition
			Water availability
			Energy uses
		Financial Resources	Crop farming
			Livestock production
			Fishing
		Human Resources	Level of education
			Skills
4	Village Services	Essential Services	Health services
			Education services
		Economic Services	Entrepreneurships
			Job availability
			Economic institutions
			Markets and marketing services
5	Living	Security and Convenience	Waste management
			Environmental protection
			Public safety
			Disaster management
		Public Facilities Accessibility	Green space facilities
			Affordable housing
			Sport area facilities
			Banking facilities
			Transport facilities
6	Tourism	Village potency	Village identity
			Tourist destinations
		Village branding	Village branding platform
			Culture and traditions

Figure 60 illustrates the smart village model of development in Kimunyu sublocation. The smart village is located in Kimunyu village as proposed by the residents and also based on suitability analysis. A self-contained residential neighborhood where all the above discussed dimensions have been incorporated forms the plan.

Figure 59: Smart Village Development Structural Plan (Author, 2019)
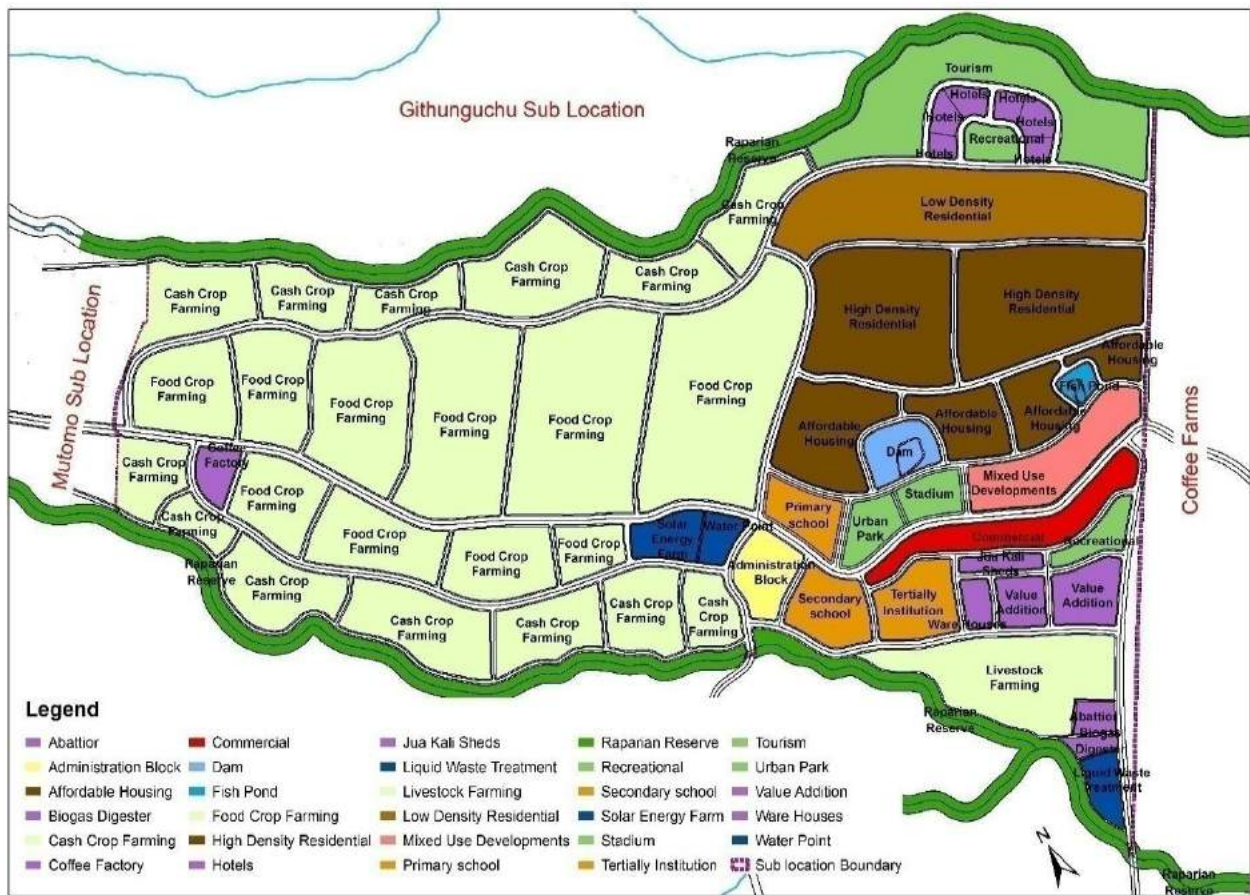
Development of the smart village will have positive impacts on the farmlands and the environment as well as provision of quality and affordable services within the sub location. There will be a boost security especially when it comes to agricultural production where theft of livestock and crop produce had resulted to loss in production. A village management system should be developed for easy interaction and enlarging of information coverage towards promoting agricultural and local business products. The smart village economic growth should be parallel to the national economic growth. Educational institutions should play a critical role in enhancing the potential of ICTs in livelihood generation by partnering with the government, the private sector, NBOs and NGOs. ICT should also be used to monitor and evaluate the smart village development activities at all stages.

Residents of the Kimunyu sublocation should be able to work together in the Smart Village to defend their farmlands and the environment. Not only should the Smart Village give internet access to remote areas, but it should also assist sustainable agriculture methods. The development of a network of small-scale agriculture-related companies, as well as a robust

network of road corridors with civic amenities such as education and health care for all, including farmers, should assist to change the face of Kimunyu sublocation. All areas of the sublocation should be examined for sustainable and inclusive development so that residents can enjoy a good level of living.

The following are 3D illustrations of the various proposed facilities

Figure 60: Affordable housing 3D Illustration 1 (Author, 2019)

Figure 61: Affordable Housing 3D Illustration 2 (Author, 2019)

Figure 62: Affordable Housing 3D Illustration 2 (Author, 2019)

Figure 63: High Density Residential 3D Illustration 1 (Author, 2019)

Figure 64: High Density Residential 3D Illustration 2 (Author, 2019)

Figure 65: High density Residential Open Space (Author, 2019)

Figure 66: Low Density Residential 3D Illustration 1(Author, 2019)

Figure 67: Low Density Residential 3D Illustration 2(Author, 2019)

Figure 68: Industrial Park 3D Illustration 1 (Author, 2019)

Figure 69: Industrial Park 3D Illustration 2 (Author, 2019)

Figure 70: Ware houses 3D Illustration 1(Author, 2019)

Figure 71: Ware Houses 3D Illustration 2 (Author, 2019)

Figure 72: Open Air Market 3D Illustration 1 (Author, 2019)

Figure 73: Open Air Market Lateral 3D Illustration 2 (Author, 2019)

Figure 74: Open Air Market Sheds (Author, 2019)

Through policies, laws and regulations, the government should make farmlands and environment protection a key priority. Additionally, a national environment week should be launched where residents come together and engage in mass farmland and environmental preservation activities. These activities range from wetland recreation activities to public lectures on best agricultural practices. Promotion of eco-tourisms, renewable energy, green homes, mass clean up and greening campaigns as well as ecosystem rehabilitation activities to mention but a few, should all form part of the smart village development. Greening components such as rainwater harvesting systems and waste treatment systems that will provide energy for cooking and organic fertilizers to boost agricultural yield for the residents should be integrated. Agro-forestry and terracing where need be where the plants can range from fruit bearing trees to medicinal and climate resilient trees should also be part of the development. All this will help realize a food secure community. Having water close to hand and biogas for cooking will help save time. This will allow women and children to concentrate on more productive activities such as school work.

5.2 Future Research Proposal

This study proposes an experimental research involving the development of a smart village in Kimunyu sublocation at the proposed site. This will provide a model village for testing the value of smart villages which takes strategic and integrated spatial approach to rural development in a Kenyan context. This will first require conduction of detailed baseline surveys within the sub location and an inventory of the existing conditions which are to form the basis for monitoring and evaluation of the model Smart Village. Additionally, the initiative will help in realizing the Government's initiative on affordable housing.

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8   APPENDICES

Appendix A

Averages Observed Land Use Allocations in Residential Neighborhood Development (E.L Menezes, Technical Paper LU NO. 12, Land Use Standards)

No.	Land use	Percentage of developed area		
		High density	**Medium density**	**Low density**
1	Dwelling plots	40-60	64-74	80-90
2	Recreation	21-29	7-16	-
3	Community facilities	5-20	9-10	0.1-1
4	Roads and streets	4-15 1-7	6-7 3-4	8-8.8 0-2.2

Appendix B

Recommended densities for residential development

Type of Dwelling	No. of dwellings per hectare	Space allocation per dwelling (m²)
Bungalow detached		
Low density	10	1000
Medium density	16	500
High density	35	285
Detached and row housing		
Low density	20	417
Medium density	32	333
High density	70	250

Type of Dwelling	No. of dwellings per hectare	Space allocation per dwelling (m²)
Multi–family dwellings		
Low density	50	200
Medium density	60	167.6
High density	70	142.8
Special Density	133	75

Appendix C

Classification of Transportation Networks (PPH, 2007)

Classification		Reserve in Meters
International trunk roads	A	60
National trunk roads	B	40-60
Primary roads	C	25-30
Secondary roads	D	20
Minor roads & SPR	E	18

Appendix D

Guidelines on area coverage of health facilities as per PPH

Health Facility	Minimum Area (in Hectares)
National referral hospital	20
Provincial hospital	8
District hospital	8
Sub-district hospital	4
Health center	3

Health Facility	Minimum Area (in Hectares)
Sub-health center	2
Nursing Homes	0.4
Veterinary clinic	0.1

Appendix E

Smart Village Formulation Process (Author, 2019)

UNDERSTAND COMMUNITY
- Potential and needs
- Location and demographics
- economic, social, cultural and environmental assets.
- Accessibility to services

IDENTIFY STAKEHOLDERS
- Government, NGOs, Corporations etc.
- Community actors
- Resources, incentives for participation.

Where are we now?

UNDERSTAND CONTEXT
- Economic, environmental and social factors
- Political and cultural factors
- Governance
- Key drives and hurdles for change

STAKEHOLDERS ENGAGEMENT
- Barriers
- Perception 'world views'
- Skills, capabilities
- Political buy-in, shared vision

COLLABORATION WORKSHOPS
- Concepts, principles, synthesis, integration of economic, environmental, social considerations and imperatives
- Community leadership
- Steps for action

SCOPE DEFINITION
- Factors and functions
- Boundaries and elements
- Types of result and impact
- Data requirements
- Times scale

Where do we want to go?

How do we get there?

GOALS
- Resilient community
- Sustainable land use and livelihoods

ENABLING MECHANISM
- Community empowerment and participation
- Cross-organisation governance structure
- Equitable development models

SYNERGISM
- Actors, local champions, social entrepreneurs.
- Assets, infrastructures and resources
- Capabilities, knowhow
- Collaborations

DEVELOPMENT MODEL
- Smart village

EVALUATE OPTIONS
- Understanding impacts
- Evaluating impacts
- Options to bridge gaps

INDICATORS
- Local economic and income generated
- Social enterprises established
- Optimal use of local resources
- Descriptive indicators for resilient community

INTERVENTIONS
- Transformation plan
- Fiscal instruments
- Regulations and policies

PUBLI-PRIVATE-COMMUTY PARTNERSHIP
- Institutional arrangement
- Performance requirements
- Regulatory frameworks
- Accountability

FINDINGS, REPORTING, COMMUNICATION

REVIEW PROCESS AND VERIFICATION

Are we getting there?

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Appendix E

Household Questionnaire

Questionnaire S/N_____

Role of Nucleated Rural Settlements in Preserving Farmlands and the Environment for Sustainable Livelihoods in High Potential Agricultural Areas in Kenya. The Case of Kimunyu Sub location

Name of Interviewer	Time Commenced	Time Finished	Date

Introduction: I am a master's student at the University of Nairobi and as part of my programme fulfilment; I am obligated to carry out a thesis research project. Am focusing on Kimunyu sub location and undertaking a household survey to find out how many people are living here, what they do for a living and how land management practices have affected livelihoods. On finding out the underlying issues again with your help we will find the solution in order to achieve dignified livelihoods in this area. Kindly help in answering the questions. It will only take about 30-45 minutes.

NO.	QUESTIONS	ANSWERS	CODE
1.	**SOCIO-ECONOMIC & DEMOGRAPHIC CHARACTERISTICS**		
1.	Respondent information		

Gender	Age	R/ship with H/H	Marital status	Religion

Gender	**Religion**	**Marital status**
01-Male	01-Catholic	01-Single
02-Female	02-Protestant	02-Married
	03-Islamic	03-Divorced
	04-Hindu	04-Deceased
05-Other(specify)		

NO.	QUESTIONS	ANSWERS	CODE
2.	What is your highest education level? State the institution from which education was acquired. 		

Education level	Institution	Location	Dist. (Km) from home

Education level:

01-Some primary education   02-Completed primary

03-Some secondary education   04-Completed secondary

05-College   06-University

07-Other (specify)

Distance:

01-<1 Km

02-1 to 5 Km

03-5 to 10 Km

04-10-20 Km

05-20-30 Km

05->30 Km

NO.	QUESTIONS	ANSWERS	CODE
3.	What is your MAIN source of household income?	01-Formal employment 02-Informal employment 03-Self employment	
4.	If **formal** employment, please provide the following information:		

Sector	Specify job	Location (town)	Dist. (Km)	Income (Kshs. Per month)

Sector:

01-National government

02-County government

03-Private sector

Distance:

01-On farm   02-0 to 10 Km   03-10 to 20 Km

04-20-30 Km   05-30-50 Km   06->50 Km

Income:

01-0 to 10, 0000   2-10, 000 to 20, 0000   3-20, 000-50, 000

04-50, 000-100, 0000   5-100,000 to 200, 0000   6-200, 000 to 500, 000

07->500, 000

NO.	QUESTIONS						ANSWERS	CODE
5.	If **informal** employment please provide the following information:							

Economic activity	Specify the economic activity	Location (Town centre)	Dist. (Km)	Income (Kshs. Per month)

Economic activity:

01-Crop farming

02-Dairy farming

03-Trading

04-Transport services

05-Jua kali

06-Other(specify)

Distance:

01-On farm

02-0 to 10 Km

03-10 to 20 Km

04-20-30 Km

05-30-50 Km

06->50 Km

Income:

01-0 to 10, 000

02-10, 000 to 20, 000

03-20, 000-50, 000

04-50, 000-100, 000

05-100, 000 to 200, 000

06-200, 000 to 500, 000

07->500, 000

---

6. Do you have school going child (ren) under the age of 18 years living with you? If **yes** please give the following information.

Name (optional)	Age (Yrs.)	Class/ Form	School Name	Dist. (Km) From home	Provider	If not in school give reason.

Dist. (Km) from home:

01-< 1 Km

02- 1 to 2 Km

03- 2 to 5 Km

04- 5 to 10 Km

05- 10 to 20 Km

06- > 20 Km

Provider:

01-Government

02-Private

03-Other (specify)

Reason not in school:

01-Lack of school fees

02-Lack of schools

03-Refused to attend school

04-Married

05-Working

06-Other (specify)

NO.	QUESTIONS	ANSWERS	CODE
7.	List all adults (18+) (including yourself) in the household, their sex, occupation and the location of the occupation		

Name (optional)	Sex	Occupation	Location Name	Dist. (Km)

Sex:

01-Female

02-Male

Distance:

01-On farm   02- <1 Km   03-1 to 10 Km   04-10to20Km

05-20-30 Km   06-30-50 Km   07->50 Km

NO.	QUESTIONS	ANSWERS	CODE
8.	What is the total household income per month?	01-0 to 10, 000 02-10, 000 to 20, 000 03-20, 000-50, 000 04-50, 000-100, 000 05-100, 000 to 200, 000 06-200, 000 to 500, 000 07- 500,000 and above	
9.	Has the total household income been increasing or Decreasing over the last five years?	01-Increasing 02-Decreasing	
10.	Give reasons for change		
2.	**HOUSEHOLD FARMLAND INFORMATION**		

NO.	QUESTIONS	ANSWERS	CODE
11.	Give the following information concerning the farmland on which your household reside		

Size in Acres

Total Acres)	Under cultivation	Built up	No. of houses/ structures	Mode of Acquisition	Ownership Document

Mode of acquisition

01-Inheritance

02-Lease

03-Allocation by government

04-Purchased

05-Others (Specify)

Ownership document

01-Title deed

02-Letter of allotment

02-Temporary Occupation License

04-Any other (specify)

05-None

NO.	QUESTIONS	ANSWERS	CODE
12.	Do you or any of your household members have any other piece of land in Kimunyu?	01-Yes 02-N0	
13.	If yes, please provide the following information		

Size in Acres

Total size	Under cultivation	Built up	No. of houses/ structures	Mode of Acquisition	Ownership Document

Mode of acquisition

01-Inheritance

02-Lease

03-Allocation by government

04-Purchased

05-Others (Specify)

Ownership document

01-Title deed

02-Letter of allotment

02-Temporary Occupation License

04-Any other (specify)

05-None

NO.	QUESTIONS	ANSWERS	CODE
14.	Have you in the past subdivided or intend to subdivide your current piece of land?	01-Yes 02-No	

NO.	QUESTIONS	ANSWERS	CODE
15.	If yes, please provide the following information. Indicate portions given to or to be given to children in acres both male and female children <table><tr><td>**Reason for subdividing**</td><td>**No. of portions**</td><td>**Size in Acres**</td><td>**Size in acres given to Male**</td><td>**Size in acres given to Female**</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table>		
16.	If you acquired your land through inheritance what was the total size of your parent's land? *Record actual size in Acres*		
17.	How many children were you? **Male** **Female**		
18.	How many acres of land did each of you inherit? <table><tr><td>**Male**</td><td></td><td>**Female**</td><td></td></tr></table>		
19.	What in your opinion do you think the farmers should do about their reducing household farmland sizes?		
20.	Would you support the idea of households living in planned nucleated rural towns and avoid construction of scattered houses and structures on rich agricultural land?	01-Yes 02-No	
21.	If no, please provide your reasons.		
22.	If yes, what would you want the government do for farmers who choose to move to the rural towns?		
23.	Which centre would you like to be developed as the rural town in this area?		
24.	Do you think that as a country we should continue subdividing high potential agricultural farmlands into plots?	01-Yes 02-No	
25.	According to your opinion, what can be done by the government to reduce the misuse of rich agricultural land such as the uncontrolled subdivision? Of fertile agricultural land in Kimunyu?		
26.	Has the distribution of houses/structures in your household taken up so much of your farmland?	01-Yes 02-No	

NO.	QUESTIONS	ANSWERS	CODE
3.	**AGRICULTURE**		
27.	What is your households' **Major** agricultural practice?	01-Subsistence farming 02-Commercial farming 03-Both 04-None	
28.	What type of farming according to you is the most suited recommendable for this area? List all that apply and give reasons for your choice. 	Recommended type of farming	Reason
---	---
29.	Name 5 crops that grow well in this area.		
30.	Please provide the following information on crop production in your farmland **Food crops** **Acreage** **Yield (in bags)** **Income/month** **Cash crops** **Acreage or Number of** **Yield (Kg)** **Income/month** **bushes/trees**		
31.	Please provide the following information on livestock farming 	Livestock	No.	Yield per month	Quantity consumed	Quantity sold	Income /month
---	---	---	---	---	---
Dairy cows					
Beef cattle					
Dairy Goats					
Meat Goats					
Sheep					
Pig					
Poultry					
Fish					
Bees (hives)					
Others(specify)							

NO.	QUESTIONS	ANSWERS	CODE
32.	What challenges does your household face in crop production? 	Crop type	Challenge	Current mitigation measure	Proposed mitigation measure
33.	What challenges does your household face in livestock production? 	Type	Challenge	Current mitigation measure	Proposed mitigation measure
34.	Have you received agricultural extension services in the last one year?	01-Yes 02-No	
35.	What hinders high agricultural production in this area according to you?		
36.	Do you believe that scattered settlement of houses on farms reduces the land available for agricultural production?	01-Yes 02-No	
4.	**MARKETING, MARKETS AND URBAN CENTERS**		
37.	Which channel do you use for the sale of your crop produce? 	Channel	Crop products		Benefits	challenges
---	---	---	---	---
	Type	**Income/month**		
Cooperatives				
Middle men				
Individually				
Others (specify)							

NO.	QUESTIONS				ANSWERS		CODE

38. Which channel do you use for the sale of your animal produce?

Channel	Animal products		Benefits	challenges
	Type	Income/ month		
Cooperatives				
Middle men				
Individually				
Others (specify)				

39. In which market centre/ urban centre do you sell your produce?

Farm produce	Market centre	Urban centre	Distance (Km)	Income/m onth

40. From which market or urban centre does your household mostly acquire goods?

Good	Market centre	Urban centre	Dist. Km	Amount spent/month
Food				
Clothing				
Farm inputs				
Others (specify)				

41. From which market or urban centre does your household mostly acquire its services?

Service	Market centre	Urban centre	Dist. Km	Amount spent/month
Health				
Education				

NO.	QUESTIONS					ANSWERS	CODE
	Administration						
	Others (specify)						
42.	Does any of your household members live in any market centre in Kimunyu or in any other nearby town? If yes give the following details						
		Occupation	**Market centre**		**Nearby town**	**Dist. (Km)**	
43.	At what stage during the production of the crops that you grow on your land do you normally incur losses?					01-During harvesting 02-In storage 03-During transportation 04-At the market 05-Other(specify)	
44.	Give reasons to the answer above						
5.	**NON-FARM/INDUSTRIAL ECONOMIC ACTIVITIES**						
45.	Which industries / factories either related to agricultural or non-agricultural production are located within this sub location?						
		Agricultural product	**Name of Industry/Factory**		**Where located**	**Dist. (Km) from home**	
		Non-agricultural product	**Name of Industry/Factory**		**Where located**	**Dist. (Km) from home**	
46.	Which are the other nearest industries/factories located outside Kimunyu sub location that serve farmers in Kimunyu?						

NO.	QUESTIONS				ANSWERS		CODE
	Agricultural product	**Name of Industry/Factory**		**Where located**	**Dist. (Km) from home**		
	Non-agricultural product	**Name of Industry/Factory**		**Where located**	**Dist. (Km) from home**		

47.	What opportunities for off-farm employment are there in this area?			
	Opportunity	**Where located**	**Dist. (Km)**	

48.	Name three **major** non-farm economic activities that you would like to be enhanced or introduced in this area?	

6.	**SOCIAL /PHYSICAL INFRASTRUCTURE AND UTILITY SERVICES**	

Energy source		

49.	What is the source of energy for cooking in this household? *List all that apply.*	01-Electricity 02-Kerosene 03-Charcoal 04-Wood 05-Solar 06-Biogas 07-Other(specify)	
50.	What is the source of energy for lighting in this household? *List all that apply.*	01-Electricity 02-Kerosene 03-Charcoal 04-Wood 05-Solar 06-Biogas	

NO.	QUESTIONS	ANSWERS	CODE
		07-Other(specify)	
Water source			
51.	What is the source of water for your household? *List all that apply.*	01-Piped water 02-River/stream 03-Borehole 04-Protected dug well 05-Other (Specify)	
52.	What challenges do you face in accessing water?		
53.	How reliable is water supply in this area?	01-Very reliable 02-Fairly reliable 03-Not reliable 04-Other (Specify)	
54.	What is the reason for your answer above?		
Access to Sanitation Facilities			
55.	Does your household have toilet(s)?	01-Yes 02-No	
56.	What is the type of the toilet?	01-Pit Latrine 02-Flush Toilet 03-Bush 04-Other (Specify)	
57.	How does your household dispose grey water (i.e. water used for washing clothes and utensils?	01-Via drainage 02-Pour onto the soil/ road or pavement 03-Pour into latrine 04-Pour onto garden 05-Re-use it	

NO.	QUESTIONS	ANSWERS	CODE
		06-Other (specify)	
Solid Waste Management			
58.	Is there a designated place to dispose garbage in this area?	01-Yes 02-No	
59.	Do you have a garbage collection service in this area?	01-Yes 02-No	
60.	If Yes, are you satisfied with the service?	01-Don't use the service 02-Unsatisfied 03-Satisfied	
61.	If answer to the question above is 01 or 02, what are the reasons?		
62.	How does your household dispose the solid waste?	01-Dumping 02-Burning 03-Burying 04-Composting 05-Designated collection point 06-Other(specify)	
Aspects of Health			
63.	Which are the leading diseases in this area?	01-HIV/AIDS 02-Malaria 03-Pnemonea 04-Typhoid 05-TB 06-Respiractory Tract infections 07-Diarrhea 08-Kwashiokor 09-Eye Infections	

NO.	QUESTIONS	ANSWERS	CODE
		08-STDs	
		09-Dental problems	
		10-Others(specify)	
64.	How often does a member of this household fall sick?	01-Very frequent 02-Frequent 03-Rarely 04-Never	
65.	When a member falls ill what do you do?	01-Give off-counter drugs 02-Use public dispensary 03-Use public hospital 04-Use private clinic 05-Use private hospital 06-Use traditional medicine 07-Others(specify)	
66.	Which is the most reliable health facility in this area?		
Transportation			
67.	What is the mode of transport commonly used by your household?	01-Walk 02-Motorcycle 03-Private car 04-Matatu 05-Bus 06-Other specify	
68.	What problems do you face with the specific mode of transport?		
69.	Do you have any suggestion that will help improve transportation in this area?		
70.	How can you describe the connection of market/urban centres and other service provision centres in this area via road transport?	01-Well connected 02-Fairly connected 03-poorly connected	

NO.	QUESTIONS	ANSWERS	CODE
		04-Other (specify)	
71.	Provide the following information for the nearest services to your household.		

Distance:

01 <1 Km   02 1 to 2 Km   03 2 to 5 Km

04 5 to 10 KM   05 10 to 20 Km   06 20 to 30 Km

07 30 to 50 Km   08 > 50Km

Provider:

01-Government

02-Private

03-Other (specify)

Condition:

01-Very good

02-Fair

03-Poor

Service	Facility name	Where located	Dist. Km	Provider	Condition	Remarks with reference to condition
Nursery sch.						
Primary sch.						
Secondary sch.						
polytechnic						
Tertiary institution						
Library						
Hospital with in-patient facilities						
Dispensary/health centre						
Pharmacy/chemist						
Religious facility						
Administrative or civic offices						
Police post						
Social hall/youth centre						
Recreational facilities						
Playing field						
General retail shops						

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NO.	QUESTIONS						ANSWERS	CODE
	Open air market							
	Super market							
	Coffee factory							
	Tea buying centre							
	Milk collection centre							
	Bank/ATM							
	Post office							
	Elderly home							
	Rehabilitation centres							
	Piped water							
	Well/spring							
	Electricity							
	Renewable energy							
	Main road							
	Village access road							
	Internal streets							
	Bus/matatu terminal							
	Cattle dip							
	Cemetery							
	Land fill							
	Agriculture cooperative society							
	Milk cooperative society							
	Small scale industries							

NO.	QUESTIONS	ANSWERS	CODE
72.	The cost of providing services to people living in dispersed settlements is said to be high as compared to services provided in nucleated settlements?	01-True 02-False	
73.	How is the general cost of services provision in this area? e.g. water	01-Expensive 02-Affordable	
74.	What has made the provision of services in this area to be expensive according to your own opinion?		
75.	Nucleated settlements attract services to themselves which leads to accumulation of services and eventually make the settlements grow big enough as to justify the provision of more services. Do you believe this statement to be true?	01-Yes 02-No	
76.	Would you consider living in a nucleated settlement where services can be provided for at an affordable cost and free up your land for farming? You still own your land	01-Yes 02-No	

7. GOVERNANCE AND LOCAL DEVELOPMENT

NO.	QUESTIONS				CODE
77.	Which institutions have been successful in steered development in the following sectors?				

Sector		Institution	Services given	Impact on development
Agriculture	Crop farming			
	Livestock farming			
Health				
Education				
Social services				
Finance				

NO.	QUESTIONS	ANSWERS	CODE
78.	Have you invested money earned from agricultural production in your farmland in nonfarm investments?	01-Yes 02-No	
79.	If yes, please provide the following information:		

NO.	QUESTIONS				ANSWERS	CODE
	Investment/Enterprise name	Where located	Income to household/month		No. of employees	
8.	**BUILT AND NATURAL ENVIRONMENT**					
80.	How has the settlement pattern in this area affected the management of solid and liquid waste?					
81.	What is the impact of settlements on the agricultural land in this area?					
82.	Were there plants/ trees species or animals that used to be plenty in Kimunyu before human activities became dense in Kimunyu that are no longer found in this area?				01-Yes 02-No	
83.	If yes to the question above please provide the following information:					

Tree/Plant species	Period of time since last seen	Impact of human settlement
Animal species	Period of time since last seen	Impact of human settlement

NO.	QUESTIONS	ANSWERS	CODE
9.	**CONCLUSION**		
84.	What kind of Kimunyu would you like to live in and raise your children? A Kimunyu that………………………………………………………….		
85.	During land consolidation land was set up for people to live in villages such as Kimunyu village. That land is still there. If that land was planned and developed into a rural town, would you encourage your children to move to such a rural town instead of building houses on good agricultural land so that family land can be used for agricultural purposes? Y/N If your answer is No, Give your reasons		

THANYOU!

Appendix F

Household farm details

Total Household Farmland Size in Acres		Total Farmland Under Cultivation in Acres		Total Farmland Built Up in Acres	
Total Farmland Size	No. of Respondents	Farmland Under Cultivation	No. of Respondents	Farmland Built Up	No. of Respondents
0.25	29	0	22	0.5	17
1	13	0.13	13	0.13	11
0.5	9	1	9	0.21	9
1.5	5	0.5	7	0.01	7
0.13	3	0.3	5	1	6
2	4	1.5	4	0.1	5
0.1	3	0.27	4	0.02	3
2.5	2	0.4	3	0.05	3
0.2	2	0.25	3	0.12	3
0.75	1	0.15	1	0.2	3
1.2	1	0.75	1	0.4	2
2.2	1	0.8	1	0.15	2
2.75	1	1.25	1	3.1	2
3	1	2	1	0.39	1
3.5	1	3	1	0.55	1
5	1	4	1	1.25	1
7	1	5	1	2	1
71.74 (Total)	**78**	**40.34**	**78**	**31.4**	**78**
0.92 (Average)		**0.52**		**0.4**	

Appendix G

Details on Food Crop Production (Author, 2019)

Size of Land Occupied by Food Crops		Yield in Bags		Income Earned per Month	
Size (Acres)	No. of Respondents	No. of Bags	No. of Respondents	Income Kshs. /Month	No. of Respondents
0.1	2	1	10	2 000	1
0.13	4	2	5	3 000	1
0.15	1	3	1	4 500	1
0.2	2	5	3	10 000	1
0.25	6	9	1	20 000	1
0.5	2				
0.6	1				
1	10				
3.5	1				
17.87 (Total)	**29**	**20**	**20**	**39 500**	**5**
0.6 (Average)		**1**		**7 900**	

Appendix H

Cash Crop Production Details (Author, 2019)

Size of Land Occupied by Cash Crops		Yield in Bags		Income Earned per Month	
Size (Acres)	No. of Respondents	No. of Bags	No. of Respondents	Income Kshs. /Month	No. of Respondents
1	3	10	1	400	1
4	2	20	1	5 000	1
5	1	40	1	15 000	2
2.8	1	15	1	50 000	1
12.8 (Total)	**7**	**85**	**5**	**70 400**	**5**

Size of Land Occupied by Cash Crops		Yield in Bags		Income Earned per Month	
Size (Acres)	No. of Respondents	No. of Bags	No. of Respondents	Income Kshs. /Month	No. of Respondents
1.83 (Average)		17		14 080	

Appendix I

Livestock Production Details (Author, 2019)

No. of Livestock Animals		Yield in Litres/Kgs/Trays		Income Earned per Month	
No. of Animals	Respondents	Litres/Kgs/ Trays	Respondents	Income Kshs. /Month	Respondents
1	8	2	2	3 60	1
2	5	3	1	3 700	1
3	1	6	1	5 460	1
6	2	4.5	1	12 000	1
4	2				
5	1				
21 (Total)	19	15.5	5	21 520	4
1 (Average)		3.3		5 380	

Appendix K

Summary of services accessible to Kimunyu Sub location Households

Service	Name of Facility	Location	Provider	Condition of the Facility	Remarks
Nursery school	Kimunyu Nursery School	Kimunyu Village	Government	Poor	Kimunyu Nursery, primary and secondary school are all located on the same piece of land that is 10.34 acres. The same goes for Gachoka nursery, primary and secondary schools which are on
	Gachoka Nursery School	Gachoka Village	Government	Poor	

Service	Name of Facility	Location	Provider	Condition of the Facility	Remarks
Primary school	Kimunyu Primary School	Kimunyu Village	Government	Poor	9.43 acres of land. According to the PPA nursery schools require 0.37 to 0.62 acres of land, primary schools as well as secondary schools require 9.64 acres each and an addition of 1.98 acres each if the teaching staff are to be accommodated. Additionally, the classrooms, play fields, libraries and laboratories were all in poor state or missing. The general learning environment of these schools is poor. This includes the private schools as well.
	Gachoka Primary School	Gachoka Village	Government	Poor	
	The Bold Shepherd Academy	Gechure Village	Private	Poor	
	Suka Academy	Thangari Village	Private	Poor	
Secondary school	Kimunyu Secondary School	Kimunyu Village	Government	Poor	
	Gachoka Secondary School	Kimunyu Village	Government	Poor	
Tertiary institution	None				
polytechnic	None				
Library	None				
Hospital with in-patient facilities	None				
Dispensary/ health center	Kimunyu Medical Clinic	Kimunyu Village	Private	Poor	Lacked most drugs in addition to them being expensive. Additionally, such a health facility ought to be on about 7.42 acres of land and not just a less than an acre plot.

Service	Name of Facility	Location	Provider	Condition of the Facility	Remarks
Pharmacy/Chemist		Kimunyu Village	Private	Fair	Expensive drugs
Religious facility	Kimunyu Catholic Church	Kimunyu village	Private	Fair	Religious facilities are sufficiently available
	P.C.E.A Kimunyu church	Kimunyu Village	Private	Fair	
	AIPCA Gachoka church	Gachoka Village	Private	Fair	
	ST. John A.C.K Kimunyu church	Kimunyu Village	Private	Fair	
Civic/Administrative offices	Kimunyu Chief office	Kimunyu Village	Government	Poor	Just a tiny building with no electricity connection or even telephone services.
Police post	Kimunyu Police Post	Kimunyu Village	Government	Fair	
Social hall/Youth Center	None				
Recreational facility	None				
Playing Ground	Kimunyu Play Field		Government	Very poor	When it rains the field normally get flooded.
General Retail Shops	Kimunyu Shopping Center		Private	Fair	Located along Kenyatta road
Open air market	Kimunyu Open Air Market	Kimunyu Village	Government	Poor	Just an open space no facilities necessary in a market are in place

Service	Name of Facility	Location	Provider	Condition of the Facility	Remarks
Supermarket	Kimunyu Supermarket	Kimunyu Village	Private	Fair	Can be improved on
Coffee factory	None				
Tea buying center	None				
Milk collection center	None				
Bank/ATM	Equity Bank	Kimunyu Village	Private	Good	
Post office	None				
Elderly home	None				
Rehabilitation center	None				
Piped water	Available		Government	Fair	Most households have no access for others won't allow connection pipes to pass through their properties
Well/spring	None				
Electricity	Available			Good	Not all households are connected
Renewable energy	None				
Main road	Kenyatta road		Government	Fair	Not safe for pedestrians. No pedestrian walks. Poor drainage
Access road	Available		Government	Poor	Are tiny and problematic to travel on when it rains.

Service	Name of Facility	Location	Provider	Condition of the Facility	Remarks
Internal streets	Available		Government	Very poor	
Bus/Matatu Terminal	None				
Cattle dip	Available	Thiririka Village			Not operational
Cemetery	Kimunyu Cemetery	Kimunyu Village	Government	Fair	Farming is done on the cemetery. Graves were barely visible.
Agricultural cooperative	None				
Milk cooperative society	None				
Small Scale Industries	None				

Appendix L

Research Work Plan (Author, 2019)

No.	Steps in the Research Plan	Deadline for Completion
1.	Preliminary literature review, selection of research topic and concept paper writing	*January 14th to 31st*
2.	Concept paper writing & Submission	*February 1st to 18th*
3.	Design of a research plan	*March 23rd*
4.	Literature review	*January 14th to May 30th*
5.	Writing a proposal and Submission	*February 19th to March 27th*

No.	Steps in the Research Plan	Deadline for Completion
6.	Proposal Defense.	*March 28th*
7.	Correction and adjustments of proposal	*March 29th to April 21st*
8.	Seeking authority to collect data	*April 22nd to 24th*
9.	Pilot study	*April 27th*
10.	Fieldwork and data collection	*April 29th to May 4th*
11.	Data frame/ coding /entry / cleaning	*May 6th to 10th*
12.	Analysis of data and presentation	*May 11th to 14th*
13.	Report Writing	*May 11th to 23rd*
14.	Defending the thesis	*May 27th*
15.	Final Project Report	*May 29th*

Appendix M

Research Work Plan Time Frame Illustration (Author, 2019)

No.	Work Item/Steps	Jan	Feb	Mar	Apr	May
1.	Selection of research topic and concept paper defense	▓	▓			
2.	Proposal writing and submission		▓	▓		
3.	Proposal defense			▓		
4.	Proposal corrections and modification of research instrument			▓	▓	

No.	Work Item/Steps	Jan	Feb	Mar	Apr	May
5.	Seek authority to collect data				█	
6.	Pilot study				█	
7.	Field work / data collection				█	█
8.	Data frame/coding/entry and cleaning					█
9.	Data analysis and interpretation					█
10.	Report writing and presentation					█
11.	Final project report					█

Appendix N

Research Budget (Author, 2019)

Item/Service	No. of Units/Quantity	Unit Cost	Total Cost
Concept and Proposal Development			
Proposal printing	111 pages	30	3330
Binding of proposal	2	50	100
Piloting			
Printing and Photocopying data collection instruments	25 pages 100	30 5	750 500
Pilot study (Travelling, Meals)			4000
Actual Data Collection			
Printing and Photocopying data collection instruments	25 pages 500	30 5	750 2500
Research assistants	12	1000	12000
Field work (travelling and meals)			5000
Field work facilitations			2000

Item/Service	No. of Units/Quantity	Unit Cost	Total Cost
Thesis writing			
Data handling			4500
Printing thesis report			6000
Binding the reports			1000
TOTAL COST			**88130**