GOVERNANCE AND MANAGEMENT OF FARMING LANDUSE PRACTICES IN RWANDA: CASE STUDY OF MUKIMIRA SECTOR

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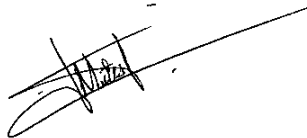**WANGARI MAATHAI INSTITUTE FOR PEACE AND ENVIRONMENTAL STUDIES**

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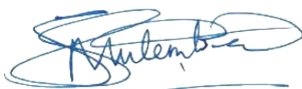
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*This **Thesis** is dedicated to my mother, Mutoni Alice ,Niyibizi Patrick and Ntwali Hunson.*

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

CIP   : Crop Intensification Program

EDPRS   : Economic Development and Poverty Reduction Strategies

FAO   : Food and Agriculture Organization

GoR   : Government of Rwanda

IDP   : Integrated Development Programme

IPCC   : Intergovernmental Panel on Climate Change

LUC   : Land Use Consolidation

LWH   : Land Husbandry Water Harvesting and Hillside Irrigation

MINAGRI   : Ministry of Agriculture and Animal Resources

MINITER   : Ministry of the Interior, Communal Development and

                           Reinstallation

NISR   : National Institute of Statistics of Rwanda

NST1   : National Strategy for Transformation phase 1

PRA   : Participatory Rural Appraisal

RAB   : Rwanda Agriculture Board

REMA   : Rwanda Environment Management Authority

SLM   : Sustainable Land Management

UN   : United Nations

UNEP   : United Nations Environmental Program

USAID   : Unites States Agency for International Development

LIST OF APPENDICES

ABSTRACT

Poor land use practices have negative effects on environment and food security because they degradelandresources.Despite Rwandahavingpoliciesandlawstoregulatelandusefarming practices it has been observed that farming activities have continued to cause land degradation over the years. The observed trend has been worrying and warranted a study to unravel the governance and management root causes of the same in order to put in place sustainable interventions.This study aimed to use the case study of Mukamira Sector to understand how existing regulatory legal and institutional frameworks for land use farming practices are currently interplaying with the actors to create sustainable management of land resources. The study took into account representative sampling of administrative units, referred to as Cells in Rwanda by treating the farming household as the primary sampling unit. Every fifth household along the walking transect of the Cell was sampled. Questionnaires were used to interview household heads and key informants. A Participatory Rural Appraisal (PRA) method was used to collect data on trends of land use practices and observed land use changes. Secondary data was obtained through review of relevant literature and documentation to obtain data on existing laws, policies and regulations. Quantitative and qualitative data was obtained. Quantitative datawas analyzed and presented as frequencies and percentages charts, graphs and tables. Qualitative data was analyzed thematically and presented as ranked perceptions. Multinomial Regression, Chi-square and Student-T tests statistics were used where applicable to deduce significance of the presented results. Majority (over90%) of the respondents engaged in farming activities that were significantly influenced by local leaders ($p<0.05$). Governance instruments and institutionalframeworkforregulationoflandusepracticesexistedinRwanda.ThePRAresults indicatedlanddegradationhasoccurredoverthelastfiveyears.Farmersadmittedtobepartof the contributory cause of the occurred land use change through their farming activities while also blaming other causes like socioeconomic, political and cultural traditions. It reportedthat

theGovernmentofRwandaneedstointegratethesocio-culturalviewsofherpopulationduring enforcementofgovernanceandmanagementoflandusepracticesforsustainability.Increased engagement of the various actors in the regulation of land use farming practices was suggested, especially the farmers themselves. The farmers were able to identify the existing problem and the interventions required to address the identified problem; they expressed their willingness to be trained on sustainable land use farming practices and to practice the same in their current and future farming activities.A participatory engagement of all actors was suggested to promote land use sustainability values. The study concluded that (i) there are elaborate legal and institutional frameworks for regulating land use practices in Rwanda, which are well safeguarded by the constitution and enacted laws, and institutions with spelt out mandate roles, (ii) farmers have expressed inadequacies in their requisite skills for sustainable land use management that is caused be declining government extension services, (iii) farmers have observed various land use changes that have occurred in the last five years that require urgent management interventions ; they highlighted and provided the actors responsible for their execution, including themselves, and (iv)farmers expressed willingness to cooperate with the government and others actors to address poor landuse practices.It was recommended that(a)there is need for the government to engage the farmers to fully understand why unsustainable land use farming practices are being carried out by farmers in spite of existence of elaborate regal and institutional frameworks, (b) various actors, including extension officers, NGOs and local leaders who are mandated with training of farmers on requisite skills for sustainable land use management need to enhance their concerted efforts in doing so at farm level,(c)there is need by the government to come up with a farmer friendly program to address the observed negative land use changes.

CHAPTER ONE

1.0 INTRODUCTION

Background Information

Land use farming practices have continuously continued to influence soil fertility with positive or negative impacts on land productivity (Willy *et al*., 2019; Zhang and Su, 2020). In Africa as population increases and farm size decreases, land use practices that sustainably maintain soil fertility are under threat leading to lower food production per acreage and diminished food at household level (R. . Scott, 2004, 2008; Willy *et al*., 2019b)

The threat in food security at household level have contributed to decisions at household and community levels that result in deteriorating farming practices that fail to adhere to laid down laws, policies and regulations for sustainable land use practices (Li *et al*., 2017; Willy *et al*., 2019)

Sustainable land use farming practices are only achieved in a country where sound environmental governance exist and the same is safeguarded by enforcement framework consisting of rules, policies and institutions that outline how humans interact with the environment as a whole (UNEP, 2010). In this regard those wishing to attain sustainable land use practices must perceive environmental governance as the basis for individual decision or reaffirmation to adhere to regulatory framework (policies, laws, procedures, practices and organizations) that regulate them as the actors trusted with the land resource in order to sustainably maintain the same for their own survival and that of future generations (Buur *et al*., 2013).

Sound environmental governance grounded in many levels in society through statutory as well as customary institutions and organizations focuses at creating networks and partnerships for land use leading to sustainable utilization of land resources and food security through accountable

practices (UNEP, 2010). Many institutions, including governments, NGOs, private sector and civil society have been involved in promotion of such practice across Africa (Buur *et al*., 2013; UNEP, 2010). However, it has been noted that communities in Africa are evolving and newer economic and development actors are emerging, who have lowered value for environmental sustainability, thereby requiring establishment of newer regulatory frameworks for environmental governance in order to safeguard sustainable land use practices (Buur *et al*., 2013).

Sustainable Development Goals (SDGs) that aim to end poverty, protect the planet and ensure prosperity for all by 2030 cannot be achieved in absence of sound environmental governance that safeguard land resources (UN General Assembly, 2015). Land use farming practices that result in land resource degradation not only threaten survival of the generation causing it but also of the future generations(Mucheru-Muna *et al*., 2007). Therefore, for sustainability of current and future generations, research is continuously required on patterns of land use practices.

In Rwanda, land degradation that is resulting from improper land use practices have been noted (X. Li *et al*., 2017). This has been attributed to inadequate and/or lack of adherence to laid down land use governance at household level (REMA, 2015). Wrong decisions made at household level coupled with inadequate agricultural extension services, weak land use legislations, failed implementation of otherwise strong laws, polices and regulations have all been blamed for the existing trend (Lamek *et al*., 2016; X. Li *et al*., 2017).

In Mukamira Sector, there are growing concerns that farming practices, including continuous cultivation without crop rotation are causing land resource degradation (Lamek *et al*., 2016). In this context it is necessary to carry out research in such an area as a case study to understand which factors are leading to such practices, especially in relation to environmental governance (REMA,

2015). Once these factors are understood and addressed, sustainable land use farming practice will be achieved to minimize threats to the land resource in order to sustain its soil nutrient content for current and future generations (Willy *et al*., 2019b).

Sound environmental governance can only be achieved whenever a scientific connection is established between the existing land use farming practices and how such practices interphase with the actors in terms of their knowledge, attitudes and practices within the confines of existing legal frameworks (Willy *et al*., 2019b). Therefore, this study seeks to provide the data in this context for Rwanda, in order to inform policy on sustainable land use farming practices using a case study of Mukamira Sector.

1.2 Problem Statement

Rwanda's most cultivatable land resource is mountainous and sloppy hills making it susceptible to soil erosion and degradation.This requires prudent environmental governance is a must safeguard sustainable land use practices (Willy *et al*., 2019b).

It was noted before this study that Rwanda's sustainable land use farming practices are currently under threat from increasing population pressure and emerging trends of farmers who do not care about environmental sustainability (REMA, 2015) and are after sustaianing their livelihoods. This trend does not only threaten survival of the current but also future farming generations of Rwanda(UNEP, 2010).

Mukamira Sector has sloppy landscapes and practicing sustainable land use farming practices such as terracing, crop rotation, agro forestry and empty furrows for land restoration is important for sustainability. However, this is not the case and Rwanda Environmental Authority (REMA) has indicated a need for research to restore such practices in the area and in the whole of Rwanda in

general (REMA, 2015). If the trend is not addressed there will be a big problem in the country's food security. This is significant enough to warrant intervention because Rwanda's population depends on her land resource to feed over 90% of her households.

Such governance require sound legislations, polices and regulations on land use farming practices that are coupled with strong extension services and responsive household decisions, which seem not to be the case currently in Rwanda (Lamek *et al*., 2016; X. Li *et al*., 2017; Price, 2015.). Such governance frameworks need to be put in place to promote sustainability in practices such as crop rotation, agro forestry, intercropping and natural manuring/mulching, amongst(X. Li *et al*., 2017). In order to inform policy, this study aimed at obtaining data for establishing a scientific connection between the existing land use farming practices and how such practices interphase with the actors in terms of their knowledge, attitudes within the confines of existing laws, policies and regulations in Rwanda.

1.3: Research Objectives

1.3.1 Overall objective

To assess governance and management of land resources in Rwanda to inform policy on sustainable land-use practicesin Rwanda using a case study of Mukamira.

1.3.2 Specific Objectives

a) To evaluate existing land use regulatory framework in Rwanda

b) To determine knowledge, attitudes, and practices of farmers regarding sustainable land use farming practices within confines of existing Rwanda's governance framework

c) To assess land-use changes that the farmers have observed for the last five years

1.4: Research Hypothesis

The study was guided by the following researchable hypothesis: -

In Mukamira Sector, types of land use practices and changes are being driven by farmers who lack sustainability requisite skills (knowledge, attitude and practices) within the laid down governance processes.

Hence, expected outputs of the study: -

   i)   Land use governance framework for land use in Rwanda documented

   ii)   Farmers land use sustainability requisite skills (knowledge, attitude and practices) within confirms of the governance framework determined.

   iii)   Farmers observed 5-year land use changes that have occurred in Mukamira over last 5 years

1.5 Justification of the Study

Sustainable land use is vital for survival of over 90% of Rwandan population that is currently under threat from degrading land (Banerjee *et al*., 2020; Lamek *et al*., 2016). There is recognition by Rwandan Environmental Management Authority (2015) that governance of land use in Rwanda has not yielded much results because the land resource continues to deteriorate over each passing year. Mukamira region is one of the most affected by this trend and it would serve as a good case study in understanding the aspect of the governance framework (household decisions, agricultural extension services, Sector policies and regulations or National laws) that seem to cause the worrying trend.

Understanding how existing land use governance interphase with the actors/stakeholders in terms of their required skills (knowledge, attitudes and practices) are influencing existing land use

practices could help unravel the main causes of the worrying trend and provide data to inform policy for possible solutions. Moreover, this study will play along way in informing the decisions being made to achieve the UN's Sustainable Development Goal number 15 on life on land as well as goal number 12 on responsible consumption and production practices.

1.6: Scope and Limitations of the Study

This study focused on governance and management of sustainable land use practices in Rwanda. A case study of one Sector region of Rwanda was the scope of the study. The study was limited to sampling of four Cells of Mukamira Sector but sample size per Cell was apportioned proportionally according to population. Random selection of households as the primary sampling unit was carried out. It was worth noting that the study scope was adequate because all households in Mukamira Sector were exposed to similar government regulated farming practices such as government subsidized inputs and extension services.

1.7: Assumption of the Study

All respondents provided honest responses to the questions posed to them.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Sustainable Land Management

Sustainable utilization of land resource requires adoption of sustainable land management (SLM), which comprises of measures and practices adapted to biophysical and socio-economic conditions aimed at protecting and conserving its resources (soil, water and biodiversity), and restoring degraded resources and their ecosystem functions (FAO, 2018).

The demand for food and bio-energy have put pressure on sustainable land use farming practices (Willy *et al.*, 2019b). Major pressure is being brought about by the ever-increasing global population growth, especially so among developing and underdeveloped countries (Nkonya *et al*., 2015). As a result, this pressure is leading to land use farming practices that result in reduced and/or depleted land resources(Willy *et al*., 2019b).

Sustainable land use farming practices are crucial in SLM. It is estimated that human activities that fail to promote sustainable land use have affected 83% of the global terrestrial land surface and degraded about 60% of the ecosystem's services in the past 50 years(Nkonya *et al*., 2015). Land use farming practices have also contributed to land cover changes that continue to define human footprint on earth, unfortunately, with major negative effects on soil, water and biodiversity(Willy *et al*., 2019b). Rwanda is not spared from such human footprints of degraded land resources (Lamek *et al*., 2016). Footprints have very high impacts population density is high and population highly dependent upon farming (Mwanjalolo Jackson-Gilbert *et al*., 2015).

Land use changes are determined by environmental, socio-cultural and economic factors, which interact in a complex manner (Costa and Soares, 2012; Geist and Lambin, 2004; Moquin *et al*.,

2012). These interactions result in varying degrees of negative or positive changes, which either put or ease pressure on the earth's surface (P. Zdruli, 2014; Pandi Zdruli *et al.*, 2011). Whenever such changes interphase synergistically to operate with others like negative climate change, soil erosion, biodiversity loss, and water scarcity results(Agyemang, 2020; Wynants *et al.*, 2018). Such changes have severe consequences, ecosystem degradation, accelerated climate variations, and increased poverty (Bremer *et al.*, 2019; Bremner *et al.*, 2003). The consequences are felt more in developing and underdeveloped countries (Nkonya *et al.*, 2015).

The world has modified the land resource in many ways and intensities to meet varying localized demands (Moges *et al.*, 2013). However, such demands have negatively altered the land resources at varying degrees also depending on how the actors of the change choose to make individualized decisions based on knowledge, attitudes and practices (Barrios and Trejo, 2003). It is important for researchers to understand existence of such land use farming practices based on such context. Whenever mankind decisions fail to incorporate the aftermath of unsustainable land use farming practice decisions, the result will always be soil erosion, loss of vegetative cover, reduced soil infiltration capacity, lowered water storage, loss of soil organic matter, reduced soil fertility, decreased soil resilience and poor natural land resurgence capacity, among others (Khormali *et al.*, 2009; Willy *et al.*, 2019b).

Worldwide farming is tending to be intensified to satisfy mankind demands at the expense of the available land resources (Moges *et al.*, 2013). Unless prudent environmental governance that blends very well with individualized decisions that integrate requisite skills of knowledge, attitude and practices for sustainable land management is enforced, land resources will continue to be threatened until they become depleted completely(Barrios and Trejo, 2003). Sustainability of land resources lies in safeguards for land use farming practices, landscape integrity and vegetative cover

that eventually determine top soil moisture, infiltration capacity, water storage, soil organic matter, fertility, resilience and natural resurgence capacity, among others (Khormali *et al*., 2009; Willy *et al.*, 2019b).

Trends on land use changes in developing countries like Rwanda (Jain and Yang, 2005; Lambin *et al*., 2003; Willy *et al*., 2019b),makes it necessary to understand the dynamics that make their society to fail to maintain sustainable land use farming practices(Mwanjalolo Jackson-Gilbert *et al.*, 2015). Since land resources play a critical role in the existence of mankind and in development of countries, such studies could generate data to inform policy on interventions on land use farming practices to promote sustainability of the same.

2.2 Environmental Governance and Management for Land Use Farming Practices

Governance and management are actions and decisions undertaken by state, its agencies, local authorities and actors to promote order and accountability in the use of public goods/resources (UNEP, 2010).Every sector, including environment, has unique governance and management structures, albeit with some similarity. Environmental governance and management is a concept with a supreme consideration for regulating all human activities by advocating for political, social and economic sustainability (Heynen and Robbins, 2005). Thus, in this context, environmental governance and management refers to the processes of decision-making involved in the control and prudent use the environment and natural resources(J *et al*., 2020). Therefore, it is the multi-level interactions (i.e., local, national, international/global) among others, and how all the actors interact with one another, whether in formal and informal ways to formulate and implement policies in response to environment-related demands and inputs from the society. Thus, the actors become bound by rules, procedures and processes that result in widely accepted behavior or characteristics for attaining environmentally-sustainable development(J *et al*., 2020).

Governance and management of land resource help to reduce conflicts that take place over natural resources, which are expected with increasing global population; expected to reach 8.6 billion by 2030, 9.8 billion by 2050 and 11.2 billion by 2100 (UN Environment Annual Report 2017.). This means at least 83 million people are added to the existing population each year to depend on constant or declining land resources.

In Africa, where countries are still experiencing the highest rates of population growth, it is estimated that by 2050, 26 African countries would have conflicts over natural resources unless sustainability in the usage of the same is aggressively advocated and practiced (UNEP, 2010).

Governance and management of land use farming practices involves all the processes that regulate the activities carried out on land resources. The regulation is undertaken by state, its agencies, local authorities and individual actors, among others(UNEP, 2010). The actions and decisions made at every level of regulation determine sustainability effect of the activities on usage of land resources (Ishtiaq, 2019; Willy *et al*., 2019b).

2.3 Governance and Management of Land Use Farming Practices in Rwanda

Rwanda is part of the 26 countries that urgently need to put in place mechanisms to promote and practice sustainability in and use activities(P. Gillingham and Buckle, 2014). Increasing population growth is causing increased land subdivision and fragmentation, which complicate application of sustainable land use practices(Byamugisha, 2014). Land fragmentation makes protection and supervision of the land use activities difficult(Bizoza, 2014).

Rwanda's land use governance and management has evolved through actions and decisions made during pre-colonial, colonial and post- colonial eras(Knickel, 2012). In pre-colonial era land resources were governed through customary arrangements while in colonial and post-colonial eras a combination of both customary arrangements and written laws have been used for regulation.

The colonial and post-colonial eras regulatory frameworks were also shaped by the events of the 1959 revolution and the 1994 Genocide, which caused massive displacement of people from their land resources leading to enactment of laws to correct the same(Ali *et al*., 2014; Jayne *et al*., 2016). In this regard, Rwanda has passed land laws and developed policies and institutional frameworks to govern and manage land resources in terms of access, ownership and usage. (Bizoza, 2014)

Land use governance and management framework employed in Rwanda is grounded on interest- and right-based regulatory procedures, which aim at helping to resolve claims of lost land resources and promote reconciliation(Abubakari *et al*., 2020; Biraro *et al*., 2015). Land acquisition is allowed by sale or donation through *umunani* or inheritance and every acquired land is transfer to the new owner and formally registered and updated through integrated government-based land information system(Knickel, 2012).

There are two different but related land policies in Rwanda; (i) land sharing and villagisation policy (grouped settlements), which is also known as the *Imidugudu* settlement policy and (ii) single pooled crop cultivation policy that ensure neighboring farmers to grow a single priority crop identified by the Ministry of Agriculture to suit local conditions, while at the same time retaining individual ownership of their land parcels. The two policies aim to promote food security in the rural villages by promoting economies of scale in agricultural production and at the same time inculcating equity, efficiency and sustainability.

Despite these efforts the problem of land degradation is common in Rwanda; deforestation, soil erosion, over grazing and high land fragmentation are rampant due to customary practices that encourage land subdivision(Desta, 2018). Many researchers are trying to bring out data to inform policy on how best to handle the problem(Willy *et al*., 2019b).

2.3.1 Role of Government in Regulation of Land Use Farming Practices

The national government through the Parliament and the Rwanda Land Use and Management Authority is tasked to develop laws and policies to ensure land resources are put to good use in a sustainable manner (Ryan Williamson *et al*., 2010). The mandate includes regulation of management property and estates, farming activities, mineral extraction, and urban and rural development (Desta, 2018; Knickel, 2012).

In this regard the government of Rwanda (GoR) has existing enacted land laws, developed land use policies and regulations, and provided relevant institutional frameworks for enforcement at different levels of governance and management of land use farming practices(Bizoza, 2014). Ownership of land is obtained through government appointed land control boards in order to protect households from losing land and exploitation by the rich(Desta, 2018). The government of Rwanda through the Ministry of Local Government via Rwanda Agriculture Board and related agencies also control prices of farming inputs and provision of extension services(Knickel, 2012).

The role of local governments is to provide training to community members through elders of grouped settlements; land use practices emphasized include soil erosion control, crop rotation, use of manure, use of restoration furrows, terracing and agro forestry, among others (GoR, 2015). Local governments work through community leaders and farmers associations, who work closely with the private sector for input supplies and registered NGOs, who support government extension services by directly engaging farmers (HU *et al*., 2019; A. Nahayo *et al*., 2013).

Despite the existence of such efforts and government structures of governance and management, many farmers are currently engaging in unsustainable land use farming practices, making it necessary to interrogate further why this is happening(Desta, 2018; Knickel, 2012; Mohawesh *et al.*, 2015).

2.3.2 Land Use Legal and Policy Frameworks

Rwanda has a national land policy of 2004 that provides general guidelines on use of land resources(Mohawesh *et al*., 2015). This policy promotes practices of proper use of land resources and prohibits land fragmentation by promoting consolidation of land through established single crop rural collective farmer settlements that bring together all individually owned land parcels into large consolidated parcel for one common farming activity(Desta, 2018; Willy *et al.*, 2019a). This policy was reviewed in 2017 to further transform smallholder farming activities through enhanced technology, intensification and subsidization of farming inputs(Desta, 2018).

Rwanda also have enacted land law no.43 of 2013, which provides a legal basis for the land policy of 2015, safeguards grouped farmer settlements in rural villages, defines minimum size of arable land not below one hectare, and provides processes of repossessing dormant/abandoned/poorly managed land resources(Constitution of Rwanda, 2008).

Land use is also regulated through the Rwanda's enacted organic law of 2005, which regulates fertilizer usage by promoting organic farming. This law safeguards standardization of all fertilizers used in Rwanda and provides guidelines for their application in farms (Agriculture, 1936; Ericsson and Lindberg, 2018).

2.4 Characteristics of Land and Existing Land Use Frming Practices in Mukamira Sector

Mukamira Sector is the capital of Nyabihu district in Western province of Rwanda. Unplanned housing and households are scattered on hills of high slopes and high-risk landscapes that characterizes Mukamira sector(Desta, 2018; Knickel, 2012). Agriculture is the foundation of Mukamira's economy and many households in the area engage in both the livestock and crop

production(Desta, 2018). The soils in Mukamira are fragile and vulnerable to landslides, erosion and flooding (Kabirigi *et al*., 2017).

Mukamira Sector is characterized by sloppy rugged landscapes whose farming activities make land to be vulnerable to soil erosion and degradation(Desta, 2018; Knickel, 2012). A strong relationship exists between land use practices and topography of the land being used; elevated, sloppy, densely forested, and water scarce land tend to directly relate with unsustainable farming activities (Saari *et a*l., 2020; Salaisook *et al*., 2020). Thus, in Mukamira Sector, where such topography exists, massive degradation of land resources has taken place due to farming activities. The situation has been made much worse by existence of small land parcels that must feed the farming community(Ali *et al*., 2014; P. Gillingham and Buckle, 2014). Therefore, land use practices that include continuous farming without crop rotation, poor soil erosion control, continuous use of artificial fertilizers, and deforestation through tree cutting are rampant in Mukamira Sector(Ali *et al*., 2014). The study area was necessary to unravel if the affected farmers were having requisite skills of knowledge, attitude and practices to help reverse the situation.

2. 4.1 Observed Impacts of Unsustainable Land Use Farming Practices in Mukamira Sector over the last Five Years

Declining agro forestry due to increased tree cutting and reduced tree planting has been noted in Mukamira Sector over the last five years(Lamek *et al*., 2016; Willy *et al*., 2019b). This trend has been attributed to attitudes of newer emerging generation of farmers. This trend is visible despite existence of the Ministerial Order of 2000, which prohibited tree harvesting without replacement,

and the Prime Minister's Order of 2002 and Ministerial Decree of 2003, which emphasizes on procedures for protection of trees and forests.

There has been also overgrazing noted in the drier Umutara region, in the North-western part of the Sector where higher density of grazing cattle are(Ali *et al.*, 2014; Ryan Williamson *et al.*, 2010). This, again, has happened in spite of existing Government grazing policies that regulate herding capacity and promote keeping of few high livestock breeds.

Massive soil erosion and land degradation has also been noted in the sloppy and mountainous landscapes (Nabahungu and Visser, 2011, 2013). This degradation has been attributed to poor land cultivation practices that result is increased soil run off(Ryan Williamson *et al*., 2010). Intensified cropping systems of that promote cultivation of food crops harvested twice each year has accentuated the situation. Scarcity of land has resulted in increased cultivation activities that encroach on protected areas such woodlots, wetlands and steep slopes(Ericsson and Lindberg, 2018; Williamson *et al*., 2010). Coupled with widespread use of fertilizers, this has negatively affected restoration efforts and diminished land productivity (Ericsson and Lindberg, 2018; P. Gillingham and Buckle, 2014; Williamson *et al*., 2010).

2.5 Factors Influencing the Observed Land Use Changes in Mukamira Sector over the last five years.

Negative effects of climate change and anthropogenic activities are to blame partly for the observed changes(Aplin, 2009; Nabahungu and Visser, 2011). However, governance and management enforcement frameworks have been the main blame on existing unsustainable land use farming practices(Ericsson and Lindberg, 2018). The fact that patterns of land use changes are fashioned by complex interactions between the environmental, bio-physical and social process,

both at local, national and global scale, breakdown on governance and management is likely the main cause of the observed changes(Lambin *et al*., 2003). These summarized five major causes of such land use change; economic, institutions, technology, demographic and culture change. All the five can be grouped into two major categories; direct and indirect governance and management drivers of land use changes.

Institutional factors, such as nonresponsive policies and strategic management plans, and inadequate governance structures play a major role in driving negative land use changes (REMA, 2015). These end up creating cultural factors, including poor attitudes towards sustainable use of land resources and loss of stewardship values (Shiferaw *et al*., 2011). The sum of it is acceleration of demographic factors like population pressure and negative effects on climate that end up justifying observed land use change (Lambin *et al.,* 2013).

2.5.1 The Role of Farmers Knowledge, Attitudes and Practices in resolving the Observed Land Use Changes in Mukamira Sector

The ability to recognize changes that occur on land is knowledge while the response towards the changes in land use is the attitude to act while the acted upon strategies to combat and or mange the observed changes becomes the practice (Adelfio *et al*., 2018; Xiao *et al*., 2018). Knowledge about occurring land use changes, where they are occurring and the rate of occurrence is critical in understanding and combating them. Moreover, it is imperative that awareness is also created to the actors for sustainable management(Nabahungu and Visser, 2011). Farmers have sufficient knowledge on the causes and the potential solutions to combat land use changes because over the years they have built indigenous knowledge base that enable then to survive.

Sustainability of land use is highly dependent upon knowledge, attitudes and practices of the actors on the same (Fielding *et al.,* 2016). Several studies have shown that these attributes influence the

behaviour of the actors involved in utilization of land resources in the way they interphase and interact with regulating institutions (J *et al*., 2020; Raciti *et al*., 2011). Such attributes are built through experience, formal training and social cues. Personal attitude (Dai *et al*., 2018) and psychological factors such as environmental identity and values (Fielding and Hornsey, 2016), are also important. In Mukamira for instance, farmers would embrace skills of managing land use practices by adapting strategies that ensure maximum yields and sustainable production(Ali et al., 2014; Ericsson and Lindberg, 2018; Williamson *et al.*, 2010).

2.6 Summary of Research Gap

- Despite Rwanda having key legal, policy and institutional frameworks to regulate land use farming practices, the same have failed to attain sustainable levels

- Many factors may be blamed for the failure but the main ones have come out as nonresponsive regulation enforcement and disjointed extension services for the same, which failed to build sustainability values at the farmer level

- Farmer requisite skills of knowledge, attitudes and practices are required to be built urgently to reverse the ongoing scenario of unsustainable land use practices, which are have caused degradation of land resources

- Sustainable solutions for addressing the expressed problem of land degradation can only be through obtained empirical evidence that demonstrate how the various farming actors interact with the governance instruments

- The government of Rwanda is encouraging scientists to conduct research on the topic to generate data that can inform policy on possible interventions for restoration of degraded land resources.

2.7 Conceptual and Theoretical Framework of the Study

2.7.1 Theoretical Framework

Previous authors have used institutional theory to argue out a case of failed sustainability values in a society (W. R. Scott, 2004). Institutional theory outlines a deeper and more adaptable aspects of social structure whereby the processes by which values are built by institutions that establish schemes, rules, norms, and routines, which then become accepted as authoritative guidelines for social behavior (R. . Scott, 2004).

Sustainable land use farming practices can only result from social behavior that promotes environmental sustainability(UNEP, 2010). Prudent environmental governance and management requires society values that get created, diffused, adopted, and adapted over space and time, to lead into the same being practiced over generations. Organizational structures and processes that used by institutions to propagate such values in the society must be responsive enough to build actors requisite skills (farmers knowledge, attitude and practices) in order acquire meaningful behavior at the actor level; in this the case the farmer to take care of the environment by taking personal responsibility. By so doing the farmers will acquire the pride behavior of managing land use farming practices within the documented laws, policy and institutions to help achieve stability in their own right, or decisions. Such behavior would then take a shape of sustained household decisions and actions (the mission and goals of the household), which become institutionalized to achieve desired results (Lincoln, 1995). Once institutions (in this case the households) have established norms of transmitted cultures on management of certain practices (in this case land use practices), such norms become means for shaping stable social behavior that is passed over generations (R. . Scott, 2008). Institutionalized protocols, procedures, customs and socio-cultural

norms help to shape communities in forming cultures and ethics of following laws, regulations and instructions (Hawley, 1968).

The theory will be used to argue if such elements exist in Rwanda for sustainable land use farming practices by testing farmers requisite skills (knowledge, attitudes and practices) interphase and interact with established regulatory frameworks to achieve or not achieve sustainable institutionalized behavior for effective management of land use practices.

2.7.2 Conceptual Framework

Moderating Variable
-Existing sustainable land use regulatory framework
(laws, policies, institutions)

Independent Variables	**Dependent Variable**
- Proper land use practices	-Sustainable Land use farming Practices
-Requisite skills (farmer's knowledge attitude and practices	
-Sound extension services	
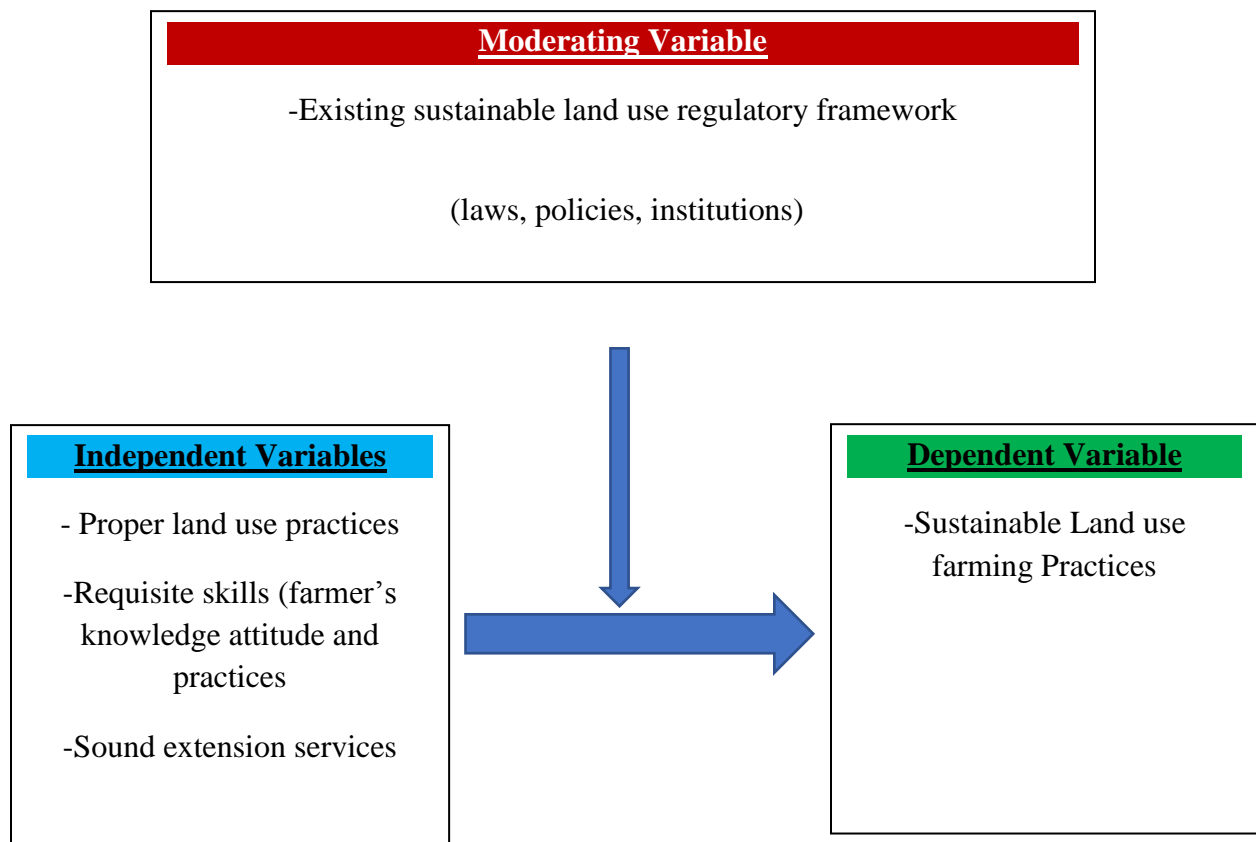
Sustainable land use farming practices (dependent variable) is determined by factors such as proper land use farming practices, requisite skills (farmers' knowledge, attitude and practices)

and sound extension services (independent variables) and the existence of sustainable land use

regulatory framework (laws, policies and institutions), which then up being the moderating

variables.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1: Study Design

The study was designed as a cross sectional descriptive survey incorporating both retrospective and prospective attributes of the governance and management of land use practices. Randomized sampling design of farming households was done in the Cells of Mukamira Sector based on their proportionate household populations. Purposive interviews of relevant key informants and data triangulation through held focus group discussions and reviewed literatures was incorporated into the design. Only farming households who had been practicing farming activities for over 12 months were included in the study.

3.2 Description of the Study Area

The study was conducted in Mukamira Sector in Nyabihu district of Western Province of Rwanda (Fig. 2). The Sector has a population of 28, 000 people living in rural farming set ups. The Sector is divided into Cell/Village administrative units. The area experiences temperate climate and has seven Cells. The area is highly sensitive to climate change and farming in the Sector relies on rain-fed subsistence agriculture but few pockets irrigated agriculture exists. The main crops of the area are cereals and vegetables, which are cultivated in predominantly rugged and sloppy landscapes. The Sector Cell units used for study were Rurengeri, Kanyove, Gasizi and Rugeshi where land use changes have been predorminant. Households are distributed uniformly in all the Cells, which represents a typical village in a densely populated African rural set up.
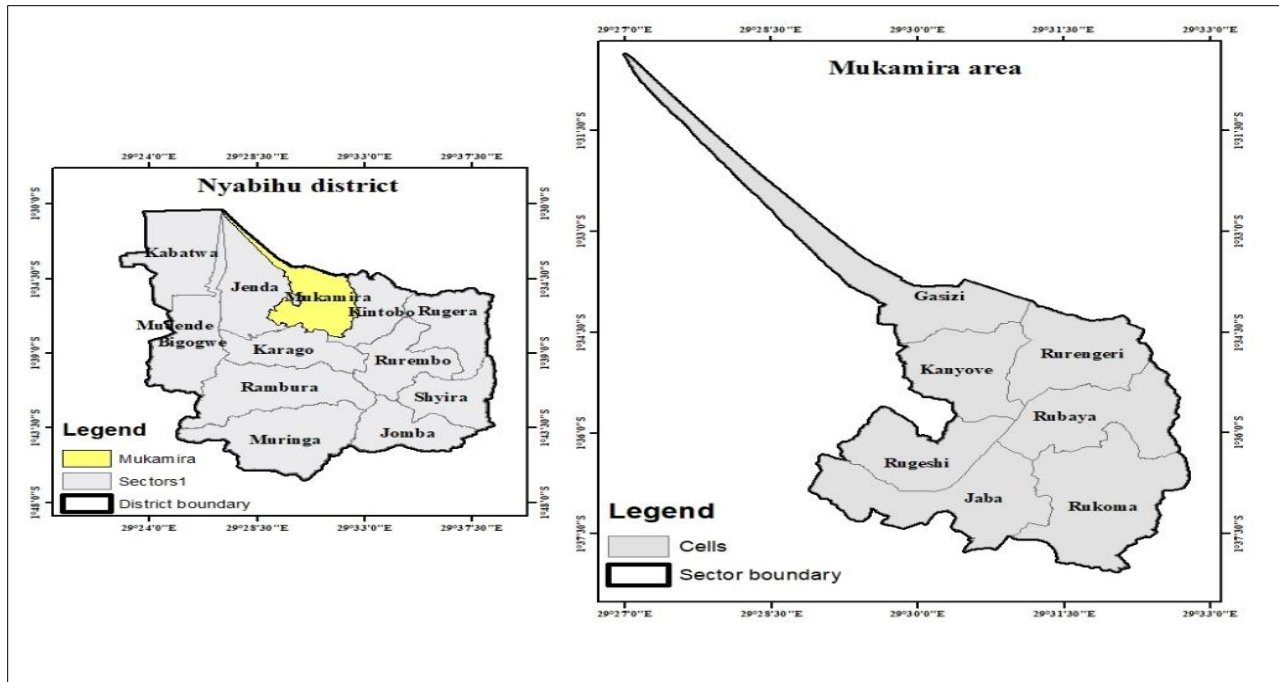
Figure 1: Map of Mukamira Sector showing the Cells

3.3: Research Methodology

Individualized household data collection was carried out using survey questionnaire, which had been developed, pretested in a reconnaissance study and modified appropriately. Only the household head (man or woman) was interviewed and questions were well explained carefully to the interviewed respondents. Household selection was done by interviewing every 10th household along the walking Cell/Village transects. Key informants were selected and interviewed in their offices. Systematic literature reviews were done to collect data on existing laws, policies and regulations that governed land use practices in Rwanda. A Participatory Rural Appraisal (PRA) exercise was also conducted in the Sector to collect data on farmers' views on existing land use farming practices and land use changes perceived to have taken place in the last five years. The PRA also facilitated the capture of the perspectives of farmers and other key actors in informing the data for management of land use practices. Personal observations were also made to observe

existing land use changes in terms of erosion and farming practices. Focus group discussions (FGDs) of 15 persons were also done to triangulate data collected during interviews, this number was found representative enough of the stakeholders.

To facilitate independence and minimize socio-cultural issues, the respondents in conducted PRA and FGDs were separated into groups with respect to gender and age. The PRA exercise was conducted with guidance of local government extension officer and emphasis was done to capture local land use practices, drivers of the practices, impacts of the practices and interventions used to curb the negative impacts of the practices.

3.4: Target Sampling Units

Households were the primary sampling units for this study. The secondary sampling units were the key informants who were selected based on their wealth of information in the sector they represented. Twelve of them were selected as shown in table below (Table 1).

Table 1: Table of Selected Key Informants

Key Informant	Sector	Numbers of KI interviewed
Environment Officer working for Rwanda Environment Management Authority (REMA)	Environment	3 (one in every Cell selected)
Land Officer at Ministry of Lands	Land	3 (one each, in charge of land acquisition, land use policies and distribution)
Officer at Ministry of Agriculture	Agriculture	3 (one specialist each, in charge in agricultural production, farm inputs and technologies)
Officers at the Ministry of Water and Natural Resources	Natural Resource Management	3 (One each, in charge of water, natural resources and conservation)

3.5: Sample Size and Sampling

A sample size of 379 farming households was used for the study. The sample size was generated from a registered number of N=7270 households in Mukamira, as calculated previously by Yamane (1967) and late modification by Mugenda Mugenda (2010), sample size (n) = N/ 1+ N (e^2) A 95% confidence level and P = 0.5 are assumed for Equation

Hence, with N=7270, then n = 7270/ [1+7270*(0.05^2)] = 379

Where n = sample size, e = 0.05.

Representative apportioning of the sample size was distributed to the four Cells (Rugeshi, Rurengeri, Kanyove and Gasizi) based on their household population as indicated in the table below (Table 2).

Table 2: Apportion Cell Sample Sizes

Cell	Household Population	Apportioned Proportion (Percentage proportion)	Sample Size
Rugeshi	2597	37%	141
Rurengeri	2496	35%	130
Kanyove	1557	22%	81
Gasizi	620	6%	27
Total	**7270**	**100%**	**379**

3.6: Data Collection

An initial reconnaissance study, as previously done by(Dikko, 2016), was done to pretest the questionnaire using 50 randomly selected respondents in Nyabihu District. The questionnaire was then amended based on the findings. Primary and secondary data was collected using a structured closed and open questions. The questions were sectioned to capture biodata information and data responsive to the three outlined objectives of the study in a chronological order. The attributes

questioned included types of existing land use practices, farmer's, knowledge, attitudes and practices for management of land use practices, and awareness of land use regulatory framework in Rwanda.

3.7: Data Entry and Analysis

Collected data filled in questionnaires, was entered into excel sheets and transported to Statistical Package for Social Science (SPSS® version 23.0) for cleaning, coding and analysis. Data was analyzed to generate tables, figures and relevant statistics. Chi-square, T-test and Multinomial Regression (Multinomial Logit (MNL) model) were used to generate the statistics, whose significance was deduced at 95% confidence level (El-Habil, 2012; Starkweather and Moske, 2013).

T-test was for comparing means of two variables (Bevan *et al*., 2016). PRA results were regressed and ANOVA was for multiple variables while Chi-Square tests were used to deduce probability of observations (X^2 *(df, N-379); P≤0.05*).

4.0 RESULTS AND DISCUSSION

4.1 Basic Data

4.1.1 Demographic Characteristics of Respondents

The demographic characteristics of the interviewed respondents are presented below (Fig 2). The age of the respondents ranged from 20 years to 61 years with the majority being 21 to 40 years of age. The most dominant farming gender was married women.
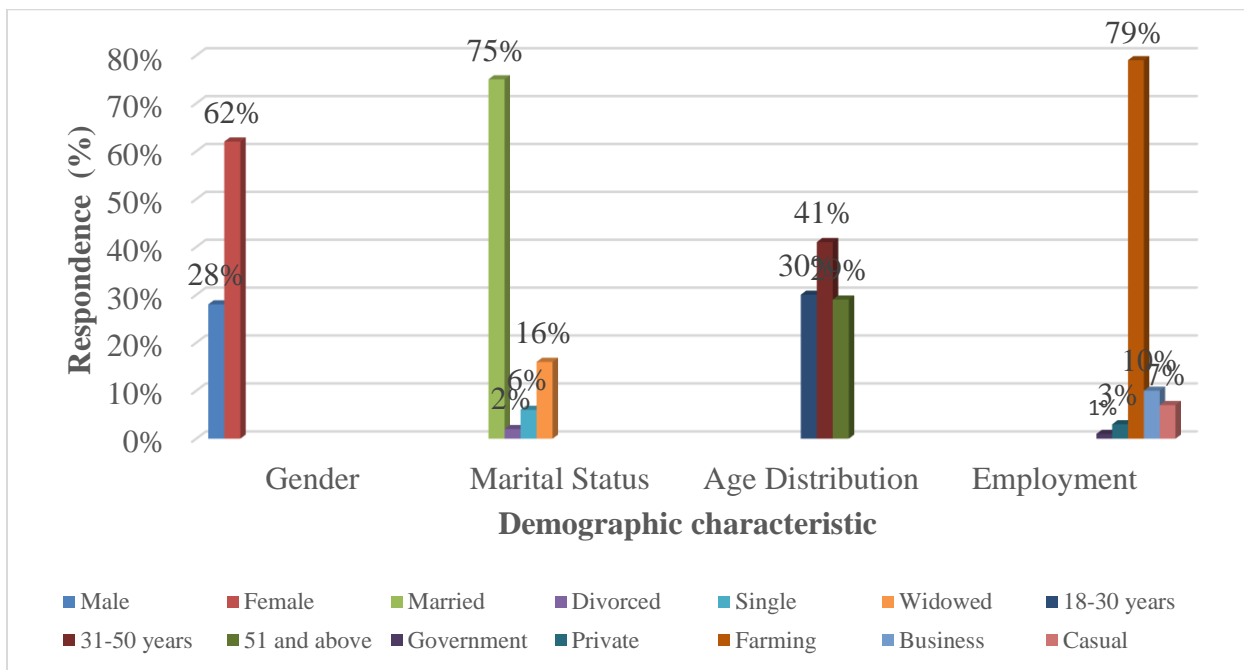
Figure 2: Demographic Characteristics and Analysis of the respondents Interviewed

The results indicate a significant youthful married female-dominated farming sector X^2(5, N=379) =7.35, P=0.02). This finding is in agreement with the observation that youthful population participate in farming activities(Mukanyandwi *et al*., 2018a)and that newer emerging trends of youthful farmers in Rwanda where women make farming household decisions (K. Gillingham and

Palmery, 2014). This segment of the population would be useful in extension and implementating sustainability values in terms of land use practices(Bryan *et al*., 2016; Cioffo *et al*., 2016; Huggins, 2014a; Willy *et al*., 2019b)

4.2 Results for Objective 1: Existing Land Use Farming Regulatory Framework in Rwanda

4.2.1 Existing Land Use Legal Instruments

The table below shows a list of existing legal instruments and what each of them regulates in relation to land use in Rwanda (Table 1).

Table 3: Existing Land Use Legal Instruments and what each of them regulate in Rwanda

Legal Instrument	What is regulated	Action Point
The Constitution of Rwanda 2017(A), Article 30	Land ownership and the related rights, including private ownership, selling and acquisition	Parliament, Rwanda Land Use and Management Authority, Ministry of Local Government, land boards
The Constitution of Rwanda 2017(A), Article 49	Entitlement to a clean and healthy environment, Protection and safeguard of environment and citizens' obligation/duty to protect and safeguard the environment	Ministry of Environment, Rwanda Environmental Management Authority (REMA), Ministry of Local Government
Law no. **43/2013** of Rwanda revised the organic land law of **2005**	land use consolidation; management of unused, grouped settlements in rural areas; prohibition of subdividing agricultural land that would generate parcels below one hectare; utilization of abandoned or poorly managed land and allocation and leasing of marshlands	Executive Government of Rwanda, Judiciary, Ministry of Agriculture
National Agriculture Policy (NAP, 2017 Pillar 1	Development and promotion of a sustainable agricultural intensification and a resilient agricultural sector	Ministry of Agriculture (MINAGRI), Rwanda Environment Management Authority (REMA)

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| National Agriculture Policy (NAP) 2017 Pillar 2 | Restoration, preservation and enhancement of landscapes and natural resources | Ministry of Agriculture, Ministry of Environment, REMA, Ministry of Local Government, Rwanda Land Use and Management Authority |
| National Agriculture Policy (NAP) 2017 Pillar 4 | Effective, Enabling Environment and Responsive Institutions | Ministry of Agriculture, Ministry of Environment and REMA |

The data shows that there are elaborate laws and policies in Rwanda that regulate land use. The finding agrees well with government reports(A, 2010; Lamek *et al*., 2016). Regulatory framework are the key governance instruments in supporting sustainability of the regulated actions(Clay and Lewis, 1990; Mukanyandwi *et al*., 2018b; Nyenyezi Bisoka *et al*., 2020). The existing regulatory framework for governance and management of land use practices could play a major role in supporting institutions tasked with the implementation the practices(Clay and Lewis, 1990; Mukanyandwi *et al*., 2018b; Nyenyezi Bisoka *et al*., 2020).

4.2.2 Land Use Regulatory Institutional Framework and the Means of Enforcement

Table 4 shows land use regulating institutions and the instruments they utilize to enforce the process.

Table 4: Rwandan Land Use Regulating Institutions and the means used to enforce the Process

Regulator	Means of Enforcement
Rwanda Environmental Management Authority (REMA)	Permits, EIA/A, REA, SEA, Easements, Arrest, Fines, Jailing
Rwanda Standard Board (RSB)	Approvals on use of fertilizers, farming chemicals/ insecticides

Rwanda Water and Forestry Authority (RWFA)	Permits, forced acquisition and use of forests and water resources, reclamation, and easements
Rwanda Land Management and Use Authority (RLMUA)	Permits, police and regulation guidelines regulations on land use, urban and rural developments, and types of farming practices
Water and Sanitation Corporation (WASAC)	Permits for effluent discharge and management, Police and regulation guidelines enforcement on land use activities and management

The results indicate that there is institutional framework in Rwanda to regulate land use farming practices. This finding is also in agreement government reports(A, 2010; Lamek *et al.*, 2016). Institutional frameworks are important pillars of enforcement of governance instruments through the mandate of the institution. The institutions usually control and monitor land use practices*(Cioffo et al., 2016;* J. lin Li *et al.,* 2019*;* Nyenyezi Bisok*a et al.,* 202*0;* Ozsahi*n et al*., 2018). Effective enforcement of regulatory laws, policies and regulations by institutions foster governance and management sustainability(Cioffo *et al*., 2016).

4.2.3 Existing Land Use Institutional Legal Obligations

A summarized legalized supportive role played by various institutions on land use farming practices in Rwanda, as enlisted by farmers and Key Informants are presented below (Table 5).

Table 5: Summary of the Land Use legalized roles played various Institutions

Government	Community based organizations/ associations	NGOs
✓ Land use policy and regulatory directions ✓ Building terraces ✓ Providing agronomists to capacity build farmers ✓ Educating the public on environmental protection ✓ Providing subsidized agricultural inputs ✓ Controlling application and use of fertilizers ✓ Training of local leaders ✓ Planning agro forestry	✓ Procurement and distribution of agricultural inputs to farmers ✓ Community land use strategies ✓ Awareness creation for government policies ✓ Encouraging public to register and participate in development programs ✓ Community/village meetings ✓ Sensitization of the public on emerging technologies and improved farming methods ✓ Local training on sustainable land use practices like erosion control measures	✓ Identifying and helping the needy farmers ✓ Providing local support to farmers through agricultural initiatives ✓ Offering training to farmers

These results indicate efforts the Government of Rwanda have put in place to support land use farming practices. This is in agreement with reports that observed involvement of the government through her agencies, extension service officers, local leaders and NGOs to engage farmers on land use practices (Nahayo *et al.,* 2013; GoR, 2015). Such roles are essential in supporting sustainability in terms of awareness creation through training and demonstrated skills by service providers(Chigbu *et al*., 2017; Cioffo *et al.*, 2016; Clay and Lewis, 1990; Mukanyandwi *et al*.,

2018b). Such processes help to create impacts of initiatives extended to the farmers like subsidized

inputs (Bizimana *et al*., 2004; Chigbu *et al*., 2017; Mwanjalolo Jackson-Gilbert *etal*., 2015)

4.3 Results for Objective 2: Knowledge, Attitude and Practice of the farmers on Land Use Practices

4.3.1 Farmers' Source of Knowledge on Land Use Practices

Sources of farmers' knowledge on sustainable land use as shown in Figure 3.
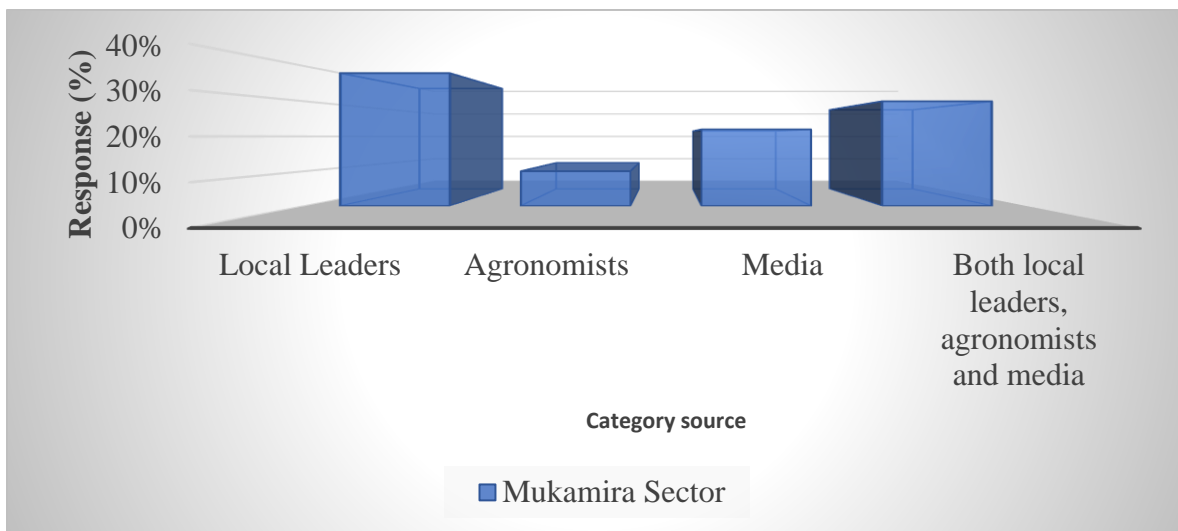
Figure 3: Sources of Farmers Knowledge on Sustainable Land Use Practices

The results indicate significant source of farmers' knowledge coming from local leaders and media X^2 (5, N=379) = 5.64, P = 0.025), the media and local leaders play a significant role in policy dissemination in Mukamira. This finding is in agreement with previously observed involvement of local leaders and the media in farmer education on land use practices (Mukanyandwi *et al*., 2018b). Sources of knowledge are critical in creating sustainability of land use(Clay and Lewis, 1990; Karamage, Shao, *et al.*, 2016; Karamage, Zhang, *et al.*, 2016; Mukanyandwi *et al*., 2018b; Woldemariam and Harka, 2020)The system of providing information to farmers by agronomists,

local leaders and media on sustainable land practices are avenues for creating networks of knowledge sharing good practices(Cioffo *et al.*, 2016; Huggins, 2014a; Mukanyandwi *et al.*, 2018b).

4.3.2 Farmers' Knowledge of Existing Legal and Institutional Frameworks for Governance and Management of Land Use Practices

Majority of the respondents (70.8%) were aware of the existence of the frameworks (Fig. 4).
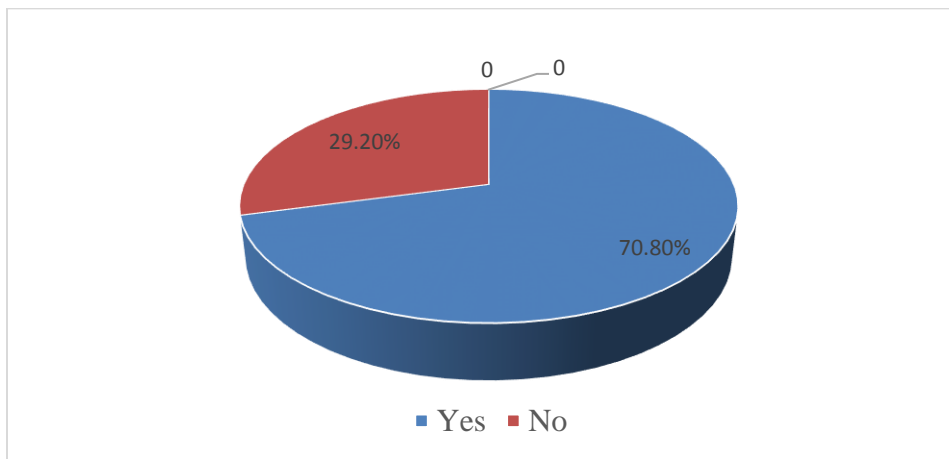
Figure 4: Respondents Knowledge on existence of Legal and Institutional Frameworks for Governance and Management of Land Use practices

Knowledge of existing laws, policies and regulations empowers the farmers to practice land use in accordance with laid down instrument, albeit, without personal defiance in spite of the existing instrument; they use the knowledge to make informed personal choices(Ansoms and McKay, 2010; Mukanyandwi *et al.*, 2019; Nyenyezi Bisoka *et al.*, 2020).

4.3.3 Farmers' Perceived Impact for Existing Legal and Institutional Frameworks on Land Use Practices

The PRA results on percentage of respondents who acknowledged the instruments created impact and the rating of created impact for various legal instruments on regulation of land use farming practices is presented below (Table 6).

Table 6: Percentage of Respondents who perceived created impact and their rating of the Impact created Land Use Practices in a PRA exercise

Legal Instrument	Percentage acknowledging impact	Rating of the impact created
National Agriculture Policy	75% ±0.03[a]	Satisfactory
Private Sector Development Strategy Policy	65% ±0.03 [a]	Fair
Rwanda's Vision 2020 Policy	70% ±0.03 [a]	Satisfactory
The Crop Intensification Program Policy	78% ±0.03 [a]	Satisfactory
Livestock Policy	90% ±0.03 [a]	Good
National Land laws	87% ±0.03 [a]	Good

[a] *denotes significantly high while the converse is true for [b]; $P \leq 0.05$*

A significant percentage of the respondents acknowledged the existing legal instruments have created impact on governance and management of land use practices and with a significant rating the impact fairly well ($P \leq 0.05$). Public perception of legal instruments ability to regulate actors practices plays a critical role in solidifying the implementation of such instruments, especially if viewed positively(Bizimana *et al*., 2004; Byamugisha, 2014; Nyenyezi Bisoka *etal*., 2020)

4.3.4 Farmers Attitude towards Regulation of Land Use Practices

Sixty-five percentage (65%) of the respondents had a favorable attitude towards regulation of land use practices based on likert scale analysis. However, the remaining 35% were reluctant to shift from their traditional farming practices. Those with favorable attitude indicated the regulations will be useful to stop the occurring land degradation and soil erosion, thereby offering a benefit of increased soil fertility and better yields. This finding is in agreement with observations that farmers can agree to have regulated farming activities whenever there are perceived benefits to them(Cioffo *etal*., 2016; Jerome, 2010; Mwanjalolo Jackson-Gilbert *et al.*, 2015).

4.3.5 Sustainable Land Use Activities Practiced by Farmers

The significant (X^2(5, N=379) =6.71, P=0.03) sustainable land use activity practiced by farmers in Mukamira Sector was terracing (Fig. 5). Both radical (*earth moving operations to create reverse slope terraces*) and progressive (*bench terraces progressively expanded*) terracing were practiced. Other activities practiced are also in indicated in the same Figure 5.
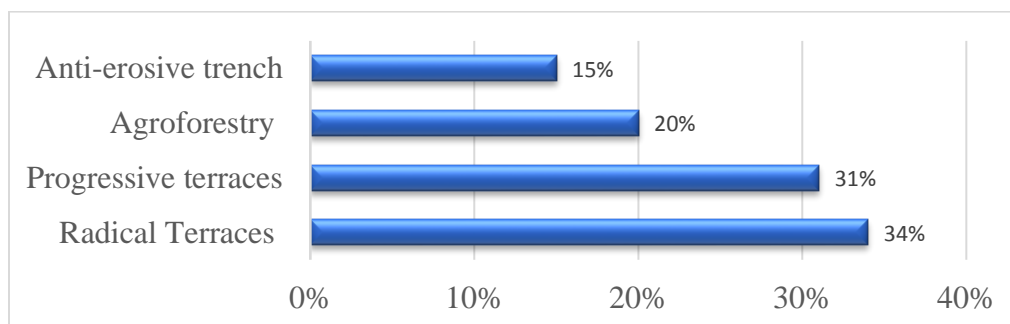
Figure 5: Sustainable land use activities Practiced by farmers in Mukamira Sector

The results indicate farmers are willing to engage in land use sustainability values as observed previously by other authors, who also reported that activities undertaken by farmers are dependent on land topography, farmers' level of knowledge and individual farmer choices (Karamage *et al*., 2016; Mwanjalolo Jackson-Gilbert *et al*., 2015). Once farmers perceive a benefit of increased land productivity, they can engage in any recommended sustainability land use practices(Clay and Lewis, 1990; Huggins, 2014; Ozsahin *et al*., 2018).

4.3.6 Role of Various Actors in supporting Practice of Sustainable Land Use Activities by Farmers

The respondents indicated they received support from government, local leadership and NGOs to enhance their sustainable land use (Fig. 6). The role played by the government was significantly higher but did not differ across the services it offered to farmers (P=0.073).
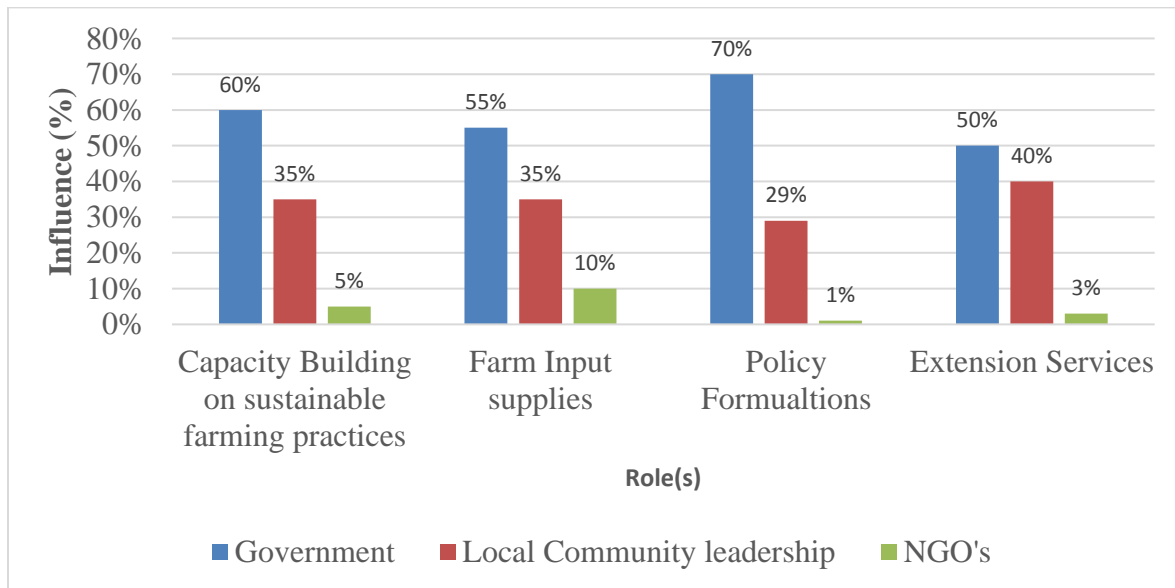
Figure 6: Indicated Supportive Roles Played by the Government, Local Leadership and NGOs in Enhancing Sustainable Land Use Practices in Mukamira

Services such as policy guidelines, training of farmers, and extension services serve to boost and build confidence to farmers' efforts in practicing sustainable land use activities (Hakorimana *et al.,* 2018; Nambajimana *et al.,* 2019). Technical backup to farmers has been demonstrated as powerful institutional instrument for ensuring sustainability building in terms of community empowerment(Chigbu *et al*., 2017; Dawson *et al*., 2016; Mwanjalolo Jackson-Gilbert *et al*., 2015).

4.3.7 Farmers' Perceived Impact for Existing Technical Support for sustainable Land Use Practices by various Actors

During a PRA exercise the respondents expressed that both the government and the local leadership have done a satisfactory role of supporting sustainable land use farming practices. However, the NGOs role was rated as not satisfactory (Table 7).

Table 7: Farmers Perceived Impact of Existing Technical Support for sustainable Land Use practices by various actors

Actor	Satisfactory	Not Satisfactory
Government	78.7% $\pm.04^a$	21.3% $\pm.01^b$
Local Leadership	60.9% $\pm.03^a$	39.1% $\pm.02^b$
NGO's	19.6% $\pm.01^a$	80.4% $\pm.04^b$

^{a} denotes significantly high while the converse is true for ^{b}; P≤0.05

Farmers perceived benefits of technical assistance by actors helps in building a cooperative and collaborative working relationship that foster synergetic sustainability of mutual efforts while the reverse leads to hostility and breakdown on synergy(Cioffo *et al*., 2016; Dawson *et al*., 2016; Gwaleba and Masum, 2018). Actors need to create positive perceptions at the farmer level if at all

they expect the farmers-buy-in for the introduced practices(Ericsson and Lindberg, 2018; Mann and Berry, 2016; Nyenyezi Bisoka *et al.*, 2020).

4.3.8 Farmers' Practiced Land Use Activities and their Perceived Impact on Sustaining the Land Resource

During the PRA exercise the farmers provided a list of the land use activities they practiced and their perception on whether they promoted sustainability of the land resources (Fig. 8). It is worth noting that crop rotation and leaving degraded land empty for restoration got low approvals by farmers.

Table 8: Farmers practices and their perceived impact on sustainability of land resources

Practice	Farmers Practicing (%)	Perceived Impact on sustainability
Crop rotation	40% $\pm.02$ [b]	Poor
Terracing	82% $\pm.04$ [a]	Good
Use of natural manure	60% $\pm.03$ [a]	Satisfactory
Use of artificial fertilizer	65% $\pm.03$ [a]	Satisfactory
Leaving degraded land empty	30% $\pm.02$ [b]	poor
Intercropping and mulching	70% $\pm.04$ [a]	Satisfactory

[a] *denotes significantly high while the converse is true for* [b]*; P≤0.05*

The farmers rating and perceived impact of practices have been observed to be critical is farming behavior, unfortunately, albeit some having negative effects on sustainability of land resources(Cioffo *et al.*, 2016; Clay and Lewis, 1990).

4.4 Results for Objective 3: Observed Land Use Changes in Mukamira Sector for the last five years

4.4.1 Observed Land Use Changes

The farmers and Key Informants list of observed land use changes in the various Cells of Mukamira Sector are presented below (Table 9).

Table 9: Observed Land Use Change in Mukamira over the last Five Years

Observed Change	Cell				Rated Extent of Occurrence		
	Rugeshi	**Rurengeri**	**Kanyove**	**Gasizi**	**Low**	**Moderate**	**High**
Declined soil fertility	-	Yes	Yes	Yes		Yes	
Increased soil erosion	Yes	Yes	-	Yes			Yes
Erratic rainfall patterns	-	Yes	Yes	Yes		Yes	
Drying rivers/streams	Yes	Yes	-	Yes	Yes		
Reduced grazing grasslands	Yes	-	Yes	Yes		Yes	
Increasing water resource related conflicts	-	Yes	-	Yes	Yes		

Yes = Approval of variable/relationship

The farmers admitted land use changes that have negatively impacted on their land resources have taken place in the last five years. This agrees with previous observations that agricultural activities are causing land use changes with far reaching effects on farmland(Chigbu *et al*., 2017; Karamage, Zhang, *et al*., 2016; L. Nahayo *et al*., 2016) that affect agricultural production(Huggins, 2014; Zhang *et al*., 2019; Woldemariam and Edo Harka, 2020).

4.4.2 Impact of Observed Land Use Changes

The farmers and Key Informants provided a list of the impacts they have associated with the observed land use changes as summarized below (Table 10).

Table 10: Impacts of Observed Land Use Change

Noted Effect	Increased	Decreased
Soil erosion	Yes	-
Soil resource related conflicts	Yes	-
Water related conflicts	Yes	-
Grazing related conflicts	Yes	-
Acreage productivity	-	Yes
Household food security	-	Yes

Yes = Approval of variable/relationship

The indicated impacts, which have affected farming have been observed by other authors(Cioffo *et al.*, 2016; Mann and Berry, 2016; Mukanyandwi *et al*., 2018a; L. Nahayo *et al*., 2016; Nyenyezi Bisoka *et al.*, 2020)

4.4.3 Causes of the Land Use Changes

The farmers and Key Informants also provided a list of what they perceived as the cause of the observed land use changes as shown below (Table 11).

Table 11: Farmers' Perceived Causes of the Observed Changes

Factor	Caused	Did not cause
Poor household decisions	Yes	
Reduced extension services	Yes	
Non-implemented laws	Yes	
Subsidizing fertilizers and seeds	Yes	
Other causes (attitude and natural/sociopolitical)	Yes	

Yes = Approval of variable/relationship

Further, the Key Informants information indicated that attitude of farmers had no influence (Fig. 7) but their level of knowledge slightly influenced the changes (Fig. 8). However other factors like

natural, demographic, political, economic and social causes were also suggested at varying degrees (Fig. 9).
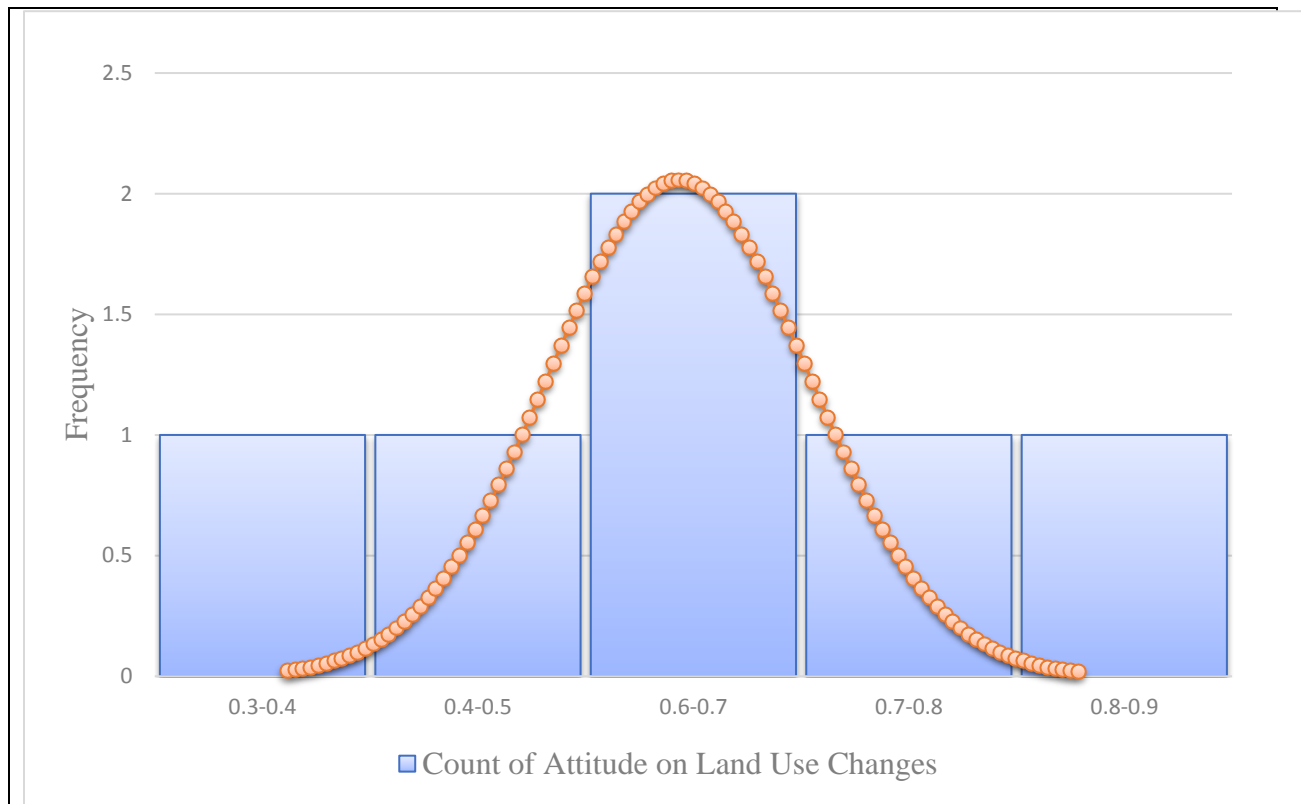
Figure 7: Influence of Farmers' Attitudes on Land Use Changes
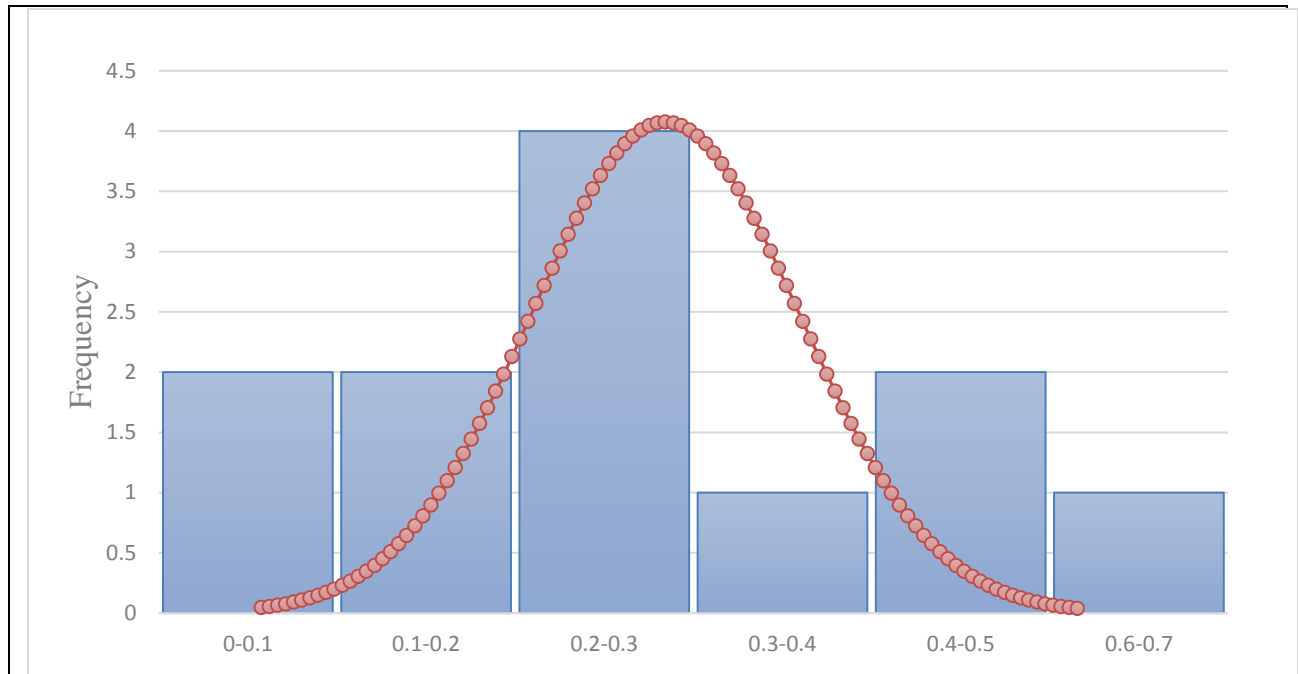
Figure 8: Influence of Knowledge on Land Use Practices
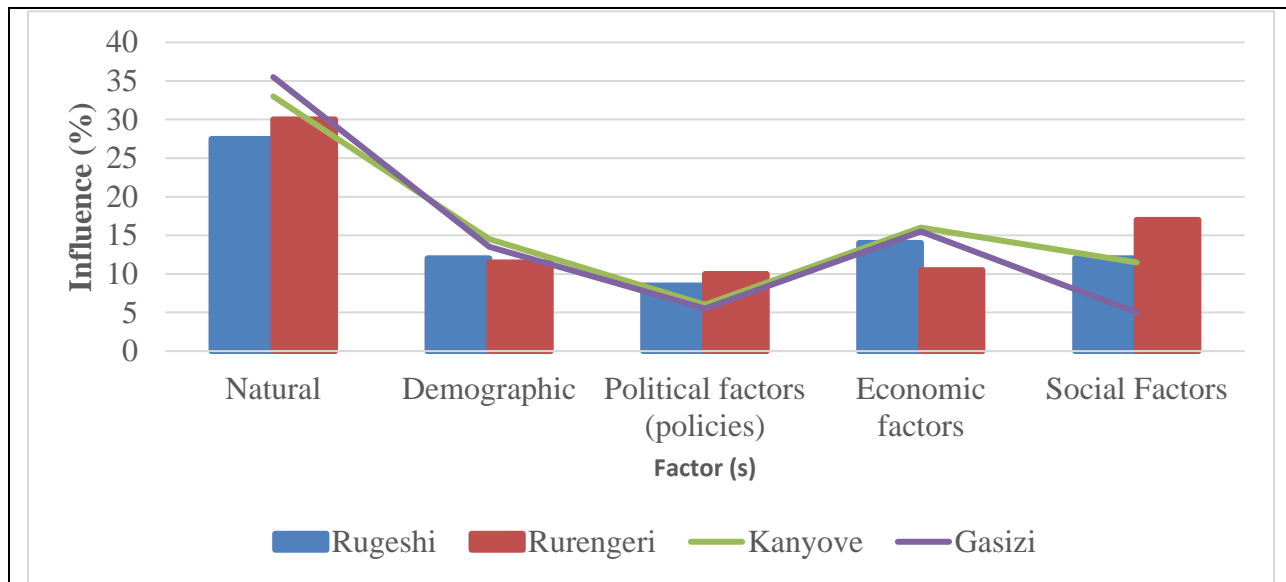
Figure 9: Other Causes of Observed Land Use change

An understanding of the contributory causes of land use changes is important in developing interventions to curb the same(Ansoms and McKay, 2010; Mukanyandwi *et al*., 2019; Nyenyezi

Bisoka *et al.*, 2020). It is important to note that the farmers' attitudes did not influence the changes, an attribute to suggest they are not likely to defy introduced interventions. Other factors such as unforeseen natural occurrences, and demographic, political, economic and social factors, have become increasingly important in driving land use changes, unfortunately, negatively (Aiginger, 2006; Huggins, 2014b; Nuhu, 2019). *Urugumo/Konesha*, a Rwandan socio-cultural practice by young men to release animals into other people's farmland has been cite as the main destructive socio-cultural factor causing land degradation (Gwaleba and Masum, 2018; Hakorimana *et al.*, 2018).

4.4.4 Farmers' Approval Rating of Suggested Interventions for to improved Practices

The farmers PRA approval rating for various interventions to improve land use practices are summarized below (Table 12); ranked on a Likert scale of 1 to 5, whereby 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5=strongly agree).

Table 11: Farmers' Approval Rating for Interventions to curb negative Land Use Changes

Statement	1	2	3	4	5	Total
Enforcement of regulations	24%	26%	40%	10%	-	**100%**
Enhanced terracing by farmers	45%	25%	21%	7%	2%	**100%**
Improved household responsibility	1%	7%%	6%	24%	62%	**100%**
Use of subsidized services	3%	10%	19%	30%	38%	**100%**
Individual Farmer efforts to act	15%	6%	3%	12%	64%	**100%**
Increased use of natural manure	1%	3%	10%	20%	66%	**100%**
Increased agroforestry	1%	8%	55%	30%	6%	**100%**
Use of integrated soil fertility practices	-	3%	30%	16%	51%	**100%**
Reduced use farming chemicals	10%	1%	21%	30%	38%	**100%**
Use of modern farming technologies	5%	10%	44%	20%	21%	**100%**
Improved research and extension services	-	1%	64%	30%	5%	**100%**

It can be noted from the results that the farmers recognized that such practices like improved terracing, application of natural manure and farmer individual drive to act, are the needed interventions to reverse negative land use changes that have been occurring in Rwanda. This is in agreement other observation that suggested localized solutions from affected as the most sustainable way of dealing with practices that degrade land resources(Gwaleba and Masum, 2018).

4.4.5 Farmers' Perception on whose responsibility it is to manage land use farming practices in farms

In a PRA exercise the farmers provided their rated perception on whose responsibility it is to manage land use practices in farms as summarized below (Table 13); ranked on a Likert scale of 1 to 5, whereby 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5=strongly agree).

Table 13: Farmers' Perception on who should be responsible to manage Land Use Practices in farms

Whose responsibility it is to manage land use practices	1	2	3	4	5	Total
National Government	-	10%	14%	54%	22%	**100%**
Farmers	1%	7%	6%	24%	62%	**100%**
Community	3%	10%	19%	30%	38%	**100%**
Local leaders	3%	10%	19%	30%	38%	**100%**
Extension Officers	1%	8%	6%	30%	55%	**100%**
NGOs	64%	6%	3%	12%	15%	**100%**

The results show that as much as the farmers accept to be part of those responsible for management of land use practices, other actors like the national government, community members, local leaders and the extension officers are also required to be part of that responsibility. This is in agreement

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with previous observations that suggest multilevel actor involvement is required to attain sustainable management of natural resources, including land resources(UN General, 2015; Gwaleba and Masum, 2018; Willy *et al.,* 2019)

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The study has concluded the following from the presented results: -

- There are elaborate legal and institutional frameworks for regulating land use practices in Rwanda, which are well safeguarded by the constitution, enacted laws and institutions with spelt out mandate roles

- Farmers have expressed inadequacies in their requisite skills for sustainable land use farming practice management that is caused be declining government extension services

- Farmers have observed various land use changes that have occurred in the last five years that require urgent management interventions, some of which they highlighted and provided the actors responsible for their execution, including themselves

- Farmers have expressed willingness to cooperate with the government and others actors to address what they expressed as land use practices affecting the productivity of the land resources and reduced yields

5.2 RECOMMENDATIONS

Informed by the concluded observations, the following are suggested: -

- There is need for the government to engage the farmers to fully understand why unsustainable land use farming practices are being carried out by farmers in spite of existence of elaborate legal and institutional frameworks for regulating the same

- The various actors, including extension officers, NGOs and local leaders, who are mandated with training of farmers on requisite skills for sustainable land use farming practice management need to enhance their concerted efforts in doing so at farm level

- There is need by the government to come up with a farmer friendly programme to address the observed negative land use changes, especially through a multilevel approach that involve the farmers

CHAPTER SIX

6.0 REFERENCES

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CHAPTER SEVEN

7.0 APPENDICES

7.1 APPENDIX 1: HOUSEHOLD SURVEY QUESTIONNAIRE

Section A: Introduction

Good morning/ afternoon, my name is **Irene Mutesi**, a student undertakimg a Master's degree in Environmental Management and Governance at University of Nairobi; Wangari Maathai Institute for Peace and Environmental Studies. My research seeks to assess drivers of land use changes/practices that influence Sustainable soil fertility in Mukamira Sector, Rwanda

The information you give in response to this questionnaire will be treated with utmost confidentiality and use only for the purposes of this study.

Section B: Household Head Bio-data

1. Name: (Optional) …………………………………………………………………

2. Age:

   ☐18years- 20 years   ☐21years- 25years☐26years- 30years

   ☐31 years –35years   ☐ 36years- 40yeas   ☐41years- 45years

   ☐46years- 50years   ☐51years-60years   ☐61years and above

3. Gender:

   ☐Male   ☐Female

4. Marital status:

   ☐Single   ☐Married   ☐Widowed   ☐Divorced

5. Sector……………… Village……………………Cell…………………

6. How long have you lived here?

☐ 1- 5 years ☐6- 10 years

☐ 11-15 years☐16- 20years   ☐over 21 years

10. Number of household members: …………………………………….

11. What is the current livelihood of the household?

    ☐ Government employment

    ☐ Private sector employment

    ☐ NGO employment

    ☐ Farming

    ☐ Business

    ☐ Casual employment

    ☐ Others (specify)…………………………………………………

Section C: Land Use Legal and Institutional Frameworks

1. Are you aware of policies/laws/ regulations regulating farming in your village?

    ☐ Yes

    ☐ No

If yes, how do you get information?

☐ By media

☐ By local leaders

☐ By agronomists

☐ By other people/ specify……………………

2. What policies/laws/ regulations are already in place that regulate farming practices in your village?

       ☐ Land use consolidation

       ☐ Grazing

       ☐ Terracing

       ☐ Fertilization and soil nutrient management

       ☐ Erosion control

       ☐ Seeds and planting material

       ☐ Pesticides (including eco-friendly and others)

       ☐ Others/specify…………………………………………………..

3. Does the government involve you in policy/regulation formulation?

    ☐ Yes

    ☐ No

If yes, how?

If no, why? (*Tick√ the appropriate)*

  ☐ There are only selected individuals who represent us

  ☐ We're not part of the decision-making process

  ☐ I don't know

4. What are major institutions and stakeholders involved in policy formulation in your area?

      ☐ Ministry for Agriculture

      ☐ Ministry for Environment

- ☐ Ministry of Local Government

- ☐ Rwanda Agriculture Board

- ☐ District

- ☐ NGOs

- ☐ Sector

- ☐ Cell

- ☐ Village

- ☐ Other, please specify……………………………………………

5. Identify and describe any existing strategies being put in place to promote sustainable land use practices?

By Government _____

By Local Community_____

By NGOs _____

By others _____

6. How would you rate their efforts? (Tick √where appropriate)

	Excellent	**Satisfactory**	**Poor**
Government			
Local Community			
NGOs			
Others, specify			

Section D: Farmers KAP and Farming Practices

1. What are the major factors that affect decision making related to land use?

    Natural factors _____

    Demographic factors _____

    Political factors/policies _____

    Economic factors _____

    Socio-cultural factors _____

2. What do you use your land for in this village?

    ☐ Agriculture

    ☐ Livestock grazing

    ☐ Forest

    ☐ Residential

    ☐ Other (Specify): …………………………………………..

3. How do you do your farming practices

    ☐ Traditional

    ☐ Intensive

    ☐ Extension services

    ☐ Mechanization/Machinery

    ☐ Land Use Consolidation

    ☐ Fertilization and soil nutrient management

☐ Pest management and plant protection

☐ Others (specify)

4. What major shifts on land use change are you able to observe? (Tick √where appropriate)

	Increased	Decreased
Crop land (Irrigated)		
Crop land (Rainfed)		
Forest Land		
Bushland		
Grassland (Private)		
Grassland (Communal)		

5. Please mention the changes (Tick √where appropriate)

Change	Yes	No
Natural forest being converted into cropland		
More infrastructure; roads and buildings		
Modern methods of farming practices		
Wetlands being converted into farmlands		

6. What are the causes of land use changes? *Tick√ where appropriate*

- ☐ Livestock grazing

- ☐ Agricultural activities

- ☐ Fuel wood collection

- ☐ Charcoal burning

- ☐ Deforestation (tree felling)

- ☐ Others (specify)

7. Is your land protected against erosion?

- ☐ Yes

- ☐ No

If yes, what do you use?

- ☐ Radical Terraces

- ☐ Progressive terraces

- ☐ Agro-forestry

- ☐ Anti-erosive trench

☐ Others (specify)

If No, why? _____

8. Have you taken any of the following measures to conserve natural wetland areas? (Please check all that apply)

☐ Rotational grazing

☐ Fencing

☐ Alternative watering sources

☐ Water control structures/dams

☐ Other (please specify)

9. What types of soil degradation are prominent in your locality? *Mark all applicable*

☐ Gully erosion

☐ Soil erosion

☐ Soil fertility decline

☐ Others, specify

10. What methods do you typically use to manage the areas on your farm operation that are adjacent to natural sources of water? (*Please check all that apply*)

☐ Leave area permanently vegetated

☐ Plant additional vegetation

☐ Plant a winter crop cover

☐ Livestock fencing

☐ None

☐ Other (please specify)

11. How do you manage your crop residues? (Please check all that apply)

☐ Chop straw and spread

☐ Bale straw

☐ Burn straw

☐ Other (please specify)

12. What are the priority things that need to be addressed in your locality to improve soil
fertility? *Mark all applicable*

☐ Inadequate trainings and capacity building

☐ Poor policy implementations

☐ Resource use conflicts

☐ Soil erosion

☐ Frequent flooding

☐ Food shortage

☐ Poverty

☐ Others, specify ……………………………….

13. Do you apply any organic fertilizer? Explain

☐ Yes

☐ No

14. Do you apply any chemical fertilizer? Explain

_____

_____

15. Do you apply any herbicides, insecticides or fungicides to your crops? Explain

☐ Yes

☐ No

16. Which type of herbicides/pesticides/insecticides do you use in your farm?

☐ Herbicide; _____

☐ Pesticide; _____

☐ Insecticide; _____

17. Did you have any of the following grazing livestock on your land? (Please check all that

apply)

☐ Cattle (Dairy and/or Beef)

☐ Sheep

☐ Goats

☐ Other (please specify)

18. Did you practice a system of moving your livestock to different pastures or grazing

paddocks throughout the growing season (rotational grazing)?

☐ Yes

☐ No

19. How many animals do you own on your farm?

_____

20. What is the size of your farmland?

    ☐   1 Less than ½ ha

    ☐   ½ ha-1ha

    ☐   1ha -2ha

    ☐   Greater than 2ha

Section E: Farmers Attitudes Land Use and Observed Changes

In a scale of 1 to 5, please indicate to what extent do you agree with the following statements; 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5=strongly agree

Statement	1	2	3	4	5	Total
Sustainable land use management is the responsibility of the government and not mine						
Building terraces on farmlands is the responsibility of the government and not mine						
It's my responsibility to ensure proper land use practices						
It is the responsibility of the government to provide farm inputs and incentives						
I use fertilizers as a please because it's my farmland						

Use of farm remains as organic manure is ideal for fertility improvement					
Burning charcoal does not harm the environment					
Land degradation is natural and there is nothing I can do about it					
The solution to farm soil fertility issues lies in integrated soil fertility management					
Human beings are responsible to the problems affecting the soils					
The environment is sacred and should be taken care of					
Human beings are superior over nature and can use the resources as they please					
Efficient use of fertilizer can help improve soil fertility					
Traditional methods of farming are effective in improving soil fertility					

Science holds the solutions to land use problems in Rwanda						

Section F: Farmers Knowledge and Causes of Land Use changes

1. What are the main pressures over the land resources due to population growth in your village?

   ☐ Deforestation

   ☐ Overgrazing

   ☐ Poor and traditional agricultural practice

   ☐ Land/soil degradation

   ☐ Urbanization

   ☐ Watershed degradation

   ☐ Other (Specify): ………………………………………..

2. Kindly tick the causes for population growth in your villages in the list below:

   ☐ High birth rates

   ☐ Poor housing

   ☐ Poor legal enforcement

   ☐ Lack of community awareness

   ☐ Low knowledge

   ☐ Lack of public participation in planning and implementation of environment policies

   ☐ Other (specify)…………………………………………

3. Do you think high population growth has significant impacts on the environment in your Village?

   ☐ Yes

   ☐ No

If yes, what are the environmental impacts due to population growth in your area?

- ☐ Increased soil erosion

- ☐ Loss of forest and vegetation cover

- ☐ Loss of biodiversity

- ☐ Loss of soil nutrients

- ☐ Loss of water

- ☐ Other (specify)……………………………………………

4. What other measures do you use to cope with environmental impacts resulting from population growth and land degradation in your village?

- ☐ Erosion control

- ☐ Applying agro-ecological techniques

- ☐ Reforestation/Afforestation

- ☐ Watershed management

- ☐ Population growth control/Family planning

- ☐ Grouped settlement (Villagisation)

- ☐ No measure

- ☐ Other (specify)…………………………………………

5. Do you think the measure used is enough? Explain your answer.

- ☐ Yes

- ☐ No

If No, Why?

☐ Nothing much has changed so the measures have no significant

☐ The government agencies seem to be unaware of their functions

☐ Corruption still thrives above service delivery

☐ There is need to enhance public participation since it's lacking

☐ There is no goodwill from those in authority

☐ Others, explain ………………………………………………………….

THANK YOU

Name_____Department _____

Position _____ Years in the position_____

1. What are the main strengths and weaknesses of the current farming strategy/policy/law in Mukamira?

2. What have been the main changes in farming systems and policy environment for farming practices in Mukamira?

3. From your point of view, do you think policies/laws/regulations governing farming practices in this area are efficient?

If yes, why?

If no, what are the gaps in the process and the keys driving factors of inefficiency?

4. What needs to be changed or added to the present agricultural policy? Or, what policy domains are missing and need to be included?

5. How can the implementation of policies governing the farming practices be strengthened?

6. How can stakeholder participation in the review/ revision process be made effective and efficient?

7. In your view, what are the challenges of current farming practices in this area?

8. What are their root causes?

9. How are those challenges addressed in this area? At which extent?

10. Who are stakeholders involved in the implementation of policies/laws/regulations governing farming practices in this area?

11. From your point of view, what are demographic factors contributing to non-sustainable land use practices in Mukamira?

12. In your opinion, what solution can you recommend to address non-sustainable land use practices in Mukamira?

7.3 APPENDIX 3: SELECTED FIELD PHOTOS

Figure 10: An aerial View of the farmlands

Figure 11: The rugged Terrain of the land prone to erosion

Figure 12: An aerial view of Rugeshi cell

Figure 13: Atypical land prepared for planting

Figure 14: A view of a well-managed farmland in Rurengeri