THE EFFECT OF LAND DEGRADATION ON POTATO PRODUCTION IN RUBANDA DISTRICT: A CASE STUDY OF MUKO SUB-COUNTY

BY

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A RESEARCH REPORT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE IN AGRICULTURAL LAND USE PLANNING AND MANAGEMENT OF KABALE UNIVERSITY

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DECLARATION

I, **NIWAHA RICHARD** declare that this research report entitled "**The Effect of Land Degradation on Potato Production in Rubanda District: A Case Study of Muko Sub County***"* is my original work and that it has never been submitted to any college or institution of higher learning for any academic award.

Signature…… Date……

NIWAHA RICHARD

APPROVAL

This research report entitled "**The Effect of Land Degradation on Potato Production in Rubanda District: A Case Study of Muko Sub County***"* has been conducted under my supervision and it is now ready for submission with my approval.

Signature……. Date……

MR. BYAMUKAMA WILBROAD

SUPERVISOR

DEDICATION

I dedicate this piece of work to my dear parents whose spiritual and financial support made me achieve this goal.

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I am grateful to Almighty God for giving me the opportunity to undertake and complete this study. I give Him thanks and praise. I would also like to extend my sincere and heartfelt appreciation to the following persons for their invaluable support and unending encouragement.

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LIST OF ABBREVIATIONS

EMCA:	Environmental Management and Co-ordination Act
FAO:	Food Agricultural Organisation
GDP:	Gross Domestic Product
ICRAF:	International Centre for Research in Agro forestry
NARS:	National Agricultural Research Systems
ROK:	Republic of Kenya
SIDA:	Swedish Development Cooperation Agency
SSA:	Sub-Saharan Africa

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ABSTRACT

The aim of the study was to establish the effect of land degradation on potato production in Muko Sub County. The study was guided by objectives which were; to determine the types of land degradation in Muko Sub County, to investigate the land degradation factors affecting potato production in Muko Sub County and to establish the measures to reduce land degradation and improve potato production in Rubanda District. The study adopted a descriptive research design and a sample of 171 respondents. Purposive and simple random sampling techniques were used in selecting respondents. Questionnaires and interview guide were used in data collection. Data was presented using frequency tables, pie-charts and graphs. Findings in revealed that 35.1% of the respondents reported that there was soil fertility decline in the study area, 29.2% of the respondents reported soil erosion, 14.6% of the respondents revealed that there was vegetation loss in Muko sub county, 11.7% of the respondents reported stone appearance while 9.4% revealed that there was waterlogging in Muko sub county. From the findings, 23.4% of the farmers ranked insufficient capital as the major constraints to potato farming, 20.5% and 17.5% of the farmers ranked high cost of farm inputs and pests and disease respectively, 11.7% reported inadequate storage. It was noted by 20.5% of the farmers that terracing improves land degradation and increases potato production. Agroforestry practices improves on soil conservation and improves on productivity of potato production was reported by 19.3% of the respondents. Controlled overgrazing reduces land degradation and increases productivity of land for potatoes as revealed by 16.4% of the respondents. More still, 14.6% of the farmers revealed that provision of information to potato farmers on improved potato technologies by extension workers reduce land degradation and improve potato production. The study found out that insufficient capital, high cost of farm inputs and pests and disease, inadequate storage, poor information network, insufficient extension agent and lack of access road were the challenges faced by farmers in potato production. It was recommended that extension agents should be well involved in disseminating information by using open field days, demonstration and control plots so as to encourage farmers in adopting better production practices. Government and other stakeholders need to also invest in extension service in sensitizing potato farmers in the study areas as this has the potential to increase farmer's productivity and income.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter covers the background of the study, statement of the problem, objectives of the study, research questions, scope of the study and significance of the study and operational definition of terms.

1.1 Background of the study

Land degradation is widely recognized as a global problem associated with desertification in arid and semi-arid zones, which cover about 47% of the globe's total surface area (UNEP, 2015). This is considered to be highly variable arising from different causes and affecting people differentially according to their economic and social circumstances. According to Thomas, (2017), land degradation affects a large number of people over a significant proportion of the earth's surface which has led to extreme poverty and hunger. This is associated with declining status of natural resources, and environmental un-sustainability. Around the world, land degradation can be viewed as any change or disturbance to land perceived to be undesirable that affect human activities like agriculture and settlements (Eswaran, 2016).

According to Intergovernmental Panel on Climate Change (2012) in Africa agriculture has been the main contributor to current economy ranging from 10% to 70% of Gross Domestic Product (GDP) and is highly affected by land degradation leading to exploitation of natural resources like forests, settlement and cultivating of fragile land, like hills and sloppy areas. Due to the information gap among people in Africa on land conservation, this has led to miss-management of natural resources causing land use change, although this has been highly challenged by global warming throughout the world.

In the early 2000s, approximately 30% of Kenya was affected by very severe land degradation (UNEP, 2015) and an estimated 12 million people, or a third of the Kenya's population, depended directly on land that is being degraded (Bai, 2018). The droughts of 1970-2000 accelerated soil degradation and reduced per-capita food production (GoK, 2014). According to Muchena (2014), land degradation estimate is increasing in severity and extent in many areas and that over 20% of all cultivated areas, 30 per cent of forests and 10 per cent of grasslands are

subject to degradation. The expansion of cropping into forested and water catchment zones accounts for much of this degradation. The damage to soil, loss of habitat, change of land use, water shortages and siltation leads to reduced ecosystem services.

Since 1972, United Nations Conference on Human Environment held at Stockholm, Sweden, the Government of Kenya has continued to reinforce formulation of policies and strategies that would address land degradation. As Murage (2013) noted, farmers' perceptions and experiences are paramount when planning to implement an enterprise counteracting the on-going land degradation. Moreover, recent diagnostic participatory approaches are increasingly showing that farmers clearly perceive and articulate differences in the levels of soil fertility on their farms.

Land degradation and low potato production are currently severe problems in Uganda. Although Uganda's soils were once considered to be among the most fertile in the tropics (Chenery, 2013), problems of soil nutrient depletion, erosion, and other manifestations of land degradation appear to be increasing. The rate of soil nutrient depletion is among the highest in sub-Saharan Africa (Stoorvogel and Smaling, 2015) and soil erosion is a serious problem, especially in highland areas. Land degradation contributes to the low and in many cases declining agricultural productivity in Uganda. Farm yields are typically less than one-third of potential yields found on research stations, and yields of most major crops have been stagnant or declining (Okidi, 2013).

Potatoes are food crops that provide enormous investment opportunities to add value. They are one of the most productive food crops in the world in terms of its yields of edible energy and good-quality protein (Burton, 2013). Nutritionally, Potatoes re considered a well-balanced major plant food with a good ratio protein and calories and substantial amounts of vitamins, especially vitamin C, minerals, and trace elements (Emana and Nigussie, 2013). Internationally, the market for Potatoes have five distinctive line segments that include seed Potato, ware Potato, frozen chips, crisps/snacks, and other miscellaneous products such as starch. Among the list, the frozen chips and snacks markets exhibited the highest rates of growth internationally (Ferris, 2015). Therefore, the two earmarked product segments (frozen chips and snacks) contribute to most of the value addition in the Potato industry. Countries such as Holland that have been successful in developing the Potato industry export 70% of their ware Potato in the form of fresh tubers and Potato products such as chips and flour (Kato, 2015). Uganda has the potential to produce and

supply its domestic market with crisps and snacks, subject to product quality that is competitive with imports (Ferris, 2015).

According to FAO (2014), statistics, the annual Potato output in Uganda is approximately 800,000 metric tons, produced on approximately 112,000 hectares with an average yield of 7.14 metric tons per hectare. Output (production) is a result of increased acreage instead of intensification (i.e., increasing productivity per unit area - yield). Extended productivity comparisons based on FAO (2014) data show that Uganda's Irish Potato yields 7.14 metric tons per hectare, which is low in relation to figures of other countries such as Rwanda (14.2 tons), Kenya (20.3 tons), China (15.8 tons), and India (23.7 tons). This in itself is suggestive of unexploited potential to increase Uganda's Potato output, contributing to latent loss in aggregate income from Potato accruing from the yield gap at the production level of the value chain. The yield gap is both a challenge and an investment opportunity for increasing the aggregate value contribution of the Potato sub-sector to agricultural GDP. This study was therefore carried out to establish the effect of land degradation on potato production in Muko Sub County.

1.2 Statement of the Problem

Land degradation and low agricultural productivity are severe problems in Uganda. Although Uganda's soils were once considered to be among the most fertile in the tropics (Chenery, 2015), problems of soil nutrient depletion, erosion, and other manifestations of land degradation appear to be increasing and affecting potato production. The impacts of land degradation in most areas in Uganda has been reduction in potato crop productivity, fuel wood and non-timber forest products, which are closely linked to poverty and food insecurity (Chenery, 2015),

Muko Sub County is divided further into upper, middle and lower zones due to differences in terrain. The area is characterized by recurrent soil erosion, landslides, deforestation for potato growing and increased water scarcity due to destroyed catchment zones; this has affected potato production negatively (Ellen, 2014). Farmers in Muko Sub County have also been encouraged to apply fertilisers, use better methods of carrying out agriculture. Terracing, intercropping, use of organic and inorganic manures and fertilizers have also been applied to reduce land degradation and increase potato production. Interestingly, the National Agricultural Research Organisation

(NARO) has made notable achievements in increasing the yield of potato. The crop breeders have developed varieties of potato, which are capable of responding to improved agricultural practices. They have gone a long way towards solving the pests and diseases problems both in the field and storage (Okonkwo, 2016). Despite the efforts done, potato production has remained low. It is against this background that the study was carried out to establish the effect of land degradation on potato production in Muko Sub County.

1.2 Aim of the study

The aim of the study was to establish the extent to which land degradation affects potato production in Muko Sub County.

1.4 Objectives of the study

i. To determine the types of land degradation on potato production in Muko Sub County.
ii. To investigate the land degradation factors affecting potato production in Muko Sub County
iii. To establish the measures to reduce land degradation and improve potato production in Rubanda District.

1.5 Research question

i. What are the types of land degradation in Muko Sub County?
ii. What are the land degradation factors affecting potato production in Muko Sub County?
iii. What are the measures to reduce land degradation and improve potato production in Muko, Rubanda District?

1.6 Scope of the study

The study was about the effect of land degradation on potato production in Rubanda District. The study focused on the types of land degradation in Muko Sub County, land degradation factors affecting potato production in Muko Sub County and measures to reduce land degradation and improve potato production in Rubanda District.

1.6.2 Geographical scope

The study was conducted in Muko Sub County in Rubanda district. Muko Sub County is located in Rubanda County west constituency in Rubanda District. Muko Sub County has coldest month averaging above 0 °C (32 °F), all months with average temperatures below 22 °C (71.6 °F), and at least four months averaging above 10 °C (50 °F). The soils of Muko Sub County are mainly volcanic soils and these are considered suitable for crop growing.

1.6.3 Time scope

The study utilized data for years ranging from 2018-2019 because it is within this period that the researcher know why there had been reduction in potato production in the area in the Sub County.

1.7 Significance of the study

The study will significantly benefit the Ministry of Agriculture, District Agriculture Officers, Agricultural Research Institute, Agricultural Extension Officers, Farmers Training Centre, farmers' policy makers and policy implementers in trying to mitigate land degradation in Uganda.

The research findings will assist to improve local awareness of the importance of preventing land degradation and create positive perceptions among the local people in terms of their role in improving agricultural productivity of potatoes.

The study will provide more data to what already exists globally in understanding the effect of land degradation on potato production.

The study will be used by policy makers to come up with useful strategies, which can be adopted to reduce on land degradation.

1.8 Operation definition of terms

Soil erosion: Soil erosion is a process of detachment and transportation of soil materials by rainfall and runoff, wind, gravity and other natural or anthropogenic agents that disaggregate and

remove soil materials at one point on the Earth's surface and deposit it elsewhere (Lambin, 2014).

Land use: Land use is the management of the environment which involves exploitation and alteration of the natural environment into artificial landscapes (settlement and semi-environment) and habitats (plantations and urban ecosystem) (Okidi, 2013).

Land degradation: The temporal or and permanent lowering of the productive capacity of natural environment, such as land, water, air, and biodiversity deteriorating at a faster rate, leaving no time for the environment to recover (Okoba, 2015).

Land: The part of the earth's surface that is not covered by water.

Potatoes: These are shrubby perennials with edible tubers, grown as cool-weather annuals in rows, raised beds, or containers (Burton, 2013).

Agricultural productivity: This is measured as the ratio of agricultural outputs to agricultural inputs (Osunade, 2014).

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter is concerned with the review of information that had earlier been written down by different scholars on related topics. The literature in this section was basically derived from the works of the previous researchers and scholars, observations and experiences as noted in textbooks, journals and other related information in the same line and order with the objectives of this study

2.1 Types of Land Degradation

Soil erosion by water: This is the removal of soil particles by the action of water. Usually seen as sheet erosion (a more or less uniform removal of a thin layer of topsoil), rill erosion (small channels in the field) or gully erosion (large channels, similar to incised rivers) (Knapen, 2016). One important feature of soil erosion by water is the selective removal of the finer and more fertile fraction of the soil.

Soil fertility depletion has been described as the major biophysical root cause of the declining per-capita food availability in smallholder farms in sub-Saharan Africa (SSA), with a decline from 150 to 130 kg per person over the past 35 years in production (Jaetzold, 2016). Adequate and better solutions to combat nutrients depletion where known, are often limited in application because of the dynamics and heterogeneity of the African agro-ecosystems in terms of biophysical and socio-economic gradients. This calls for system-specific or flexible recommendations, rather than monolithic technical solutions such as blanket fertilizer recommendations.

According to Vacca (2015), runoff and soil erosion in areas under different land use (abandoned grazing land, burned *Machia* and *Eucalyptus sp*) have different amounts of runoff, and soil erosion results from different land uses where the highest surface occurs from bare inter-canopy patches. Decrease in canopy cover density due to overgrazing leads to rapid water erosion in rangelands and the loss of vegetative cover as a result of human activities such as overgrazing and deforestation, leads to the formation of soil seals (Oztas, 2013), which increases the risk of runoff and soil erosion.

Soil erosion by wind: The removal of soil particles by wind action. Usually this is sheet erosion, where soil is removed in thin layers, but sometimes the effect of the wind can carve out hollows and other features. Wind erosion most easily occurs with fine to medium size sand particles (Lambin, 2014).

According to Stringer (2014), soil is considered one of the world's limited, non-renewable resources. The continued maintenance of fertile soil is essential in order to meet basic human needs and provide ecosystem services such as food production, and provides the basis of livelihoods for millions of people across the world. Achieving the goal of land and soil sustainability requires an interdisciplinary approach, and provides an enormous challenge to policy makers, scientists and land users.

The degradation of land and soil resource being degraded relates to national sovereignty concerns, while the indirect impacts of degradation transcend village, district and national boundaries and affect food prices, food security and ecosystem service provision in downstream locations, far away from the site of degradation. However, these complex multi-scale linkages present a clear need to frame land and soil degradation as global issues that require international recognition particularly in driving investment in funding, technology transfer and capacity building to tackle the land and soil challenges (Lambin, 2014). In the absence of the sustainable use and management of land and soil resources, global sustainable development and environmental sustainability are at risk (Bai, 2018).

Soil acidification is a particular type of nutrient depletion (Schreier, 2018). It occurs when the cationic nutrients (mainly potassium, calcium and magnesium) are depleted, and are replaced by the acidic cations hydrogen and aluminium, which are released from the soil particles. The process occurs naturally, due to leaching by rainfall and is intensified by the natural acids generated during the decomposition of organic matter. Human activities intensify the process by heavy and unreplaced off-takes of the nutrient cations through harvesting and burning. An additional type of agricultural acidification occurs when inorganic nitrogenous fertilisers are applied in excess of the needs and uptake capacity of the crop. The excess nitrogen forms acids in the soils and accelerates the natural leaching of cationic nutrients (Tang, 2017). Acidification

by nitrogenous fertilisers is not uniformly distributed. It is much affected by the soil's parent rocks, and is absent or negligible in soils derived from limestone. For instance, it is a greater hazard in the gneissic hill soils around Thimphu than in the more calcareous hill soils around Paro (Stoessel, 2016). Over-fertilisation with urea, the most widely used N-fertiliser has been noted in maize in eastern Bhutan, and in rice in other parts of the country.

Other types of chemical degradation occur when different chemical fertilisers are applied in excess of crop needs. The only other instance of chemical degradation of this type so far observed in Bhutan has been attributed to the over-application of P fertilisers in some apple orchards in western Bhutan. The excess P locks up other nutrients in forms that are not available to crops, and induces deficiencies of zinc and iron. Very severe types of chemical degradation are caused by pollution with industrial wastes. They are of very limited extent so far in Bhutan, affecting only small areas downslope and downstream of a few industrial plants and workshops. However, they are not easily reversed, and can have far–reaching effects off–site, particularly where the pollutants are spread by contaminated irrigation water.

The two most common types of in situ physical land degradation in Bhutan is top soil capping and sub soil compaction. Like chemical degradation, they are not highly visible and tend to overlook. However, they are quite apparent in the feel of the soils, particularly when ploughing and digging. They are widespread and may reduce the productivity of Bhutan's soils more than is realised. Both of them tend to make soils more liable to erosion. Capping is the formation of a thin but hard crust on the soil surface, which can delay and even prevent seedling emergence. It is mainly due to the beating action of raindrops on bare soil surfaces, especially where topsoil structures are weakened by depletion of organic matter. It is more likely in silty and fine sandy top soils, which are widespread in the cultivated lands of Bhutan. It is usually a temporary feature, and is less serious that subsoil compaction. Compaction arises when the structures in the upper subsoil are weakened, the soil particles are compressed together, and the intervening pore space is reduced (Ghildyal, 2018). It is caused by combinations of reduced organic matter, cultivation when the soil is wet, cattle trampling in wet soils after the rice harvest, and high contents of silt and fine sand.

In Bhutan it is reported to be associated with chemical fertilisers, especially urea. If the urea is used as a substitute for, rather than as a complement to organic fertilisers, its association with compaction may be indirect mainly due to reduced organic matter. However, there may also be a direct microbial-physical effect due to the stimulation of soil fungi by flushes of available nitrogen. Profuse growth of fungal hyphae on the surfaces of soil structures may render them hydrophobic, making it difficult for water to infiltrate and soften dry clods. Waterlogging is an in situ physical degradation process, which tends to affect limited but widely scattered areas. Poor drainage fills the soil pores with water and reduces the supply of oxygen to plant roots. This has serious negative effects on the productivity of most crops. In mountainous terrain like Bhutan there is the serious additional danger that gullies and landslides can be initiated by impeded or uncontrolled drainage. The disposal of excess water is a crucial element in management for land stability in Bhutan. Waterlogging and slope destabilisation are major problems for farmers engaged in potato production (Anon, 2017). It is of particular concern in places where roads and channels have to be constructed across areas of hushing, as the soils are artificially saturated by irrigation for long periods.

2.2 Land Degradation Factors affecting Potato Production

The major land degradation factor that affect potato production are soil erosion by heavy rain which facilitate by farming sloppy and clearing forest land for cultivation due to raising of human population (Feyera and Tsetadirgachew, 2015). The degradation of land and soil resource being degraded relates to national sovereignty concerns, while the indirect impacts of degradation transcend village, district and national boundaries and affect food prices, food security and ecosystem service provision in downstream locations, far away from the site of degradation. However, these complex multi scale linkages present a clear need to frame land and soil degradation as global issues that require international recognition particularly in driving investment in funding, technology transfer and capacity building to tackle the land and soil challenges (Lambin, 2017).

Landslides usually occur on steep slopes, areas of low relative relief with high rainfall, ground failure of river bluffs, highway and building excavations, mine-waste piles, open-pit mines and quarries. The landslides are restricted to steep slopes and irrespective terrain does not accurately reflect the real nature of the problem. Causes for such wide geographic coverage have much to

do with the many different triggering mechanisms for landslides (Knapen, 2016). Likewise, landslides also occur on land and under water; they can occur in soils or bedrock; cultivated land, barren slopes and natural forests are all subject to landslides. Extremely dry areas and very humid areas can be affected by slope failures and most important, steep slopes are not a necessary prerequisite for landslides to occur. In some cases, gentle slopes as shallow as 1–2 degrees have been observed to fail (Knapen, 2016).

The loss of vegetation cover may lead to the formation of soil seals, which can increase the runoff and erosion during the early stages of seal development. According to Vacca, (2015), runoff and soil erosion in three areas under different land use (abandoned grazing land, burned *Machia* and *Eucalyptus sp*) have different amounts of runoff, and soil erosion results from different land uses where the highest surface occurs from bare inter-canopy patches. Decrease in canopy cover density due to overgrazing leads to rapid water erosion in rangelands and the loss of vegetative cover as a result of human activities such as overgrazing and deforestation, leads to the formation of soil seals (Oztas, 2013), which increases the risk of runoff and soil erosion.
Snyman and duPreez (2015) assert that range land degradation leads to increased surface water runoff and composition of soil due to the decreased plant cover, reduced aggregate stability, reduced soil fertility, and decreases in the soil water content in all soil layers. According to Merzer (2017), bare plots produce significantly more runoff than in vegetative plots. Due to the lack of natural resources management, most forests that have undergone deforest action, especially over the past two decades; have led to the development of gullies and high surface runoff (Mohammad and Mohammad, 2013).

2.3 Measures to Reduce Land Degradation and Improve Potato Production

A number of studies have been conducted on coping strategies to land degradation, for instance Maitima, (2016) observed that although most coping strategies are affected by global changes, diversification of agricultural production is crucial. According to Okoba and Sterk (2016), continuous neglect of the land degradation challenge makes it hard to restore land for food crop production instead converted to other enterprises like stone crushing for construction materials and sand excavation. Soil conservation activities can also be adopted in lowland zones by use of large gabions placed at regular distances in the stream (Johansson and Svensson, 2014).

The exposure of land to erosion usually varies within catchments. The factors that control erosion are: the nature of the plant cover, the erodibility of the soil, the erositivity of the eroding agent and the slope of the land (Morgan, 2015). In Some areas farmers cope with land degradation by increasing crop diversity. Use of livestock manures and crop vegetative residues by farmers maintains more fertile and more productive farms. By contrast, in traditional rural societies that still represent the majority of small farmers worldwide, the use of conventional soil survey information frequently fails because it does not take into account soil knowledge of local people and their experience in working with soils (Osunade, 2014; WinklerPrins, 2018; Barrera-Bassols, 2015). Approaches have been proposed to incorporate environmental knowledge of rural communities through the participation of local farmers (in land use planning), either from a study of soil point of view (Sillitoe, 2014). Due to lack of appropriate approaches to evaluate land degradation, the land-use planners in most countries have adopted recommendations that are derived from site-specific experiments or based on modeling approaches that are not fitted to the local conditions.

Agroforestry is increasingly recognized as a useful and promising approach to soil conservation that combines goals of sustainable agricultural development for resource-poor tropical farmers with greater environmental benefits than less diversified agricultural systems, pastures, or monoculture plantations (Forman, 2015). Among these expected benefits is the conservation of a greater part of the native biodiversity in human-dominated landscapes that retain substantial and diversified tree cover that reduce soil erosion that would degrade land and this improve Irish potato production. Although the protection of natural habitat remains the backbone of biodiversity conservation strategies, promoting agroforestry on agricultural and other deforested land could play an important supporting role, especially in mosaic landscapes where natural habitat has been highly fragmented and forms extensive boundaries with agricultural areas.

The most promising and profitable technological option for improving potato productivity is using a combination of organic and inorganic fertilizers, with erosion control measures where necessary. Sources for organic materials include manure, coffee husks and other crop residues. Improved management of existing organic sources, such as methods integrating manure and composting, may significantly increase soil organic matter and reduce nutrient loss (Briggs and

Twomlow 2012). Other sources of organic materials include legume cover crops, useful especially where population densities are intermediate and fallow is still practiced. They can produce high quality fodder as well as green manure and other soil enhancing properties. A rotation with *mucuna* (velvet bean) earned higher returns than with fertilizer for some areas in Eastern Uganda (Pender, 2012).

Adeogun (2017) states that the efficiency of extension organizations providing information to potato farmers on improved potato technologies play a significant role in the level of farmers' innovation uptake with respect to potato production. Additionally, Ikechukwu (2015) reported that proper application of fertilizer has been described as an essential prerequisite for the realization of increase crop yield as well as for restoration and maintenance of soil fertility.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the methodology that was employed to ease the success of this study. It includes research design, population of the study; the sample size, sampling techniques, data collection instruments, data collection procedure, data analysis, ethical considerations and limitation of the study.

3.1 Study Area

Muko Sub County is located in Rubanda County west constituency in Rubanda District. Muko Sub County has coldest month averaging above 0 °C (32 °F), all months with average temperatures below 22 °C (71.6 °F), and at least four months averaging above 10 °C (50 °F). The soils of Muko Sub County are mainly volcanic soils and these are considered suitable for crop growing.

3.2 Research Design

The study adopted a descriptive research design which attempt to answer a research question that asks what effects one variable has on another variable. It also described situations and events such that, an observer observes an event or a situation and tries to describe it as best as he/she can according to how things unfold. The study involved both qualitative and quantitative approaches during data collection. Qualitative approach enabled the researcher to give a complete, detailed description of phenomenon while quantitative approach enabled the researcher to construct statistical models in an attempt to explain the findings.

3.3 Study Population

The target population for the study was 300 farmers dealing in potato growing in Muko Sub County.

3.4 Sample Size Determination

The researcher used a sample size of 171 respondents which was reached using Israel Glen (2012) formula $n=\frac{N}{1+N(e^2)}$ where N is the target population, n is the sample size, e is the level of precision (0.05)

$n=\frac{300}{1+300(0.05^2)}$ = $n=\frac{300}{1+300(0.0025)}$ $n=\frac{300}{1.75}$ = 171 respondents

3.5 Sampling Techniques

The researcher employed simple random sampling technique in selecting respondents. This method involved giving all the members in the target population an equal chance of being selected to participate in the study. A list of household heads was requested from the village heads. Respondents were chosen randomly from household heads. Simple random sampling was used because it gives each of the total sampling units of the household heads an equal chance of being selected. Through the simple random sampling, a sample of 170 farmers was picked.

The researcher also applied purposive sampling technique to select one agricultural extension worker. Purposive sampling was applied when collecting data from agricultural extension worker because he was involved in sensitization of farmers about land degradation control and how to increase potato production.

3.6 Data Collection Tools

3.6.1 Questionnaires

The current study used questionnaire in collecting data. The researcher used this tool to collect data from farmers because they were convenient as respondents would fill questionnaires during their free time and have a chance to consult for views and information about the research problem. This tools produced a more focused and relevant data for the study. The questionnaire had sections on the background information of respondents, types of land degradation, land degradation factors affecting potato production and measures to reduce land degradation and improve potato production.

3.6.2 Interview Guide

Interviews were used as informal conversations that allowed the researcher to extract rich and detailed information from agricultural extension worker. The researcher designed an interview guide that helped me to remember questions to ask respondents. This tool was quite important whereby the well informed respondents provide the researcher with rich and detailed information on the subject of inquiry.

3.7 Data Collection Procedure

I sought an introductory letter from the Department of Agricultural Sciences at Kabale University that helped in introducing the researcher to respondents. Questionnaires were designed by the researcher and presented to the supervisor to check whether they were valid. A visit to the study area was done first for the purpose of familiarization and pre-testing of the questionnaire. This facilitated necessary adjustments to the questionnaires and increased the reliability of the data. I again sought consent from respondents who would participate in the study. This was done orally since some farmers were not able to read. Data was collected by administering questionnaires and carrying out interviews. After data collection, data was entered into a computer for coding and analysis.

3.8 Data Analysis

Data collected from the field was examined for its accuracy and completeness of information given. It was then entered into Micro soft excel and analyzed to generate frequency tables to give clear presentation of findings. Descriptive statistics such as frequencies, percentages, frequency tables were used to generate reports for discussion. Frequencies and percentages were used because they easily communicated research findings to the majority of the readers. Frequencies easily show the number of times a response occurred and the number of respondents in a given category, while percentages were used to inform the comparison of the sub groups that differ in size and proportion. Qualitative data, particularly responses from interviews were analysed using prose sentences and presented in narrative summary. After each interview conducted, the researcher repeatedly read the notes taken during interviews for editing and after reading them, the researcher came up with themes and patterns of categorizing the information according to the questions on data collection instruments to see whether the questions were relevantly answered.

3.9 Ethical Considerations

Before anyone participates in a study, informed consent was sought. People participating in research were entitled to confidentiality. I sought consent from respondents. The researcher affirm respondents the right of privacy. Privacy is the freedom an individual has to determine the time, extent and general circumstances under which private information was shared with or withheld from others ".

3.10 Limitation of the Study

During interviews some respondents did not easily disclose some information which limited the amount of data collected. However, the researchers made use of rapport; this involved building trust and confidence in the key informant by assuring the interviewee that the research was for academic purpose.

In making arrangements with the respondents, they gave wrong time just to avoid the researcher and this delayed the process of data collection. This was however minimized by presenting to them an introductory letter explaining the purpose of the study.

Some respondents were not able to translate the questionnaire into their own language which might delay the study. This was dealt with by sourcing enough funds from friends in order to get money to help in data collection.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Introduction

This chapter presented the results of the study. It presents and discusses the findings. The findings are organized in reference to the research objective which were;

i. To determine the types of land degradation on potato production in Muko Sub County.
ii. To investigate the land degradation factors affecting potato production in Muko Sub County
iii. To establish the measures to reduce land degradation and improve potato production in Rubanda District.

4.1 Demographic Characteristics

The demographic characteristics of respondents who participated in the study were investigated and the following were the findings.

4.1.1 Gender of the Respondents

The table below shows the gender of respondents who participated in potato growing;

Table 1: Gender of the respondents

Sex	**Frequency**	**Percentage**
Male	110	64.3
Female	61	35.7
Total	**171**	**100.0**

Source: Field Data, 2020

In table 1, the highest percentage of respondents was males represented by 64.3% while the lowest were males with 35.7%. The percentage of males was high mainly due to the fact that males were more involved in coffee farming than females. The findings indicated that potato production was mainly involved in by males. The low percentage of the female participating in potato production was attributed to the fact that females in the study area have limited capital to engage in potato farming yet this activity requires enough capital. This is in line with World

Bank (2015) which states that most women find it difficult to cope with labour intensive works as compared to men counterparts.

4.1.2 Age of the Respondents

Frequency table was used to present the findings on the age of respondents who participated in the study.

Table 2: Age of the respondents

Age bracket	Frequency	Percentage
18-25	0	0.0
26-33	20	11.7
34-41	36	21.1
42-49	40	23.4
50-57	45	26.3
58 and above	30	17.5
Total	**171**	**100.0**

Source: Field Data, 2020

As shown in table 2 below, the highest percentage of respondents indicated by 26.3% was aged between 50-57 years, 23.4% were in the range of 42-49years, 21.1% were aged 34-41 years, 17.5% were aged 58 and above years while 11.7% of the respondents were aged 26-33 years. Results showed that people aged between 50-57 years formed the majority of respondents involved in potato production. The results indicate that most of the respondents were of the middle age, the age at which they were still energetic and hence can actively involve in production activities (Lupilya, 2017). This finding disagrees with the findings of Pur, Ibrahim; and Sabo (2017) and Nwakor (2018) that the level of youth involvement in agriculture has reduced due to schooling and part-time farming.

4.1.4 Level of Education of Respondents

The frequency table below shows the level of education of respondents;

Table 3 Level of education

Education level	Frequency	Percentage
Primary level	15	8.8
Secondary level	50	29.2
Diploma	70	40.9
Degree	36	21.1
Total	**171**	**100.0**

Source: Field Data, 2020

From table 3 above, the highest percentage of respondents indicated by 40.9% had finished diploma level of education, 29.2% had finished secondary level of education, 21.1% had finished a degree while the lowest percentage of respondents indicated by 8.8% had finished primary. The findings indicated that there were no respondents who had degree and masters. The implication of education in agricultural production according to Arnon (2017) is that education is an important socio-economic variable and a form of human capital for agricultural development. Similarly, Ogunbameru (2016) noted that education would likely enhance the adoption of modern farm technologies by youth and thereby sustaining a virile farming population. Ojukaiye (2015) posited that education is an important socio-economic factor that influences a farmer's decision because of its influence on the farmer's awareness, perception, reception and the adoption of innovation that can bring about increase in production. Since a high percentage of the youths were educated, their education was expected to enhance potato production in the study area.

The researcher investigated the number of years respondents had spent in potato production and the findings were indicated in the table below;

Table 4: Number of years Spent in Potato Farming

Years	Frequency	Percentage
1-2	6	3.5
3-4	20	11.7
5-6	40	23.4
7 and above	105	61.4
Total	**171**	**100.0**

Source: Field Data, 2019

From the above table, 61.4% of the respondents who participated in the study had spent 7 and above years in coffee growing, 23.4% of the respondents had spent between 5-6 years in coffee growing, 11.7% indicated that they had spent 3-4 years while 3.5% had spent 1-2years. Majority of the respondents has spent 7years and above meaning that they were more informed about land degradation and Irish potato production in the study area. Farming experience is used as a measure of management ability, the more experience the farmer is, the more his ability to make farm decision. This result showed that most of the respondents had long years of farming experience, implying that such farmers are likely to make decisions that would increase their output and income.

4.2 Types of Land Degradation in Muko Sub County

The researcher asked respondents the land degradation in Muko Sub County and the following were the findings;

Table 5: Types of Land Degradation in Muko Sub County

Types	Frequency	Percentage
Soil erosion	50	29.2
Soil fertility decline	60	35.1
Vegetation loss	25	14.6
Stone appearance	20	11.7
Waterlogging	16	9.4
Total	**171**	**100.0**

Source: Field Data, 2020

From table 5, 35.1% of the respondents reported that there was soil fertility decline in the study area, 29.2% of the respondents reported soil erosion, 14.6% of the respondents revealed that there was vegetation loss in Muko sub county, 11.7% of the respondents reported stone appearance while 9.4% revealed that there was waterlogging in Muko sub county. From the above findings, production of potato was not very high and this was majorly attributed to soil fertility decline and soil erosion.

The findings on soil fertility decline concur with Jaetzold (2016) who states that soil fertility depletion has been described as the major biophysical root cause of the declining per-capita food availability in smallholder farms in sub-Saharan Africa (SSA), with a decline from 150 to 130 kg per person over the past 35 years in production.

The above findings are in agreement with Vacca (2015) who states that runoff and soil erosion in areas under different land use (abandoned grazing land, burned *Machia* and *Eucalyptus sp*) have different amounts of runoff, and soil erosion results from different land uses where the highest surface occurs from bare inter-canopy patches. Decrease in canopy cover density due to overgrazing leads to rapid water erosion in rangelands and the loss of vegetative cover as a result of human activities such as overgrazing and deforestation, leads to the formation of soil seals (Oztas, 2013) which increases the risk of runoff and soil erosion.

In harmony with the above findings, (Anon, 2017) states that waterlogging is an in situ physical degradation process, which tends to affect limited but widely scattered areas. Poor drainage fills the soil pores with water and reduces the supply of oxygen to plant roots. This has serious negative effects on the productivity of most crops. In mountainous terrain like Bhutan there is the serious additional danger that gullies and landslides can be initiated by impeded or uncontrolled drainage. The disposal of excess water is a crucial element in management for land stability in Bhutan. Waterlogging and slope destabilisation are major problems for farmers engaged in potato production.

> In an interview with an extension officer, it was reported that "*soil erosion is the most widely recognised and most common form of land degradation and, therefore, a major cause of falling productivity. However, since the effects of soil loss vary depending on the underlying soil type, soil loss, by itself, is not an appropriate proxy measure for productivity decline. For example, a loss of 1 mm from a soil in which the nutrients are concentrated close to the surface will show a greater impact on productivity than the same level of soil loss from a soil in which the nutrients are more widely distributed*"

The researcher asked respondents whether market for their potato yields was available and the following were the findings;

Table 6: Market Availability

Responses	**Frequency**	**Percentage**
Yes	171	100.0
No	0	0.0
Total	**171**	**100.0**

Source: Field Data, 2020

From table 7, all the respondents revealed that there was availability of market for potatoes. However, it was noted that the market was characterized by price fluctuation. It was further found that due to price fluctuation, some farmers decide to grow other kind of crops such as beans and sorghum resulting in less production of potatoes in Muko Sub County.

Table 7: Bags of Potato produced by each farmer in Muko Sub County

Bags	Frequency	Percentage
Below 10	23	13.5
10-15	40	23.4
16-20	18	10.5
21-25	20	11.7
26-30	30	17.5
31-35	25	14.6
36 and above	15	8.8
Total	**171**	**100.0**

Source: Field Data, 2020

The table above indicates that 23.4% of the respondents revealed that they produced 10-15 bags of potatoes, 17.5% of the respondents reported that they produced 26-30 bags. Furthermore, 13.5% of respondents noted that they produced below 10 bags, 14.6% indicated that between 31-35 bags of potatoes were being produced, 11.7% of the farmers produced 21-27 bags, 10.5% of the respondents reported that 16-20 bags were being produced while the remaining 8.8% reported that 36 and above bags of potatoes were being produced. The above findings indicate that there were low yields of potato production. Farmers attributed this to loss of soil fertility, poor seeds and limited capital to inject in potato growing.

4.3 Land Degradation Factors affecting Potato Production in Muko Sub County

The researcher investigated the land degradation factors affecting potato production in Muko Sub County and the following were the findings;

Table 8: Land Degradation Factors affecting Potato Production in Muko Sub County

Responses	Frequency	Percentage
Runoff caused by heavy rain fall contributes to land degradation and loss of potato production	36	21.1
Loss of vegetation cover facilitates soil erosion and loss of potato production	30	17.5
Low water retention by the soil lead to reduced potato yields	25	14.6
Loss of soil nutrients contributes to low potato yields	45	26.3
Poor cultivation lead to reduced potato production	20	11.7
Overgrazing leads to low potato yields	15	8.8
Total	**171**	**100.0**

Source: Field Data, 2020

From the table, majority of the respondents represented by 26.3% of the respondents reported that loss of soil nutrients contributed to low potato yields in Muko Sub County, 21.1% of the respondents reported that runoff caused by heavy rain fall contributed to land degradation and loss of potato production, 17.5% reported that loss of vegetation cover facilitates soil erosion and loss of potato production. Furthermore, 14.6% of the respondents revealed that low water retention by the soil led to reduced potato yields in the study area, 11.7% indicated poor cultivation while the remaining 8.8% noted that overgrazing led to low potato yields.

The findings concur with Feyera and Tsetadirgachew, (2015) who state that the major land degradation factor that affect potato production are soil erosion by heavy rain which facilitate by farming sloppy and clearing forest land for cultivation due to raising of human population.

In support of the above findings, Vacca, (2015) states that runoff and soil erosion in three areas under different land use (abandoned grazing land, burned *Machia* and *Eucalyptus sp*) have different amounts of runoff, and soil erosion results from different land uses where the highest surface occurs from bare inter-canopy patches. Decrease in canopy cover density due to overgrazing leads to rapid water erosion in rangelands and the loss of vegetative cover as a result of human activities such as overgrazing and deforestation, leads to the formation of soil seals (Oztas, 2013), which increases the risk of runoff and soil erosion.

An agriculture extension worker reported that "*Farmers are always encouraged to carry out terracing in hilly areas to avoid soil erosion but some farmers keep a deaf ear. Therefore soil erosion is very prone to these areas which lead to loss of soil fertility and limited potato productivity.*

Sources of Information about recommended Potato Production Practices

The table below presents the findings on the recommended potato production practices in Muko Sub County

Table 9: Sources of Information about recommended Potato Production Practices

Responses	**Frequency**	**Percentage**
Agricultural extension worker	50	29.2
Co-farmers/friends	40	23.4
Research institutions	36	21.1
Media	45	26.3
Total	**171**	**100.0**

Source: Field Data, 2020

The sources of information on recommended potato production practices available to farmers included extension worker, village/community leaders, co-farmers/friends, research institutions and media. It was found that most of the respondents represented by 29.2% acquired information

about recommended potato production practices through extension worker, approximately 26.3% through media, 23.4% acquired information from co-farmers while 21.1% acquired information from research institutions. The efficiency of extension organizations providing information to potato farmers on improved potato production play a significant role in the level of farmers' innovation uptake with respect to potato production. This finding is in agreement with Adeogun (2017) who reported that the efficiency of extension organizations providing information to potato farmers on improved potato technologies will play a significant role in the level of farmers' innovation uptake with respect to potato production.

Sources of information about recommended potato production practices are also presented on the graph below;

4.4 Measures to improve Potato Production in Muko Sub County

The challenges/constraints faced in potato production were first investigated and the following were the results

Table 10: Challenges/constraints faced in Potato Production

Responses	Frequency	Percentage
Insufficient capital	40	23.4
Pests and disease	30	17.5
Inadequate storage	20	11.7
Poor information network	18	10.5
Insufficient extension agent	15	8.8
Lack of access road	13	7.6
High cost of farm input	35	20.5
Total	**171**	**100.0**

Source: Field Data, 2020

The constraints faced by farmers in the potato production are presented in the Table. It was found that about 23.4% of the farmers ranked insufficient capital as the major constraints. Credit is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity. Furthermore, access to micro-credit could have prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities. Approximately, 20.5% and 17.5% of the farmers ranked high cost of farm inputs and pests and disease respectively, 11.7% reported inadequate storage. Furthermore, 10.5% of the farmers noted poor information network as another constraint for potato production.

Finally, insufficient extension agent and lack of access road were reported by ranked by 8.8% and 7.6% of the farmers. According to the respondents, due to high cost of improved seed they make use of seeds from their previous harvest which is not reliable and can jeopardize improved and sustainable potato productivity.

Table 11: Measures to improve Potato Production in Muko Sub County

Responses	Frequency	Percentage
Fertilizer and livestock manures as well as and crop vegetative residues reduce land degradation and improves on potato yields	50	29.2
Agroforestry practices improves on soil conservation and improves on productivity of potato production	33	19.3
Provision of information to potato farmers on improved potato technologies by extension workers	25	14.6
Controlled overgrazing reduces land degradation and increases productivity of land for potatoes	28	16.4
Terracing improves land degradation and increases potato production	35	20.5
Total	**171**	**100.0**

Source: Field Data, 2020

From the above table, 29.2% of the respondents reported that fertilizer and livestock manures as well as and crop vegetative residues reduce land degradation and improves on potato yields. It

was noted by 20.5% of the farmers that terracing improves land degradation and increases potato production. Agroforestry practices improves on soil conservation and improves on productivity of potato production was reported by 19.3% of the respondents. This concur with Forman, (2015) who states that agroforestry is increasingly recognized as a useful and promising approach to soil conservation that combines goals of sustainable agricultural development for resource-poor tropical farmers with greater environmental benefits than less diversified agricultural systems, pastures, or monoculture plantations.

Furthermore**,** Controlled overgrazing reduces land degradation and increases productivity of land for potatoes as revealed by 16.4% of the respondents. This implies that farmers should control overgrazing to reduce land degradation and increase on potato production. More still, 14.6% of the farmers revealed that provision of information to potato farmers on improved potato technologies by extension workers reduce land degradation and improve potato production. The findings imply that extension workers should always sensitize potato farmers about how land degradation can be averted and improved hybrid seeds should be encouraged in farming.

The findings are in agreement with Adeogun (2017) who states that the efficiency of extension organizations providing information to potato farmers on improved potato technologies play a significant role in the level of farmers' innovation uptake with respect to potato production. Additionally, Ikechukwu (2015) reported that proper application of fertilizer has been described as an essential prerequisite for the realization of increase crop yield as well as for restoration and maintenance of soil fertility.

The findings concur with Briggs and Twomlow (2012) who state that the most promising and profitable technological option for improving potato productivity is using a combination of organic and inorganic fertilizers, with erosion control measures where necessary. Sources for organic materials include manure, coffee husks and other crop residues. Improved management of existing organic sources, such as methods integrating manure and composting, may significantly increase soil organic matter and reduce nutrient loss.

Table 12: Level of Adoption of Recommended Potato Production Practices

Responses	Frequency	Percentage
Planting materials	28	16.4
Planting time	25	14.6
Weeding time	23	13.5
Harvesting techniques	12	7.0
Planting depth	18	10.5
Method of planting	20	11.7
Planting space	15	8.8
Fertilizer application	30	17.5
Total	**171**	**100.0**

Source: Field Data, 2020

The complementary recommended potato production practices include fertilizer application, planting time, method of planting, planting depth, planting space, weeding and harvesting. These components of recommended potato production practices were adopted by the farmers in varying degrees.

It was found that 16.4% of the respondents adopted planting material, while 14.6% adopted planting time, approximately 13.5% adopted weeding time while 10.5% adopted plant depth, also 11.7% and 8.8% of the respondents adopted method of planting and planting space, respectively while 7.0% reported harvesting techniques.

Fertilizer application has the highest adoption (17.5%) level. This can be seen as evident in the yield. This agrees with Ikechukwu (2015) who reported that proper application of fertilizer has been described as an essential prerequisite for the realization of increased crop yield as well as for restoration and maintenance of soil fertility.

Qualitative findings revealed that few farmers apply rotten cow dung mixed with grasses to increase productivity of potatoes. Others do not apply due to inadequate finance to purchase fertilizer.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of findings, conclusions arising from the study and recommendations made by the researcher that could draw the attention of farmers and agricultural extension workers to reduce land degradation and increase potato production.

5.1 Summary of Findings

The findings of this study were arranged objective by objective as indicated below;

5.1.1 Types of Land Degradation in Muko Sub County

Findings in relation to the types of land degradation in Muko Sub County revealed that, 35.1% of the respondents reported that there was soil fertility decline in the study area, 29.2% of the respondents reported soil erosion, 14.6% of the respondents revealed that there was vegetation loss in Muko sub county, 11.7% of the respondents reported stone appearance while 9.4% revealed that there was waterlogging in Muko sub county.

It was also revealed that soil erosion is the most widely recognised and most common form of land degradation and, therefore, a major cause of falling productivity. However, since the effects of soil loss vary depending on the underlying soil type, soil loss, by itself, is not an appropriate proxy measure for productivity decline.

5.1.2 Land Degradation Factors affecting Potato Production in Muko Sub County

From the findings, 26.3% of the respondents reported that loss of soil nutrients contributed to low potato yields in Muko Sub County, 21.1% of the respondents reported that runoff caused by heavy rain fall contributed to land degradation and loss of potato production, 17.5% reported that loss of vegetation cover facilitates soil erosion and loss of potato production. Furthermore, 14.6% of the respondents revealed that low water retention by the soil led to reduced potato yields in the study area, 11.7% indicated poor cultivation while the remaining 8.8% noted that overgrazing led to low potato yields. In addition, farmers are always encouraged to carry out terracing in hilly areas to avoid soil erosion but some farmers keep a deaf ear. Therefore soil erosion is very prone to these areas which lead to loss of soil fertility and limited potato productivity.

5.1.3 Measures to improve Potato Production in Muko Sub County

From the findings, 23.4% of the farmers ranked insufficient capital as the major constraints to potato farming, 20.5% and 17.5% of the farmers ranked high cost of farm inputs and pests and disease respectively, 11.7% reported inadequate storage. Furthermore, 10.5% of the farmers noted poor information network as another constraint for potato production while insufficient extension agent and lack of access road were reported by ranked by 8.8% and 7.6% of the farmers respectively. However, 29.2% of the respondents reported that fertilizer and livestock manures as well as and crop vegetative residues would reduce land degradation and improves on potato yields. It was noted by 20.5% of the farmers that terracing improves land degradation and increases potato production. Agroforestry practices improves on soil conservation and improves on productivity of potato production was reported by 19.3% of the respondents. Controlled overgrazing reduces land degradation and increases productivity of land for potatoes as revealed by 16.4% of the respondents. More still, 14.6% of the farmers revealed that provision of information to potato farmers on improved potato technologies by extension workers reduce land degradation and improve potato production.

5.2 Conclusion

The findings found out that soil fertility decline in the study area, vegetation loss, stone appearance and waterlogging in Muko Sub County were the types of land degradation that were affecting potato production in Muko Sub County.

The land degradation factors that were found to be affecting potato production in Muko Sub County were loss of soil nutrients, runoff caused by heavy rain fall, loss of vegetation cover which facilitated soil erosion and loss of potato production, low water retention by the soil, poor cultivation and overgrazing.

The study found out that insufficient capital, high cost of farm inputs and pests and disease, inadequate storage, poor information network, insufficient extension agent and lack of access road were the challenges faced by farmers in potato production. However, it was found out that fertilizer and livestock manures as well as crop vegetative residues would be used to reduce land degradation and improves on potato yields. It was established few people were practicing terracing to improve land degradation and increase potato production. Agroforestry practices

were being practiced to improve on soil conservation and improve on productivity of potatoes. The study also established that controlled overgrazing and provision of information to potato farmers on improved potato technologies by extension workers would reduce land degradation and improve potato production.

5.3 Recommendations

Based on the summary of findings and conclusion of the study;

It is recommended that extension agents should be well involved in disseminating information by using open field days, demonstration and control plots so as to encourage farmers in adopting better production practices.

Government and other stakeholders need to also invest in extension service in sensitizing potato farmers in the study areas as this has the potential to increase farmer's productivity and income.

Poor information network was part of the constraint faced by potato farmers in the study area. Farmers should form a production clusters to improve their market intelligence. This could be achieved through the formation of producer groups or cooperatives. In each group there should be an advisory committee trained in various aspects of marketing which will be able to have access to up-dated pricing information and make it available to farmers on time.

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APPENDIX A: QUESTIONNAIRE FOR FARMERS

Dear Respondent,

I am **Niwaha Richard**, a student at Kabale University undertaking a research study entitled **The Effect of Land Degradation on Potato Production in Rubanda District: A Case Study of Muko Sub County.** You have been identified as one of the respondent to provide information for the study. This is therefore to request you to complete the questionnaire as honestly as possible. All information that you provide shall be treated with utmost confidentiality and will be used for the purpose of this study only.

SECTION A: BACKGROUND INFORMATION OF RESPONDENTS

1. What is your age?

.....……

2. Gender:

Male ( )

Female ( )

3. Marital status:

(i) Single ( )

(ii) Married ( )

4. What is the number of people in your Household? ……

5. What is your highest level of formal education attained?

i No formal education [ ]

ii Primary education [ ]

iii Senior secondary education [ ]

iv Diploma [ ]

vi Degree [ ]

6. How long have you been in the farming business?.....

7. Do you engaged in other activities apart from farming?

Yes [ ] No [ ]

SECTION B: TYPES OF LAND DEGRADATION IN MUKO SUB COUNTY

8 Is there land degradation in your area?

Yes [ ] No [ ]

If yes, what are the types of land degradation in your area?

……

……

……

……..

9 Has potato production reduced as a result of land degradation?

Yes [ ] No [ ]

SECTION C: LAND DEGRADATION FACTORS AFFECTING POTATO PRODUCTION IN MUKO SUB COUNTY

10 where do you get information on the recommended potato production in your area?

……

……..

How many times do receive the information in a year?

……

11. What land degradation factors affect potato production?

……

……

……

……..

SECTION D: MEASURES TO REDUCE LAND DEGRADATION AND IMPROVE POTATO PRODUCTION IN RUBANDA DISTRICT.

12 Are you faced with challenges/constraints in the adoption of recommended potato production practices?

If yes, what are these constraints?

Insufficient capital [ ]

High cost of farm input [ ]

Insufficient extension agents [ ]

Lack of access roads [ ]

Problem of roots/tuber Pests and diseases [ ]

Poor information network [ ]

Others, (specify): ……

13 What will you suggest as the best way to improve the recommended potato production in your village?

……

……

……

APPENDIX B: INTERVIEW GUIDE FOR AGRICULTURAL EXTENSION WORKER

Dear Respondent,

I am Niwaha Richard, a student at Kabale University undertaking a research study entitled **The Effect of Land Degradation on Potato Production in Rubanda District: A Case Study of Muko Sub County.** You have been identified as one of the respondent to provide information for the study. This is therefore to request you to complete the questionnaire as honestly as possible. All information that you provide shall be treated with utmost confidentiality and will be used for the purpose of this study only.

1. Which agricultural practices do you encourage farmers to do in Muko Sub County?
2. Is there land degradation in Muko Sub County?
3. What are the types of land degradation common in Muko Sub County?
4. What land degradation factors affect potato production in Muko Sub County?
5. Do you provide improved seeds to farmers?
6. Do farmers face challenges/constraints in the adoption of recommended potato production practices?
7. How do you sensitise farmers to prevent land degradation?
8. What are the best ways to improve the recommended Irish potato production practices by farmers?