

**ASSESSING THE EFFECT OF INTEGRATED FARM PLANNING (PIP)
APPROACH ON SOIL EROSION CONTROL ON THE SLOPES OF
MOUNT ELGON, EASTERN UGANDA**

**NAMUSOKE REBECCA
20/U/ GMAG/13423/WKD**

**A RESEARCH DISSERTATION SUBMITTED TO THE DIRECTORATE
OF RESEARCH AND GRADUATE TRAINING IN PARTIAL
FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF
MASTER OF ARTS IN GEOGRAPHY OF KYAMBOGO UNIVERSITY.**

NOVEMBER 2024

DECLARATION

I Namusoke Rebecca do affirm that this research thesis entitled “Assessing the effects of the Integrated Farm Planning (PIP) approach on soil erosion control on the slopes of Mount Elgon, Eastern Uganda”, is solely my original work and has not been submitted for any academic award at any academic institution of higher learning. All sources used in this research have been properly cited and referenced. The findings presented in this document are a product of my independent research.

.....

.....

Rebecca Namusoke

Date

APPROVAL

This Thesis has been submitted for examination with our approval as the university supervisors (department of Geography).

Signature:

Date:

Main supervisor

Associate Professor. Barasa Bernard

Signature:

Date:

Second supervisor

Dr. Fiona Mutekanga

DEDICATION

This work is dedicated to my dear spouse, Bryan Corr Mbaziira, my children, Benjamin and Briella, and my father Mr. Mutebi Solomon, and my siblings for their constant support, encouragement, and sacrifice throughout my academic journey.

ACKNOWLEDGEMENT

I wish to express my profound gratitude to the Almighty God for his sufficient and unfailing grace and protection throughout my life and during the period of my study and writing of this thesis. I convey my sincere gratitude to my dear academic supervisors, Dr. Barasa Bernard and Dr. Fiona Mutekanga, for working tirelessly and relentlessly to give shape to this work through their professional mentorship, guidance, and timely comments and suggestions. I am humbled by the sacrifice and the many hours you spent guiding me to come out with the best research work. I am grateful to Ms. Doreen Misanya. I have always looked up to you, and your inspiration and guidance have helped me come this far.

I am extremely grateful to Dr. Aad Kessler of Wageningen University, The Netherlands, and Africa 2000 Network Uganda. Your generous support and financial assistance made this endeavour possible. I am also grateful to the entire staff of the MWARES project and course mates for their feedback and moral support.

Thanks also go to my research assistants for their help during the data collection and to the anonymous respondents for sacrificing their valuable time to give me the information.

Lastly, I would like to express my sincere thanks and gratitude to my family especially my father, siblings, spouse, and children. Their belief in me has kept my motivation and spirit high during this process. Thank you so much for the emotional support.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES	x
LIST OF FIGURES	xi
ABBREVIATIONS	xii
ABSTRACT.....	xiii
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background	1
1.2 Problem statement.....	6
1.3 Research objectives.....	7
1.3.1 General Objective	7
1.3.2 Specific objectives.....	7
1.4 Research questions	7
1.5 Scope of the Study.....	8
1.6 Conceptual framework	9
1.7 Significance of the Study	10
CHAPTER TWO	11
LITERATURE REVIEW	11
2.1 Soil erosion risk on the slopes of Mount Elgon	11
2.2 The PIP Approach	13

2.3 Soil erosion control practices	15
2.4 Constraints faced when implementing of erosion control practices.	15
2.5 Use of GIS in monitoring farming and soil erosion	16
2.6 Soil erosion modelling	16
2.7 RUSLE model	17
CHAPTER THREE	18
RESEARCH METHODOLOGY.....	18
3.1 Study area.....	18
3.1.1 Location	18
3.1.2 Climate.....	19
3.1.3 Topography	19
3.1.4 Soils	20
3.1.5 Population.....	20
3.2 Study Approach	20
3.3 Social-economic data collection.....	21
3.3.1 Research design.....	21
3.3.2 Target Population and Household Size Determination	21
3.3.3 Sampling framework	22
3.3.4 Data collection methods and tools.....	23
3.4 Data analysis	25
3.5 Mapping of soil erosion risk	26
Data 26	
RUSLE model description.....	27
Validation of the model	29
CHAPTER FOUR.....	30
PRESENTATION AND INTERPRETATION OF RESULTS.....	30
4.1 Socio-economic and demographic characteristics of the respondents	30

4.2	Farming practices and soil erosion risk.....	33
4.2.1	Extent of Soil Erosion Risk.....	33
4.2.2	Model validation.....	34
4.2.3	Perceived signs of soil erosion and extent	35
4.2.4	Characterisation of farming practices implemented.	37
4.3	Factors determining the adoption of the PIP approach by smallholder farmers	40
4.3.1	Major determinants for adoption	40
4.3.2	Percentage distribution of the adoption of the practices controlling soil erosion and PIP approach.....	42
4.4	Effectiveness of the PIP approach on the use of soil erosion control practices	43
4.4.1	Smallholder farmer uptake and applicability of the PIP principles	43
4.4.2	Perceived effectiveness of the PIP approach on the use of soil erosion control practices.....	44
4.5	Challenge/ Constraints faced by farmers in the use of soil erosion control measures... ..	47
CHAPTER FIVE		49
DISCUSSION OF FINDINGS		49
5.1	Demographic features of the study group.....	49
5.2	Farming practices and soil erosion risk in the study area.	49
4.6	Factors determining the adoption of the PIP approach by smallholder farmers	50
5.3	Effects of the PIP approach on soil erosion control on the Mount Elgon slopes....	51
5.4	Constraints faced by farmers in the use of soil erosion control measures.	52
CHAPTER SIX.....		54
CONCLUSIONS AND RECOMMENDATIONS.		54
6.0	Conclusion.....	54
6.1	Recommendations	55
REFERENCES		57
APPENDICES		63

Appendix I: Household Survey Questionnaire.....	63
Appendix II: Focus Group Discussion Guide	73
Appendix III: Key Informant Interview Guide	75
Appendix IV: RUSLE model.....	76

LIST OF TABLES

Table 1: Social and demographic characteristics of the respondents.	32
Table 2 The social and economic characteristics of the respondents.	32
Table 3 Categorisation of soil erosion risk (threshold).....	33
Table 4: Extent of soil erosion risk.	35
Table 5: Farming Practices being implemented among the study groups.	38
Table 6 Farming practices and associated soil erosion risk.....	38
Table 7: Association of study characteristics and use of soil erosion control practices.....	41
Table 8 Adoption of the PIP approach and other factors.....	42
Table 9: Effectiveness of PIP principles on the use of erosion control practices (N=173)	44
Table 11: PIP approach and its influence towards the use of soil erosion control practice the training offered.	46
Table 12 Constraints faced by farmers in using soil erosion control measures.....	47
Table 13 Constraints faced by farmers in implementing soil erosion control measures along the slope.	48

LIST OF FIGURES

Figure 1: Conceptual Framework. Source: Researcher's conceptualisation	9
Figure 2: Map of the study area	19
Figure 3: Topography of the study area	20
Figure 4: Study Sampling framework	23
Figure 5: Converging for a Focus Group Discussion with farmers in Bushika subcounty.	24
Figure 6: Map showing soil erosion hotspots in the study area	29
Figure 7 A graphical representation of various sources of household income	33
Figure 9: Soil erosion risk of Bushika sub-county	34
Figure 10: Soil erosion risk of Bumasheti sub county	34
Figure 11: Receiver operating curve (ROC)	35
Figure 12 Farmers perception on extent of signs of soil erosion	36
Figure 13 Farmers perception on extent of erosion	36
Figure 14: Dirty water of River Manafwa a sign of erosion up stream.	37
Figure 15: Exposed rocks in a farmer's garden in Bumasheti	37
Figure 16: Exposed tree roots in Bushika sub county a sign of erosion	37
Figure 17: Mixed cropping in Bunamee in Bumasheti sub county	39
Figure 18: Digging up slope in one of the gardens in Bukibokolo in Bumasheti sub county.	39
Figure 19: Mulching practiced in Munyende village to control erosion.	40
Figure 20: Trenches in a farmer's garden in Bushaki village	40
Figure 21: Elephant grass planted along the stretches to stabilise them	40
Figure 22: Zero grazing practised by a farmer in Bunabutiti village in the Bushika sub county.	40

ABBREVIATIONS

AHI	African Highlands Initiative
EUROSEM	European Soil Erosion Model
EGEM	Ephemeral Gully Erosion Model
GIS	Geographical Information System
MWARES	Manafwa Watershed Restoration and Stewardship
NGO	Non-Government Organization
PIP	Integrated Farm Plans
PMA	Plan for Modernisation of Agriculture
RS	Remote Sensing
RUSLE	Revised Universal Soil Loss Equation
SALT	Sloping Agricultural Land Technology
SEMMED	Soil Erosion Model for Mediterranean Regions
UBOS	Uganda Bureau of Statistics
USLE	Universal Soil Loss Equation

ABSTRACT

Soil erosion is a major contributor to land degradation, attributed to inappropriate farming practices, rigid cultural beliefs, and the steep nature of the landscape. This has resulted in a reduction in soil productivity, leading to food insecurity. The government of Uganda has enacted natural resource management policies, such as the NUSAF (Northern Uganda Social Action Fund), Uganda's wildlife conservation policy, Environment Act, and afforestation in degraded land areas, however, these efforts have been largely ineffective due to their top-down nature. The PIP approach, which is a bottom-up strategy involving the lowest-level stakeholders, aims to address these issues. The study objective served to assess the effectiveness of the PIP approach (Integrated Farm Planning) on soil erosion control practices. A quasi-experimental design was used to draw a comparison between the selected sub-counties of Bumasheti (control) and Bushika (intervention) in Bududa District, Eastern Uganda. This was achieved by evaluating the impact of farming practices by smallholder farmers on soil erosion risk, identifying the constraints farmers face in using measures that control soil erosion and assessing various factors determining the adoption of the approach. The study used is based on primary data collected from 277 georeferenced respondents using the Global Positioning System (GPS). To map the extent of soil erosion risk, Remote Sensing and GIS, along with the Revised Universal Soil Loss Equation (RUSLE), were employed in the study area between 2019 and 2023. The study used mixed methods, and household interviews, Key Informant Interviews (KIIs), and Focus Group Discussions (FGDs) were conducted to gather socio-economic data. A total of 277 records were analyzed; data cleaning was performed in Excel, and statistical analysis was carried out using STATA 15. Descriptive tools such as frequencies, percentages, and means were used for univariate analysis, chi-squared tests for bivariate analysis, and logistic regression for multivariate analysis. The study's findings revealed that farming practices such as agroforestry (69%), trenching (86%), planting Napier grass (67%), and planting cover crops (49%) have contributed to a reduction in soil erosion risk in the study area. Further analysis indicated that marital status ($\text{Chi}=32.7295$, $p=0.000$), receiving training ($\text{Chi}=54.6766$, $p=0.000$), extension services ($\text{Chi}=16.5296$, $p=0.000$), education level ($\text{Chi}=9.8533$, $p=0.02$), and age ($\text{Chi}=8.38$, $p=0.0038$) were significantly associated with the PIP approach adoption. The PIP approach has positive effects on soil erosion control, attributed to its principles of integration (90%), collaboration (86%) and empowerment (87%), the three pillars of PIP. The power of the PIP plan empowers and motivates farmers to work together and take action to restore and conserve their environment independently. Major constraints faced by farmers in implementing soil erosion control measures include limited financial resources (23%), limited labor (21%), and inadequate tools for certain practices (19%). However, with training from the PIP approach and its principles, many of these constraints can be addressed. In conclusion, the PIP approach plans to motivate families to work together through collective action to conserve the land. This suggests that, when adopted by farmers, the approach can significantly contribute to soil conservation and restoration. The study recommends increasing awareness-raising workshops and PIP training among community members.

CHAPTER ONE.

INTRODUCTION.

1.1 Background

In sub-Saharan Africa, severe land degradation has threatened agricultural productivity, undermining efforts to reduce poverty (Barungi et al., 2013). It is regarded as the most serious form of land degradation worldwide and is increasing despite efforts to curb it (Obalum et al., 2012; Chapman et al., 2021). It is rampant in developing countries like India, China, and Uganda and in developed countries like Spain (Barungi et al., 2013; Jiang et al., 2014; Wuepper et al., 2020). It is estimated that 12 million hectares of cropping land and 75 billion tons of soil are lost leading to 38% of global cropland lost (Ighodaro et al., 2016). This is attributed to the removal of topsoil thus effecting the productive capacity of the soil negatively, water quality, and ecological well-being (Jiang et al., 2014; Semalulu et al., 2014). Soil erosion often does not receive the attention it deserves due to its gradual nature, and measures are always not implemented until it reaches a point where it's too costly (Ighodaro et al., 2016). Due to soil erosion, productivity has declined by 50% in some African countries (Barungi et al., 2013; Wuepper et al., 2020).

East Africa has been highlighted as the focal point of soil erosion (Chapman et al., 2021). Uganda is one of the countries in East Africa with very high rates of soil erosion; it is widespread and varies in magnitude from one part of the country to another depending on the farming systems and practices, population pressure, the abundance of rainfall, the vulnerability of the soil to denudation and local relief (Barungi et al., 2013). The increase in soil erosion is due to poor farming methods, population pressure, and the steep nature of the landscape. It is further accelerated by poverty, limited knowledge, and cultural beliefs (Barungi et al., 2013). To meet their livelihoods, people in developing countries like Uganda use land unsustainably, as manifested in overgrazing, destruction of forests, unscientific agricultural activities, and slash-and-burn practices, among others (Buyinza & Mugagga, 2010; Mugagga et al., 2012). As a result, soil erosion causes negative on-site and off-site environmental, economic, and social outcomes. These negatively impact the soil quality leading to low agricultural productivity, water pollution, flooding, and habitat destruction. This diminishes the soil's ability to produce adequate food (Ighodaro et al., 2016;

Karamage et al., 2017). As a result, approximately 66% of the global population is presently experiencing malnutrition. In Uganda, once a child reaches the age of two, the consequences of stunting become irreversible, with 54% of today's adults having experienced stunting during their childhood. (Karamage et al., 2017).

Soil erosion has greatly contributed to soil loss in Uganda and the worst affected areas are highland areas of eastern Uganda (Bududa, Bulambuli, Sironko) which have an estimated percentage of 75%-80%, South Western Uganda in areas of Kabale and Kisoro estimated to be 85%-90% and some dry areas of Moroto, Nakasongola, and Rakai (Karamage et al., 2017). The need to manage the increase in soil erosion has led to the development of several models that can be used in assessing its risk (Meliho et al., 2020). According to Atoma et al., (2020), Geographic Information Systems (GIS) and Remote Sensing (RS) are of advantage in the modelling of soil erosion. These can be integrated with the RUSLE model (Revised Universal Soil Loss Equation) and can be used to assess the spatial extent and soil erosion (Thapa, 2020). The RUSLE model is the most widely used method and this is attribute to the reliability of its results, availability and access to it data, and its simplified applicability (Ghosal, 2020).

Although soil erosion cannot be prevented, it can be controlled and reduced (Xiong et al., 2018). Many solutions to address the effects of soil erosion have been suggested, and many have centred on the use of resource sustainably, especially by using soil conservation techniques (Turinawe, 2019). In Uganda, from 2010, between 45% and 80% of the country's annual budget is dedicated to sustainable land management specifically towards the advancement and spread of soil conservation methods (Turinawe, 2019). However, the techniques employed by farmers vary based on factors such as terrain, their perception on effectiveness, associated costs, and the availability of information regarding these technologies (Turinawe, 2019). Just like in Ethiopia, the most commonly used soil conservation techniques in Uganda include: afforestation, terraces, mulching, hedgerows, strip cropping, contour bunds, manure/compost, minimum tillage, crop rotation, agroforestry, cover crops, and fallowing, among others (Xiong et al., 2018; Belachew et al., 2020). These practices are used in highland areas like on the slopes of Mt Elgon and their adoption by farmers is a positive step towards increasing economic growth, especially in the agrarian economies like Uganda (Barungi et al., 2013). In banana-coffee farming systems, Wairegi et al. (2016) suggest that soil and water conservation measures could include terraces, bunds, trenches, and off-drains.

Farming by rural households is the backbone of the food system in Sub-Saharan Africa (Giller et al., 2021). These activities have developed among smallholder farmers over decades and around the world (Asten et al., 2015). For example, intercropping of bananas and coffee is practised in countries like Columbia, Latin America, and Indonesia (Asten et al., 2011) and in Eastern Uganda on Mount Elgon slopes. Good farming practices sometimes referred to as soil conservation practices are crucial in protecting biodiversity, reducing environmental degradation, improving soil quality, and controlling soil erosion (Galnaitye, 2017). These practices include planting cover crops, minimising tillage, intercropping, crop rotation, and perennials, integrating livestock and crops, and application of fertilizers plus agroforestry. In the Elgon region, intercropping is mainly of banana and coffee (Wairegi et al., 2016). Other crops grown include maize, Irish potatoes, and beans, and livestock activities include cattle rearing (Elgon investment profile, 2018). However, these farming practices can also contribute to a reduction in soil quality, hence accelerating soil erosion (Woniala & Nyombi, 2014; Dhiman, 2020).

Apart from the already practised soil conservation measures, there have been interventions like natural resource management policies by the government, for example, the Plan for Modernisation of Agriculture (PMA), among others. However, despite these interventions, soil erosion along the Mt. Elgon slopes persists. This study examines the contribution of an integrated farm planning approach to controlling soil erosion along the Mt. Elgon slopes in Eastern Uganda. This approach, referred to as the PIP approach, uses a learning-based intervention to engage smallholder farmers in learning and practising soil and water conservation practices aimed at soil erosion control. PIP learning processes focus on changing smallholder farmers' perceptions towards sustainable soil conservation practices and soil erosion control.

1.1.1. The PIP approach.

PIP is an acronym for the 'Plan Intégré du Paysan' (in French). In English, it means the Integrated Farm Planning approach. The PIP approach finds its origin in Bolivia, where it was developed and first tested in 2000-2003, where integrated farm planning was part of a strategy that changed the passive Bolivian Andes farmers into active participants in natural resources conservation (Kessler et al., 2016). It was further developed in Burundi from 2013-2016 by the SCAD project (Projet de Solidarité Communautaire pour l'Auto Developpement), in the three provinces of Gitega, Muyinga, and Makamba. In Burundi still, the next phase of developing and validating the approach was done by the PAPAB project at a larger scale in six provinces and with enriched new components and experiences (Kessler et al., 2016). The approach was further

implemented in Uganda by the MWARES project in 2019. This was in the Bududa district in Eastern Uganda, which is in three sub-counties: Bushika, Bushiyi, and Bukalasi. The approach is expanding to other parts of Uganda and Africa at large.

The PIP approach emphasises sustainable land management. This is in response to increased pressure on land as smallholder farmers try to feed their growing families on small pieces of land, leading to overuse of the land and loss of soil nutrients, resulting in a decline in food production. In addition, soil erosion, drought, and irregular intensive rainfall due to climate change have negatively impacted the soil quality, leading to land degradation. This decline in soil productivity and crop yield greatly impacts food and financial security, forcing farming households to start farming on land unsuited for intensive farming (for example, steep slopes), resulting in more catastrophes. Sustainable land management feeds all people on the planet, therefore the focus of the PIP approach is on people and land because motivated people who invest in their land with good practices create and maintain sustainable food production (Kessler et al., 2018). In the PIP approach, intrinsically motivated farmers and productive land are cornerstone for sustainable development. This is simplified by the approach's slogan of "proud farmers, better soils, and more food."

The aim of the PIP methodology is to promote robust agricultural systems and resilient ecosystems that sustainable local development. It focuses on farms capable of withstanding or bouncing back from shocks such as droughts, landslides, pests, and diseases and continue producing food sustainably (Kessler et al., 2016). Managing complex societal issues such as land degradation cannot be done by top-down interventions or incentive-based approaches because only the self-reliant efforts of poor people and poor societies themselves can end poverty (Kessler et al., 2021). Therefore, development agencies and groups should become enablers of bottom-up community-based development.

The applicability of the approach is based on planning (the PIP itself). Where farmers look at their current situation and plan for a better future using an action plan. The entire process starts with a series of awareness raising workshops at the subcounty, village and parish levels (community level). In these awareness raising workshops, the PIP approach is introduced, the social, economic and environmental problems affecting the community are discussed and possible solutions are to the problems are discussed. This is followed by selecting the 25 Farmer Innovators (PIs) who are participatorily selected by the community members themselves this is because they are representatives of the community. The PIs should not come from the same household (each

household should be represented by one individual) and should be a member in that community (A. Kessler et al., 2018). The selection is followed by training the PIs in PIP at household level who later after training they are presented to the community in a big gathering called “open days” (all community members are gathered, and the PIs showcase what they have learned) and they are launched to train fellow farmers in PIP approach at household level. This is followed by PIP at the Community/subcounty level.

Pip approach involves drawing two drawings and an action plan. The first drawing is called our current situation, the second is called our desired/ future situation, the two drawings are followed by an action plan that will be followed to help the family/community to shift from the current situation to the desired situation. This plan looks at environmental, social, and economic aspects of the household or community for example Sustainable Land Use Management, water sanitation and hygiene, education, accessibility to the markets etc. All this is done based on the PIP approach principles (Kessler et al., 2021). In addition, when drawing household PIPs, the entire household members should be involved and the same applies to community PIPs there should be a good representative of the community members. These PIPs are usually pinned in an open space where they can be seen by household and community members. Implementing them should be done together as a community or household (collaboration principle).

1.2 Problem statement

Soil erosion is a main contributor to land degradation, which results in low agricultural productivity. This is attributed to inappropriate farming practices, rigid cultural beliefs, the steep nature of the landscape, and poverty (Mwanake et al., 2023). Soil erosion results in a reduction in water quality, soil productivity, and the ecological wellbeing of the environment, leading to food insecurity (Karamage et al., 2017). To address these impacts, the government of Uganda has passed natural resource management policies and these include planting trees in degraded land areas, Uganda's wildlife conservation policy, improvement in the farming systems, Environment Act, and terrace improvement, (Buyinza & Mugagga, 2010). Other approaches have been applied in the Elgon region, including the NUSAF, which promoted water and land conservation practices, and PMA (Plan for Modernization of Agriculture). In addition, various Non-Governmental Organizations (NGOs) like Sloping Agricultural Land Technology (SALT), and the African Highlands Initiative (AHI) projects, together with the Ministry of Agriculture, Animal Industry and Fisheries, have conducted training sessions for farmers focused on soil conservation techniques on the slopes of Mount Elgon. While many of these initiatives aim to enhance agricultural practices in Uganda, sustainable production remains elusive, and land degradation persists. This is because most of the programs are top-down and do not trigger intrinsic motivation among the farmers, leading to a lack of ownership and stewardship among the smallholder farmers. Therefore, this study looks at the Integrated Farm Planning approach, with a participatory bottom-up methodology that is geared towards changing the mindset of the farmers towards resilient farming plus soil conservation. PIP is being implemented in Bududa district in 3 Sub counties: Bushika, Bushiyi, and Bukalasi. However, its adaptability rate and effectiveness on soil erosion control have not been given attention, yet this information is important to farmers and policymakers in the Elgon region. There is a need to adopt research paradigms based on participatory and interdisciplinary catchment approaches with key elements of providing scientifically sound information for decision-makers and the involvement of key stakeholders. Therefore, this study explored the contribution of a participatory bottom-up approach (PIP) towards soil erosion control on the slopes of Mount Elgon.

1.3 Research objectives

1.3.1 General Objective

The study sought to investigate the soil erosion risk and how the PIP approach has contributed to soil erosion control by smallholder farmers on the slopes of Mount Elgon.

1.3.2 Specific objectives

1. To assess the effects of farming practices by smallholder farmers on soil erosion risk on the slopes of Mount Elgon.
2. To establish the factors that determine the adoption of the PIP approach by smallholder farmers on the Mount Elgon slopes.
3. To assess the effectiveness of the PIP approach on soil erosion control on the slopes of Mount Elgon.
4. To ascertain the constraints faced by farmers when implementing soil erosion control measures as promoted by the PIP approach.

1.4 Research questions

The key research questions answered in the study results include:

- i) What are the effects of farming practices by smallholder farmers on soil erosion risk on the slopes of Mount Elgon?
 - a. What is the geographical extent of soil erosion risk?
 - b. What is the characterisation of farming practices implemented by the smallholder farmers?
- ii) What factors determine the adoption of the PIP approach by smallholder farmers on the slopes of Mount Elgon?
 - a. What are the major determinants of the PIP approach?
- iii) What are the effects of the PIP approach on the use of soil erosion control practices on the slopes of Mount Elgon?
 - a. What are the effects of the PIP principles?
- iv) What constraints/ challenges do smallholder farmers face in implementing soil erosion control practices as promoted by the PIP approach?

1.5 Scope of the Study

The research study was conducted in Eastern Uganda on the Mount Elgon slopes in Bududa District, in the Sub Counties of Bushika and Bumasheti. Bushika Sub County was chosen because it is one of the areas implementing the Integrated Farm Planning approach, and Bumasheti was chosen as a control Sub County because it is located on the steep slopes close to the National Park, just like Bushika, and all have evidence of soil erosion. The research concentrated on assessing the impact of the PIP approach (Integrated farm planning approach) on soil erosion control practices, mapping soil erosion hotspots in the area and determining the use of soil erosion control practices. The study was conducted in July 2022 using an intervention and control subcounty. The themes of the study were erosion control, erosion mapping and the perception of farmers using Key Informant Interviews, household surveys, and focus group discussions.

1.6 Conceptual framework

The conceptual framework in this study illustrates the link between the Integrate Farm Planning (PIP) and its effectiveness on erosion control on the Mount Elgon slopes. The PIP approach and its core principles are independent variables. The use of soil erosion control practices is the dependent variable. Rampant erosion of the soil in the Elgon region is mainly due to increased population, poor farming methods, and the mountainous nature of the landscape. This experience calls for the adoption of soil conservation practices by smallholder farmers. As such, the PIP approach was adopted to equip smallholder farmers with coping strategies and mitigation measures to avert the soil erosion extent along the Mt. Elgon slopes. Under the Integrated Farm Planning approach, the foundations and guiding principles have proven to have positive effects on the use of practices that control soil erosion among the farmers which then help in reducing soil erosion risk and extent. This study was conceptualized based on this model to test the effectiveness of the PIP Approach (principles) on soil conservation, soil erosion control practices, and soil erosion risk and extent along the slopes of Mt. Elgon.

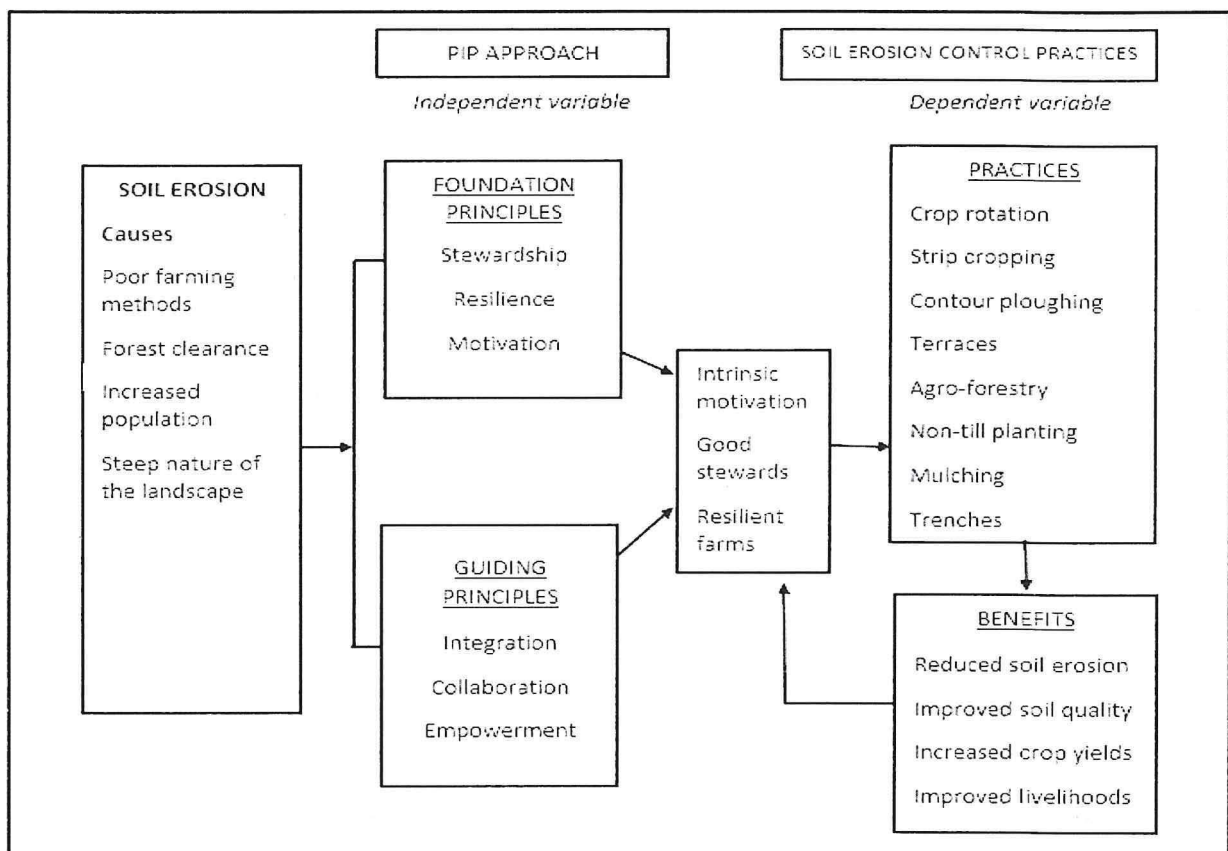


Figure 1: Conceptual Framework. Source: Researcher's conceptualisation

1.7 Significance of the Study

This study aimed to investigate the PIP approach's contribution to management of soil degradation on the Mt. Elgon slopes. The researcher was looking at how PIP training has contributed to the increased use of practices that lead soil erosion control, reduction of erosion risk and extent along the slope of Mt. Elgon. These findings will help the stakeholders in Bududa district to understand the effectiveness of the PIP approach in improving soil conservation, therefore as useful information in policy improvement or formulation and implementation directives to the officials in Bududa district.

The study findings will also help the implementers of the PIP approach to evaluate the effectiveness of the intervention and document key areas for improvement for better outcomes before the end of the project cycle.

The study results will also help other stakeholders, including smallholder farmers in the Bududa district, understand the most resilient farming methods well suited for the steep nature of the Mt. Elgon areas. Adapting this learning will then help improve the adoption of effective practices that lead to soil conservation, reduce erosion risk plus extent, and increase agricultural productivity.

Through the enlightenment of the farmers, policy formulation will be simplified as the lowest stakeholders will also realise their importance in decision-making in the conservation and restoration of the environment. This will make formulation and abiding by the bylaws easy as the lowest stakeholders will be empowered to take part in it.

CHAPTER TWO

LITERATURE REVIEW

2.1 Soil erosion risk on the slopes of Mount Elgon

Soil erosion in watersheds is by either soil mass movement, surface or gully erosion. Surface erosion refers to process in which topsoil particles and minor aggregates are detached and carried away from site by water or wind. This type of erosion is primarily triggered by the impact of rain drops and surface runoff. Gully erosion is the process by which soil particles are detachment and transported in a well-defined channel. It is accelerated by inadequate land management practices. Soil mass movement describes the process of erosion where cohesive groups of soil and rock material are displaced and transported downhill due to gravitational forces. This movement occur rapidly as seen in landslides or slow such as creep and channel slumps (Ffolliot et al., 2013).

Soil erosion is a two-phase process involving the detachment of individual soil particles from the soil mass and their transportation by erosive agents such as running water and wind. When there is a reduction in the energy to transport, a third phase of deposition occurs (Morgan, 2005). The process of soil erosion is modified by terrain, soil, ground cover, and climate (Ganasri & Ramesh, 2016). Rain splash is the most important detaching agent as it strikes the bare soil surface. According to Morgan (2005), soil can also be broken up by the weathering process, both mechanical and biochemical. It is also disturbed by the tillage and trampling of people and livestock. Running water and wind are further contributors to the detachment. All these processes loosen the soil so that it can be easily removed by the agents of transport. The transporting agents comprise rain splash, surface runoff/overland flow, and wind. There is also transportation in small channels known as rills, gullies, and rivers (Morgan, 2005; Pimentel et al., 2009).

There are various types of soil erosion, and these include splash erosion is also referred to as raindrop erosion. This is because it starts with the fall of rain. This type of erosion occurs when a raindrop hits the soil and disintegrates the soil particles splashing them up and away and making the particles vulnerable to being swept away by other forces. Sheet erosion is another type of erosion where soil particles broken down by splash erosion are washed away by running water. Heavy rain or runoff that crosses a shallow surface can allow enough water to gather to pull the loosened soil particles from surfaces and sweep them away. Rill erosion is another type of erosion

that leaves the ground marked with parallel lines of small clear-cut channels. The rills are generally no more than 30cm deep. If rills are not attended to and the water keeps on taking away soil particles, the rills will be widened into gullies. Gullies are channels that are very deep and cannot be eradicated by normal tillage and these are due to a type of erosion called gully erosion.

The major causes of soil erosion are water and wind (Ighodaro et al., 2016). The effects of these two are accelerated by human activities, as explained. And clearance of vegetation for agricultural purposes. The increasingly high demand of a growing population for commodities like coffee, and food among others has led to the clearing of land for agriculture and settlement (Borrelli et al., 2017; Karamage et al., 2017). According to Karamage et al., (2017) there has been a lot of forest clearance in the Elgon region. Therefore, this study seeks to find out how the PIP approach promotes sustainable land management to restore degraded land resulting from overgrazing, continuous tillage, and unsustainable agricultural practices (Pimentel et al., 2009). According to Karamage et al., (2017), over cultivation without proper soil conservation practices can have negative effects on the soil especially. Since the PIP approach emphasizes sustainable land management, this study seeks to find out if it's effective in the Elgon region. Poverty, landlessness, lack of rural jobs, and rapid increase in population force farmers to compete for a limited land base hence farming on marginal land leading to increased soil erosion (Olabisi, 2012).

According to Morgan (2005), the increasing pressure as world population numbers continue to grow, meeting the greater demand for food through more intensive use of existing land will increase erosion, and failure to control erosion will lead to food insecurities. According to UBOS (2017), Bushika has the highest population in the Bududa district. Therefore, this study seeks to find out how the PIP approach is increasing the adoption of soil conservation practices and improvement of livelihoods so that the increasing population and poverty don't accelerate soil erosion. The steep nature of the landscape also causes and accelerates soil erosion in mountainous areas (Karamage et al., 2017). Since the Mount Elgon slopes have steep landscapes, this study seeks to find out the different causes of soil conservation practices suitable for steep landscapes.

The most harmful effect of soil erosion is reducing crop productivity. It reduces the availability of water, nutrients, and organic matter. This is due to rapid run-off, where most of the water is lost, reducing the availability of water to plants (Pimentel et al., 2009). In addition, water and wind erosion reduces the water-holding capacity of the soil by removing organic matter and the finer soil particles. Water infiltration may reduce as much as 90% in soils degraded by erosion. Shortages of soil nutrients removed by erosion limit soil productivity (Morgan, 2005). According

to Pimentel et al. (2009), it leads to serious off-site environmental effects. Sediments from erosion fill riverbeds, lakes, and reservoirs significantly reducing their usefulness for navigation, irrigation, hydroelectric power, fisheries, and recreation. It has also led to pollution and eutrophication of rivers and lakes (Karamage et al., 2017).

According to Morgan (2005), there is a clear need for soil protection, but the case for it needs to be made concerning local on-site and offsite effects. This study seeks to find out the effectiveness the Participatory Integrated Planning approach on soil erosion control on the slopes of Mount Elgon. Erosion has adverse effects on productivity of the land, and it must be regulated using soil conservation practices (Morgan, 2005; Pimentel et al., 2009; Karamage et al., (2017). Therefore, this study seeks to find out the impact of the PIP approach on the adoption of practices that conserve the soil leading to reduced soil erosion on the slopes of Mount Elgon.

Good farming practices are soil conservation practices, and these have proven to be effective in achieving sustainability, improving soil quality, and reducing soil erosion (Galnaitytè, 2017). These include intercropping, crop rotation, planting cover crops and perennials, reducing tillage, integrating livestock and crops, and agroforestry. In the Elgon region, intercropping are mainly of banana and coffee (Wairegi et al., 2016). Other crops grown include maize, Irish potatoes, beans, and livestock activities such as cattle rearing (Elgon investment profile, 2018). However, poor farming practices like monoculture can also contribute to a reduction in soil quality due to the loss of soil nutrients and accelerate soil erosion (Woniala & Nyombi, 2014). Therefore, this study seeks to assess the soil erosion risk of farming practices.

2.2 The PIP Approach

The Integrated Farm Planning (PIP) approach, known as Plan Intégré du Paysan in French, was implemented and developed for the first in Bolivia between 2000 and 2003. Subsequently, from 2013 to 2016, it was implemented in Burundi through the Fanning the Spark (SCAD) Project. In a follow-up phase, this approach was scaled up and tested within the PAPAB project (A. Kessler et al., 2018). The approach was later introduced to more countries in African countries such as Uganda in Bududa district, Rwanda, and Ethiopia. It was first implemented in Uganda in 2019 within Bududa district under the MWARES project. The approach concentrates on motivated farmers and better performing soils, emphasizing a focus on both land and mindset of the people. Kessler et al., (2018) assert that committed individuals paired with healthy land the cornerstone of sustainable development.

This approach primarily intends to promote resilient farming systems to withstand, and overcome multiple shocks such as floods, droughts, or pest infestation to foster sustainable food production via resilience-based stewardship. This stewardship motivates farmers to preserve their land and to increase the resilience of their farms (Kessler et al., 2018). In this study the researcher intends assess the contribution of the Integrated Farm Planning approach to soil conservation on Mount Elgon slopes. There are three PIP approach foundation principles, and these include stewardship (responsibility to manage and protect), and resilience (ability of the land to return to its original condition) and motivation (inspiration to act) (Kessler et al 2021). In the study, the researcher intended to find out how pip builds intrinsic motivation among the farmers and how this gives them the ability to manage and protect their land. Furthermore, PIP is based on three guiding principles of integration, collaboration and empowerment all of which are key in defining a strong community structure (Kessler et al., 2018).

The approach addresses critical needs by promoting empowerment that helps farmers recognize their capacity for change while fostering a collective family vision. It encourages integration by allowing diverse activities without relying on external incentives but rather, it cultivates intrinsic motivation among participants. Collaboration is stimulated through open days and exchange visits that facilitate rapid scaling up of practices while engaging institutional stakeholders like policymakers alongside dedicated personnel who believe wholeheartedly in this approach. In practical terms, implementing the approach unfolds over four phases the first phase is community awareness raising lasting two months, second phase is creation of PIPs with Farmer Innovators over four months, the third phase is scaling up PIPs within each community over one year. And this is followed by expanding into neighbouring communities over an additional (A. Kessler et al., 2018)

As highlighted by Rik Linssen, (2020), the approach leads to a growing number of proud and motivated farmers who come to understand that land is a vital and they have an intrinsic motivation for investing in its improvement. PIP is a bottom-up approach that intrinsically motivates the farmers to engage actively sustainable land management. This was highlighted by Olabisi (2012) who noted that effective erosion control often starts from decisions made by the lowest stakeholder who is a farmer at the household level. Therefore, this study is geared towards assessing whether the PIP approach can effectively contribute to soil conservation and sustainable land management practices on Mount Elgon's slopes.

2.3 Soil erosion control practices

According to Pimentel et al. (2009), the most effective method of controlling soil rapid runoff and soil erosion is planting and maintaining of enough vegetative cover. Plants leaves interrupt the energy in rain drops making water to get to the surface with no damage. In addition, roots, stems, and organic matter reduce runoff by 90% and increase infiltration into the soil. There are different proven conservation technologies for different soil types, crops, slopes, rainfall, and wind. These include strip cropping, crop rotation, terraces, contour ploughing, mulches, grass strips, non-till grass strips, planting, ridge planting, tree/shrub hedge, agroforestry, shelter belts, infiltration ditches, trenches among others (Morgan, 2005; Pimentel et al., 2009; Turinawe, 2019; Karamage et al., 2017; Belachew et al., 2020;). Soil conservation techniques have a lot of functions that provide different ecological services such as increasing soil fertility, improving land productivity, increasing crop yield, and ensuring food security, creating aesthetic landscapes, enhancing biodiversity (Xiong et al., 2018).

According to Belachew et al. (2020), soil conservation and environmental protection are important in enhancing crop yields and improving the livelihoods of rural farming households. The need to control erosion has attracted global and national attention. For example, the United Nations Global Development Agenda 2030 addresses soil erosion control under the Sustainable Development Goals (SDG). In Uganda, Uganda's Green Growth Agenda 2017/2018-203/31 emphasises the protection of natural capital, and the third National Development Plan (NDP III 202/21-2024/25) seeks to reduce environmental degradation (Bamutaze et al., 2021). In addition, the government of Uganda has encouraged more policies for management of natural resource and these include; improvement in the farming systems, Uganda's wildlife conservation policy, Environment Act, planting trees in the degraded land areas, and terrace improvement (Buyinza & Mugagga, 2010). Other approaches have been applied in the Elgon region, including (PMA) Plan for Modernization of Agriculture and NUSAF, which promoted water and land conservation practices. All these are top-down and do not cater for the opinion of the lowest stakeholder. Therefore, this study is assessing the impact of the PIP, a bottom-up integrated approach to soil conservation, since it is also geared towards people and land. And it is also assessing the effect of these practices on the production of crop and livestock.

2.4 Constraints faced when implementing of erosion control practices.

Smallholder farmers face various constraints when implementing soil erosion control practices. These include perception, limited knowledge, land shortage, limited labour, and financial

constraints (Zelege,2020). There are inadequate extension and advisory services in the Elgon region, and this has led to limited knowledge among the farmers where most of the farmers lack enough knowledge on the best practices like trenches, mulching, agroforestry, and application of herbicides and fertilizers (Barungi et al., 2013). Land shortage constrains farmers from using soil erosion control practices like trenches, terraces, and agroforestry. Trenches absorb land by occupying big spaces, while trees shade crops. Digging trenches is labour-intensive, yet the farmers are constrained by limited labour (Chinseu et al., 2019). Limited capital is also a constraint, as farmers are not financially stable to invest in herbicides during the non-till erosion control practice. According to Jones (2002), farmers' perception is also a constraint as most of the farmers do not consider erosion to be a problem, especially sheet and rill erosion.

2.5 Use of GIS in monitoring farming and soil erosion

According to Chang (2019) a Geographic Information System (GIS) refers to a computer-based system that is used for capturing, storing, retrieving, querying, analysing, and displaying geospatial data. It comprises hardware, software, people, and organization in addition to the spatial data. It has evolved over the past half-century and it has made a lot of contributions to geographic research and applications (Lü et al., 2019). GIS is beneficial in farming as it gives accurate information on agricultural activities like crop identification, classification, growth and yield estimation, mapping soil characteristics, identifying different farming practices, and estimating soil erosion (Vibhute, 2017).

2.6 Soil erosion modelling

Modelling of soil erosion has a long history of more than 7 decades (Alewell et al., 2019). Several methods, including physical models, empirical models, statistical models, etc., have been used by researchers to predict soil erosion (Pandey et al., 2021). These include USLE, (Universal Soil Loss Equation 1965), EPIC (Erosion/Productivity Impact Calculator, 1984), EUROSEM (European Soil Erosion Model, 1993), RUSLE (Revised Universal Soil Loss Equation, 1997), Rill Grow (a model for rill initiation and development, 1998), SEMMED (Soil Erosion Model for Mediterranean Regions, 1999), EGEM (Ephemeral Gully Erosion Model, 1999) etc. All those models have been used to assess soil erosion risk, but results have shown that RUSLE is the most popular model (Pandey et al., 2021).

2.7 RUSLE model

The Revised Universal Soil Loss Equation (RUSLE) is a commonly-known and universally accepted empirical model that is implemented to estimate the annual rate and risk of soil erosion (Ghosal et al., 2020). Its first development was in the 1960s as a field scale model by Wischmeier and Smith of the United States Department of Agriculture. It was later reviewed in 1997 and is still used. To estimate the average annual soil loss (A), five factors are integrated, that is, rainfall erosivity (R) signifies the impact of rainfall intensity the on soil. It needs continuous rainfall data, for computation. The erodibility of the soil (K) reflects the soils susceptibility, to erosion it is evaluated based on soil textures. the soil textures. Slope length and slope steepness (LS). Slope length is the distance from the place of origin of overland flow to a point where deposition starts or to a point where runoff enters a defined channel. Slope steepness represents the effect of the steepness of the slope on erosion. Erosion increases based on the steepness of the slope. Cover management (C) represents the effect of vegetation cover on the rate of soil erosion. Conservation practice (P) accounts for the practices of soil erosion control that minimise the potential of erosion caused by runoff. The model uses satellite images and institutional data like soil and rainfall data (Getu et al., 2022). The model is convenient because it uses satellite images that can easily be obtained using GIS and the model's parameters can easily be integrated with GIS for better analysis.

$$A = R * K * LS * C * P$$

Advantages of the RUSLE model.

The model predicts erosion cell-by-cell, which is effective when attempting to identify the spatial pattern of soil loss on a large scale.

The model requires land use and land cover maps, which can easily be generated using GIS. The model's parameters can also easily be integrated with GIS for analysis.

Disadvantages of the RUSLE model.

The RUSLE model only accounts for soil loss through sheet and rill erosion and ignores the effects of gully and dispersive soils.

The model is limited by the availability and access to local data. Rainfall and soil data are needed to estimate the soil erosion risk but accessing them is difficult.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study area

3.1.1 Location

The study was conducted in Bududa district which was carved out of the Manafwa district in 2006. It is in the Eastern region of Uganda bordering the Republic of Kenya in the east, Mbale is found to the west, while the districts of Kween, Sironko, and Bulambuli are located to the north. and in the south it is Manafwa district. This region is positioned between longitudes $34^{\circ} 16' 18''$ and $34^{\circ} 32' 6.69''$ East, as well as latitudes $00^{\circ} 58' 45.63''$ and $1^{\circ} 7' 22.07''$. The total land area measures 274 km², with approximately 40% of it being part of Mt. Elgon National Park (Bududa District HRV Profile, 2016, p. 4).

According to (Karamage et al., 2017) Bududa district is one of the six districts that experience high rates of soil erosion, and it was ranked the highest in 2017. In Bududa District the study was conducted in Bushika Sub County and Bumasheti Sub County. The choice of the two sub-counties was based on their high population sizes (Nakileza et al., 2017) which represent negative effects of the high population on vegetation cover such as clearing vegetation to create more land for agriculture and settlement, and land fragmentation which in turn accelerates soil erosion (Karamage et al., 2017) the PIP approach is being implemented in Bushika therefore, it was studied as an intervention sub-county, while Bumasheti Sub County, which bears the same terrain and socio-economic characteristics as the Bushika sub-county, was used as the control sub-county, given it did not receive PIP intervention approaches.

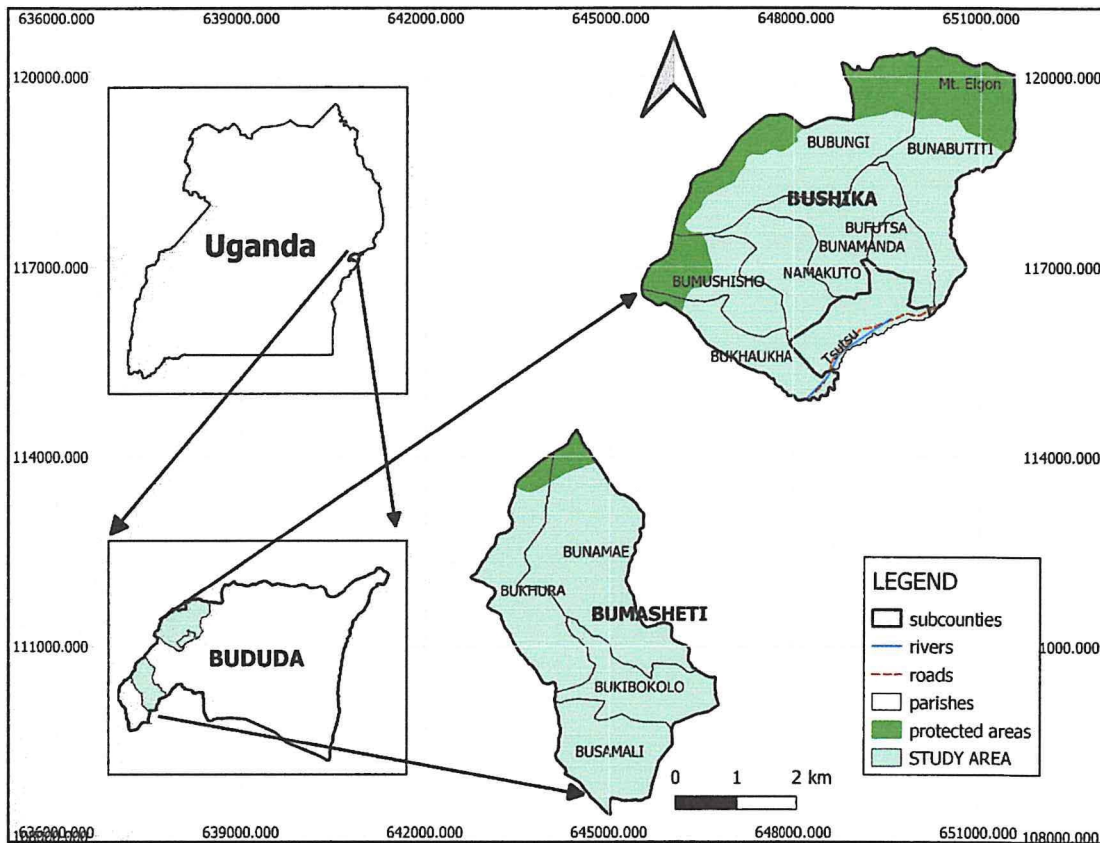


Figure 2: Map of the study area

3.1.2 Climate

Bududa district is in a typically humid tropical climate and the typical maximum monthly temperatures range from 25°C to 29.6°C. There is a prolonged dry spell from December- March 2022. The humidity in the region can generally range between 80% and 90%. The annual average precipitation is about 1800mm per year. There are two farming seasons starting in March to June and from September to November every year (HRV profile, 2016).

3.1.3 Topography

Bududa is dissected by streams and rivers from Mt Elgon, hence the rugged topography, which is characterized by steep slopes mainly in the north and gentle slopes and broad valleys in the south. The highest elevation point is 2068m above sea level and the lowest is 1249m above sea level. Over 60% of the land is located on slopes greater than fifteen degrees which accelerates soil erosion. (Nakileza et al., 2017) and both the intervention and control sub-counties bear equal topography. Thus, the two are comparable Sub Counties.

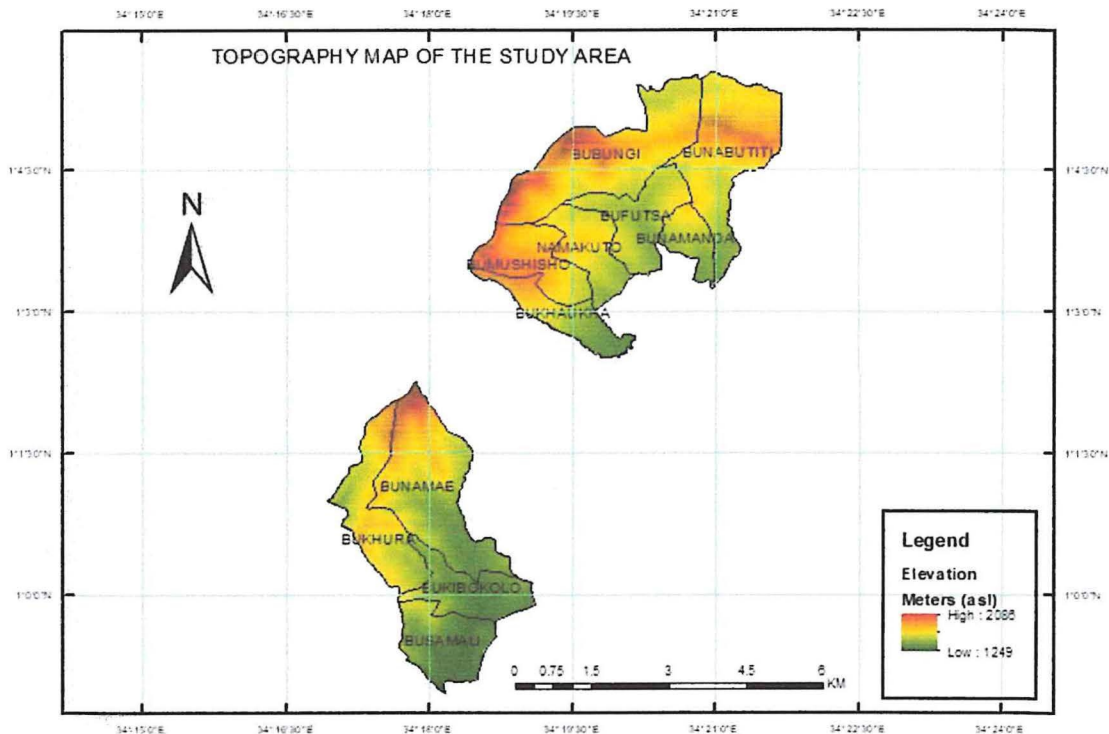


Figure 3: Topography of the study area

3.1.4 Soils

The district's soils are mainly clay loams originating from the volcanic formations of Mt. Elgon, as well as non-laterite brown sandy clay loams originating from the basement complex. The major soil classifications include leptosols, acrisols, lixisols, cambisols, ferrallisols, and gleysols. These variations are primarily influenced by the region's topography and its humid tropical climate (Nakileza et al., 2017)

3.1.5 Population

In terms of population density and size, Bududa is densely populated and according to the (Uganda Bureau of Statistics, 2017) Bushika has the largest population of 31,530 people compared to other Sub counties, and Bumasheti has 18,179 people—nearly half of Bushika’s size. According to Nakileza et al., (2017) Bushika has a high population density, averaging 952 people per square kilometre, with certain parishes reaching up to 1300 people per square kilometre.

3.2 Study Approach

The study approach adopted is mixed methods and it was used to collect data which was both quantitative and qualitative. A quasi-experimental design was used to assess the effectiveness of

the PIP approach on the use of soil conservation practices on the Mt Elgon slopes. It focused on comparing results from one of the MWARES project Sub counties of intervention with a non-intervention sub-county. As such, this study provides a mid-term measure of the effectiveness of the PIP approach on the use of soil conservation measures in the intervention communities.

3.3 Social-economic data collection

3.3.1 Research design

This study used a quasi-experimental research design commonly known as Post-test Only Non-equivalent Groups Design. This design consists of administering an outcome measure to two groups: a project or intervention group and a comparison group. In this case, the intervention group was farmers who received PIP training over a period of 2-3 years, herein known as “PIP farmers”, while the comparison or control group was farmers who did not receive any PIP approach-related training, herein known as “non-PIP farmers”. The main assumption was that the PIP approach trainings had minimal or no spillover effects on the comparison sub-counties. and, similarly, there was little to no external influence on the non-PIP farmers.

In July 2022, we adopted this study methodology to examine the use of soil conservation practices and the extent of soil erosion among PIP farmers in Bushika Sub County Bududa district. The farmers in the control sub-county were incorporated in the study to provide information on “what would have happened to the farmers in the intervention sub-counties had they not been exposed to the PIP approach; hence, this study was a semi “counterfactual impact evaluation (CIE)” of the PIP approach.

3.3.2 Target Population and Household Size Determination

The target population was primarily smallholder farmers in the sub-counties of Bushika and Bumasheti. According to Kamara et al., (2019), a smallholder farmer operates between 1-3 acreage on a subsistence basis and rarely uses sophisticated production technologies like irrigation. These farmers are always reliant on the favours of weather and climate (Anderson, et al., 2016)The appropriate sample size for the research study was established by applying Yamane’s (1967) formula, as outlined below.

$$n = \frac{N}{1 + N(e)^2}$$

Where n = sample size, N = total population size of both Sub counties based on UBOS (2020): Bumasheti has a total population of 3137, Bushika 6767, and e = level of precision (0.05).

$$n = \frac{9904}{1 + 9904(0.05)^2}$$

$$n = \frac{9095}{1 + 9904 \times 0.0025}$$

$$n = 396 \text{ respondents.}$$

To get the proportions for each sub-county, the researcher divided the population size of each sub-county according to UBOS (2020) by the sum total population of the two and multiplied the resultant number by the number of respondents.

$$\text{Bumasheti} = \frac{3137}{9904} \times 396$$

$$= 125 \text{ Respondents.}$$

$$\text{Bushika} = \frac{6767}{9904} \times 396$$

$$= 271 \text{ Respondents.}$$

The sample size of the farmers surveyed was 277 (173 farmers in the intervention and 104 in the control sub-county) against 396 farmers (271 in the intervention and 125 farmers in the control sub-county). This was because some of the households were deserted, and according to the LCI chairpersons, they had migrated to Kenya to provide labour there.

3.3.3 Sampling framework

The farmer households were the study participants and were drawn from two sub-counties in Bududa Districts, and these sub-counties were purposively sampled. Bushika, which was the PIP approach intervention sub-county, and Bumasheti, which was the control sub-county. Under each of the two sub-counties, two (2) parishes were purposively selected as interest was in those in steep slopes closer to the National Park. Subsequently, 2 villages were selected randomly per parish. Lists of villages in the parishes were received for the sub-county headquarters with the help of the parish chiefs. Villages were randomly sampled from the parishes selected. Lists of households were acquired from the LCI chairpersons. In total, 173 study participants of the study were drawn from Bushika, and 104 participants were drawn from the Bumasheti sub-county; this brings the overall total number of participants both in control and intervention sub-counties to 277.

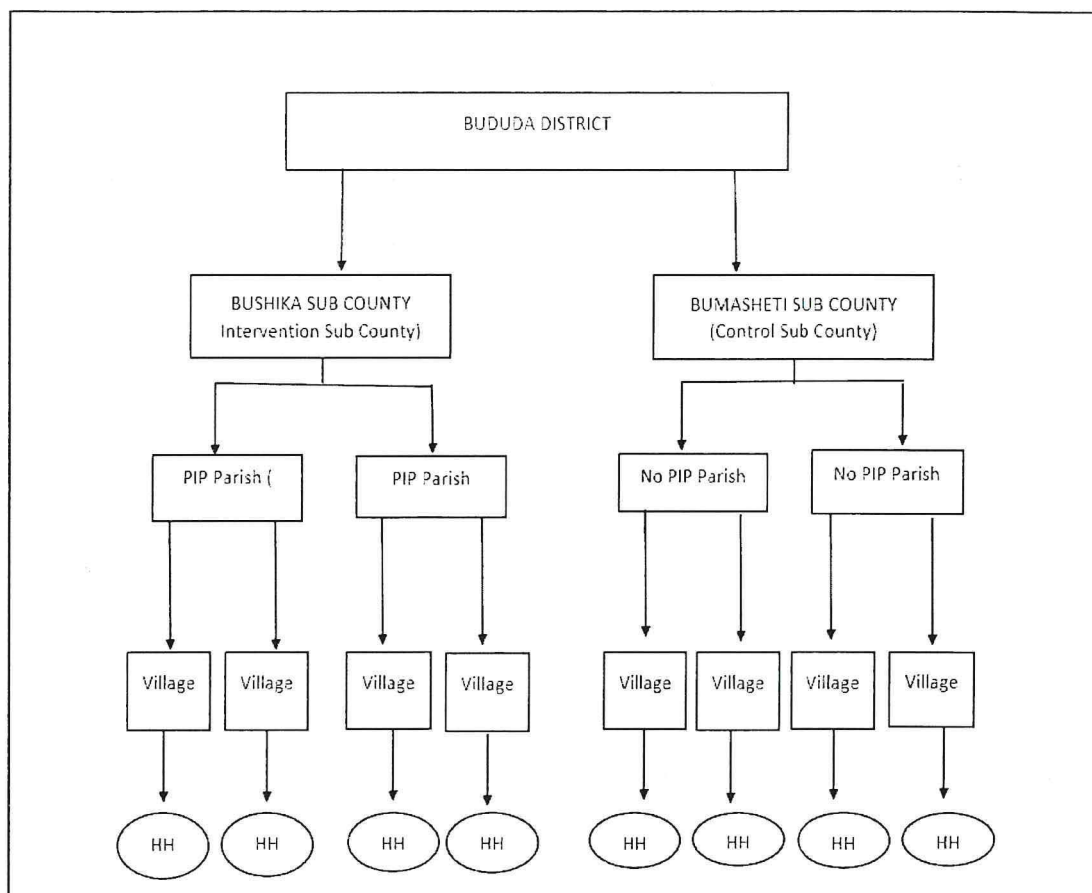


Figure 4: Study Sampling framework

3.3.4 Data collection methods and tools

The study used quantitative farmer household survey as the main data collection method, and this was complemented by Key Informant Interviews, observation, Focus Group Discussions, and literature review.

a) Household Survey

A structured questionnaire was used to survey the effect of the PIP approach on the use of practices that control soil erosion by smallholder farmers on the Mount Elgon slopes, the contributions of existing farming practices on the soil erosion risk, constraints faced by farmers in using the measures that control soil erosion and determinants for the PIP approach adoption. The survey targeted farmer household heads (men or women) randomly selected from the sample villages within the intervention and control Sub County, respectively. Due to Yamane's sample size calculation formula, 396 respondents were the expected households to be surveyed (271 in the intervention and 125 farmers in the control

sub-county). However, one ground the households were less than expected because some farmers migrated to Kenya, leaving empty households. Therefore, the surveyed samples were 277, 173 from Bushika and 104 from Bumahseti.

b) Key Informant Interview

Qualitative data was collected using three different methods, including Key informant interviews (KIIs) administered to key stakeholders to get information to validate the household survey data. A semi-structured key informant guide was administered to five (5) key informants: the District Environmental Officer, District Production and Marketing Officer, the Project Coordinator MWARES and project Junior Agronomist on their knowledge and experience of the effectiveness of the PIP approach on the use of erosion control practices by smallholder farmers on the Mount Elgon slopes, and the ultimate impact of soil erosion control practices on the crop and livestock production of smallholder farmers.

c) Focus Group Discussion

Using a Focus Group Discussion methodology, a discussion with farmers was held using a semi-structured Focus Group Discussion guide. In the intervention villages, group discussions were conducted with Innovative Farmers (PIs) and in control, they were held with farmers to assess farmers' perspectives on the effectiveness of the PIP approach on the use of practices for soil erosion control, use of soil erosion control practices, extent, and the constraints faced by farmers in the implementation of the practices. A total of 3 focus group discussions were held subcounty in each, with 10 participants per group comprising five male and 5 female farmers.

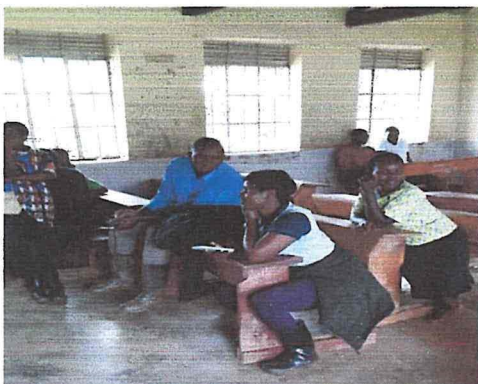


Figure 5: Converging for a Focus Group Discussion with farmers in Bushika subcounty.

3.4 Data analysis

Quantitative survey data was collected using Kobo collect, and data was extracted (downloaded) in Excel CSV format, cleaned, transformed, and exported to Stata SE 17.0 for further analysis. The clean and transformed quantitative data obtained from the household survey was examined and analysed through multivariate, bivariate, and univariate analyses to outline the characteristics of the study participants and their soil conservation practices and to assess the relationships between categorical data. Descriptive statistics shown as frequencies and percentages were used to find out the study outcomes, that is the percentage distribution of the study variables. Pearson chi-square, Cross tabulation and ANOVA (analysis of variance) were used to measure associations, while binary logistic regression was utilized to measure the relationships plus association between various dependent and independent variables. Furthermore, multiple logistic regression and linear regression were applied to determine the joint significance of the study variables.

Bivariate analysis: The factors influencing the adoption of the PIP approach were identified by conducting a chi-square test, which assessed the relationship between soil control measures and other variables.

$$x^2 = \sum_{i=1}^r \sum_{j=1}^e \left(\frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right)$$

Where; O_{ij} = observed value, E_{ij} = expected value, x^2 = Chi-square, r = the number of classifications of independent variables, $i = 1, j = 1 \dots e$; presuming independent variables, e = the number of classifications of the dependent variable.

Multivariate analysis: To explore the relationship between adoption of the PIP methodology along with other study variables, logistic regression was used. The results of the logistic regression were applied to explain which if factors of adoption are significant. This was because logistic regression provided the best model.

Key Informant Interviews and Focused Group Discussions captured qualitative data that was transcribed, and the findings got were used to examine the results of household survey. The themes and issues that emerged and connected to the research questions plus objectives were used to elucidate the findings from the household survey further. In some cases, the emerging issues were captured by quoting verbatim what the respondents said during the qualitative interviews, thus providing information to explain some survey findings further.

Model formulation: Logistic regression was utilized to examine the factors that lead to the adoption of soil control measures along with various other determining variables

$$\ln \left(\frac{p}{1-p} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_m X_m + e_t$$

Where p is probability of adoption of the PIP approach and probability that the erosion control measures are used by the farmer and (the likelihood a positive outcome in the dependent variable.)

X_i – independent variables for $i = 1, 2, 3, \dots, m$

$p/(1-p)$ - odd ratio

β_i – slope coefficients of X_i for $i = 1, 2, 3, \dots, m$ of independent variables

β_0 – the intercept

3.5 Mapping of soil erosion risk

Soil erosion modelling was carried out using the RUSLE method to determine the effects of the PIP approach on erosion control on the slopes of Mount Elgon. Mapping of erosional features was undertaken to validate the level of change. To achieve this, a GPS was used to map erosion types per the project area. A Land Use and Land Cover map of Bududa district was acquired and used to separate erosion and non-erosion-prone areas to assess the rates of erosion for different land cover and land use types. In addition, topography/terrain maps, soil maps, soil conservation maps, rainfall maps and farming practices maps were used in the study.

Data

The study adopted sentinel images downloaded from the Copernicus data European Space Agency (ESA) <https://scihub.copernicus.eu/dhus/#/home> because they have a high resolution (10m). The years of study are 2019 and 2023 representing years before and after PIP consecutively. Seasons of interest are after MAM (March, April, May) and SON (September, October, November, December) when erosional features are visible and cloud cover is minimal. Sentinel 2A images of dates 21.01.2023 and 12.01.2019 with a cloud cover of less than 10% were used. Image correction to remove inherent data errors was undertaken, and the cover factor was finally cultivated.

To calculate the practice factor and LS (slope length) factor, ALOS PALSAR DEM of 12.5m resolution was used. The DEM was already corrected for atmospheric and geometric errors and thus is fit for direct use. The DEM was reprojected to Arc 1960 UTM zone 36N. Sink filling was performed to remove DEM gaps. 2014 soil data from NARO (National Agricultural Research Organization) was used to extract the erodibility values (K factor). Monthly Rainfall data was

acquired from UNMA (Uganda National Meteorological Authority) for the Bulambuuli, Bukalasi, Sironko and Bududa weather stations.

RUSLE model description.

The Revised Universal Soil Loss Equation (RUSLE). Its first development was in the 1960s as a field scale model by Wischmeier and Smith of the United States Department of Agriculture. It was later reviewed in 1997 and is still used today. It is a commonly-known and world-wide accepted soil erosion estimation empirical model founded on the Universal Soil Loss Equation (USLE). (Angima et al., 2003; Ghosal, 2020). It is designed for use at the runoff plot or single hill slope scales. To estimate the average annual soil loss (A), five factors are integrated, that is, rainfall erosivity (R) signifies the impact of rainfall intensity the on soil. It needs continuous rainfall data, for computation. The erodibility of the soil (K) reflects the soils susceptibility, to erosion it is evaluated based on soil textures. (Ghosal, 2020). RUSLE quantifies the average annual erosion using an Equation which states as follows:

$$A = R \times K \times LS \times C \times P$$

The rainfall erosivity factor (R)

Rainfall erosivity describes how the intensity of rain impacts soil through kinetic energy. It also helps forecast the volume and speed of runoff, which is closely linked to specific precipitation events (Ghosal, 2020). The R factor, indicating rainfall influence, is defined in Equation 1. as proposed by Jiang et al. (2014).

$$R = \sum_{i=1}^{12} 1.735 \times 10^{(1.5 \times \log_{10}(\frac{p2i}{p}) - 0.08188)} \dots \dots \dots (1)$$

The soil erodibility factor (K)

This is a numerical description of the inherent erodibility of a particular soil. It is a measure of the resistance of soil particles to detachment and transport by rainfall and runoff. The soil erodibility factor depends upon geological and soil properties, which include; soil texture, structure, organic matter and perviousness. (Ffolliot et al., 2013; Larionov et al., 2018; Ghosal, 2020) This K factor was derived from soil data by NARO and calculated from equations 2 and 3 as proposed by Shabani et al. (2014).

$$K = \frac{A}{N} \dots \dots \dots (2)$$

$$\text{And } N = \frac{[\sum_{j=i}^n (1.213 + 0.89 \log_{10} l_j)(i_j T_j)]}{173.6} \times l_{30} \dots \dots \dots (3)$$

The slope length (L) and steepness (S) factor

This reflects on the effect of the area topography on the soil erosion rate (Ghosal, 2020). Length is defined as the distance from the point of origin of overland flow to the point where the slope decreases to the extent that deposition begins (Ganasri & Ramesh, 2016). The amount and rate of cumulative run-off increases as the length of the slope increases. As the land slope increases, the run-off velocity increases leading to huge erosion (Tian et al., 2021). This was calculated using Equation 4.

$$LS = (FA \times \left\{ \left(\frac{\text{cell size}}{32.13} \right) \right\}^{0.4} \times \left\{ \frac{\sin(\text{slope} * (0.01745))}{0.09} \right\}^{1.3} \times 1.6 \dots \dots \dots (4)$$

Crop/vegetation management factor (C)

The soil loss is highly dependent upon the amount and type of vegetation cover. Basically, the vegetation cover prevents the raindrops from impacting the soil surface and reduces the kinetic energy of rainfall before reaching the surface of the soil. The cover management factor (C) is directly influenced by the vegetation type, stage of growth of the vegetation and percentage of vegetation cover (Ganasri & Ramesh, 2016; Ghosal, 2020). This factor is calculated from equations 5 and 6 below. Equation 5 was adopted because it fits areas experiencing equatorial climatic conditions with more intense rainfall, which is where our study area lies.

$$NDVI = \left(\frac{NIR - R}{NIR + R} \right) \dots \dots \dots (5)$$

$$C = 0.1 \left(\frac{-NDVI + 1}{2} \right) \dots \dots \dots (6)$$

The conservation practice factor (P)

This indicates the effect of practices that reduce the rate and amount of run-off and thus reduce the amount and rate of erosion. The P factor reflects the proportion of soil loss for a particular conservation practice. The P value is calculated as the ratio of the rate and amount of soil loss due to a specific support practice to the soil loss due to row farming upward and downward the slope condition (Ghosal, 2020). This factor was calculated by equation 7, where S denotes the percentage slope of the study area.

$$P = 0.2 + 0.03 * S \dots \dots (7)$$

Validation of the model

A transect survey was used to map erosion features. Using ArcGIS, the GPS coordinates of the erosion features in the study area were used to create a map. This map was then overlaid with the RUSLE maps to validate the RUSLE outcomes using the Receiver operating curve method (ROC), where the area under the curve was determined.

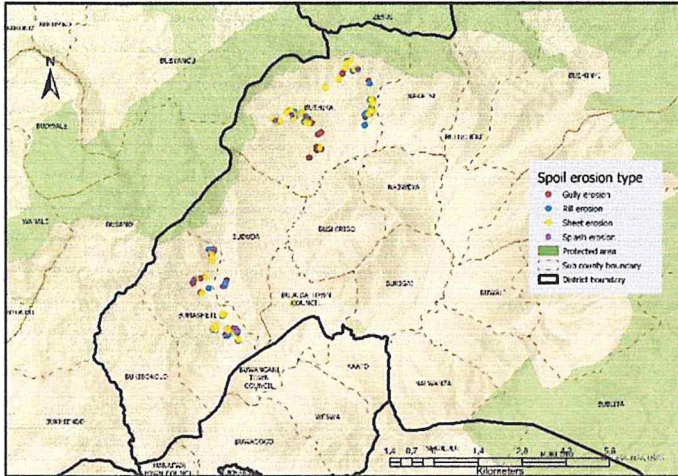


Figure 6: Map showing soil erosion hotspots in the study area.

CHAPTER FOUR

PRESENTATION AND INTERPRETATION OF RESULTS

4.1 Socio-economic and demographic characteristics of the respondents

The demographic characteristics and a comparison of the two study groups are summarized using Table 1. The total number of smallholder farmers surveyed was 277 at the household level; 62% (173) of the farmers were drawn from Bushika sub-county (intervention) and 38% (104) from Bumasheti sub-county (control). Fifty-four per cent (54%) of the farmers from the intervention sub-county were female, and 46% were male. In the control sub-county, 42% of the farmers interviewed were female, and 58% were male. Although a bigger number of females was surveyed in the Bushika sub-county (intervention group) and more males in the Bumasheti sub-county (control group), the gender distribution between the two groups did not show any significant difference. Thus, the study was principally representative of both genders.

In terms of the mean age differences, the mean age of the intervention and control group had no significant difference. In the intervention group, mean age was 43 years, and 39 years in the control group. Since the targeted respondents were household heads of farming households, the results got were expected. In the various age groups, only 34% of the participants in the control group were youth aged 18-30 years, 55% were adults aged 31-59 years, and 12% were elderly farmers above 60 years, while among the intervention group: 28% of the participants were youth aged 18-30 years, 55% adults aged 31-59 years and 17% were elderly farmers above 60 years. The age structure of the two study groups was similar, which signifies that the control group was a true mimic of the intervention groups by age, and so, they were comparable.

The marital status among control and intervention sub counties had no significant difference. Seventy two percent (72%) of the farmers in Bumasheti (control sub-county) were married people, 15% were single or never married, 10% were widowed, and only 3% were divorced; a similar characteristic was observed among the intervention group; most farmers (85%) were married people, 9% were single or never married, 4% were widowed and only 2% were divorced, This finding was also expected as the interview groups were household heads and, most likely, married adults. In terms of education attendance, 18% of the farmers in the control group never attended

formal education, 56% attended primary, 18% attended secondary school, and only 3% attended post-secondary education, while in the intervention, 6% never attended school, 68% attended primary, 26% attended secondary and no farmer attended post-secondary education. Education attendance was observed to be slightly lower among the control group compared to the intervention group, but it was a significant difference according to the statistical calculation performed.

More than half (68%) of the control group participants interviewed were household heads, 28% were spouses to household heads, and 4% were children belonging to the household heads. Among the intervention group, the majority (51%) of the farmers interviewed were household heads, 43% were spouses, and 5% were children of the household heads.

The study also assessed the average size of a household across the two study groups. The findings revealed that the average size of a household in the control group was 5.6 and 6.7 in the intervention group. This finding indicates a slightly feeble difference in the household size in the control group in comparison to the intervention subcounty. As expected, majority of the respondents in both intervention and control Sub County have agriculture as their main source of income. Eighty-six per cent (86%) of the farmer households in the control group earn their main income from crop cultivation, followed by business (5%), formal employment (5%) and livestock rearing (3%). Similarly, in the intervention group, the majority (86%) of the farmers earn their main income from crop cultivation, followed by livestock rearing (9%) and business (4%), which encompasses mainly produce, retail and roadside trade. These findings show almost no differences in the main source of household income across the two study groups.

Regarding household average monthly income, the majority (43%) of the surveyed farmer households from the control group earn between 100,000 – 300,000 Uganda Shillings a month compared to 50% among the intervention group. Thirty-four (34%) of farmer households in the control group and 24% in the intervention group earn less than 100,000 Uganda Shillings a month. A notable percentage of farmers in the control group (13%) and the intervention group (6%) reported earnings of 1,501,000 and above a month. Overall, the intervention subcounty had a notably increased monthly income than the control subcounty. The study revealed that there was a slight difference in the topography where the control and intervention farmers were located; 61% of farmers in the control group were located along the gentle slope of the terrain, and 39% on the steep slope in the intervention group, 47% of farmers were located on the gentle slope and 47% along the steep slope as shown below.

Table 1: Social and demographic characteristics of the respondents.

Variables	Label of variables	Frequencies		Bumasheti		Bushika	
			Standard	Mean	Standard	Mean	Standard
Gender	Female	0.495	0.03	0.42	0.049	0.54	0.038
	Male	0.505	0.03	0.58	0.049	0.46	0.038
Age of respondent	18-30	0.152	0.022	0.12	0.031	0.17	0.029
	31-59	0.549	0.03	0.55	0.049	0.55	0.038
	Above 60	0.3	0.028	0.34	0.047	0.28	0.034
	Mean age	40.8	0.95	42.9	1.71	39.5	1.11
Marital status	Divorced	0.025	0.009	0.03	0.016	0.02	0.011
	Married	0.801	0.024	0.72	0.044	0.85	0.027
	Single/ Never married	0.112	0.019	0.15	0.036	0.09	0.021
	Widowed	0.061	0.014	0.1	0.029	0.04	0.015
Education level	Never attended school	0.108	0.019	0.18	0.038	0.06	0.019
	Primary	0.632	0.029	0.56	0.049	0.68	0.036
	Secondary	0.231	0.025	0.18	0.038	0.26	0.033
	Above secondary	0.029	0.01	0.08	0.026		
Household head	No, household head	0.422	0.03	0.32	0.046	0.49	0.038
	Yes, head of the household	0.578	0.03	0.68	0.046	0.51	0.038
	Average size of the household	6.32	0.186	5.6	0.29	6.73	0.237

Data Source: Smallholder farmer household survey.

Table 2 The social and economic characteristics of the respondents.

Variables	Variable Label			Control		Intervention	
		Mean	Standard	Mean	Standard	Mean	Standard
Land ownership	Customary	0.913	0.01699	0.92	0.02626	0.91	0.02221
	Bought	0.667	0.02843	0.62	0.04794	0.7	0.03512
	Lease offer	0.014	0.00721	0.01	0.00962	0.02	0.01001
Land terrain	Gentle slopes	0.525	0.03011	0.61	0.04815	0.48	0.0382
	Steep slopes	0.475	0.03011	0.39	0.04815	0.52	0.0382
Average household income	1,001,000-1,200,000	0.029	0.01012			0.05	0.0161
	1,201,000-1,500,000	0.025	0.00948	0.05	0.02108	0.01	0.0082
	1,501,000- and above	0.087	0.01699	0.13	0.03259	0.06	0.01871
	100,000-300,000	0.475	0.03011	0.43	0.04882	0.5	0.03824
	301,000-500,000	0.072	0.01563	0.04	0.01895	0.09	0.02221
	501,000-800,000	0.018	0.00804	0.02	0.01353	0.02	0.01001
	801,000-1,000,000	0.014	0.00721			0.02	0.01153
	Les than 100,000	0.279	0.02705	0.34	0.04656	0.24	0.03285
Sources of income	Crop cultivation	0.855	0.02123	0.86	0.03462	0.85	0.02695
	Livestock rearing	0.065	0.01489	0.03	0.01649	0.09	0.02158
	Formal employment	0.018	0.00804	0.05	0.02108		
	Business (produce,	0.047	0.01278	0.05	0.02108	0.05	0.0161

Data Source: Smallholder farmer household survey.

In general, the study was gender-representative. Majority of the people interviewed were household heads and were married. Majority primary-level dropouts, and this explains why this main source of income is cultivation and not formal employment. This has contributed to the low-income levels in both the control and intervention sub-counties, hence over-cultivation and

pressure on land leading to soil erosion. Below is a graph showing household income source and percentage of income in the study area.

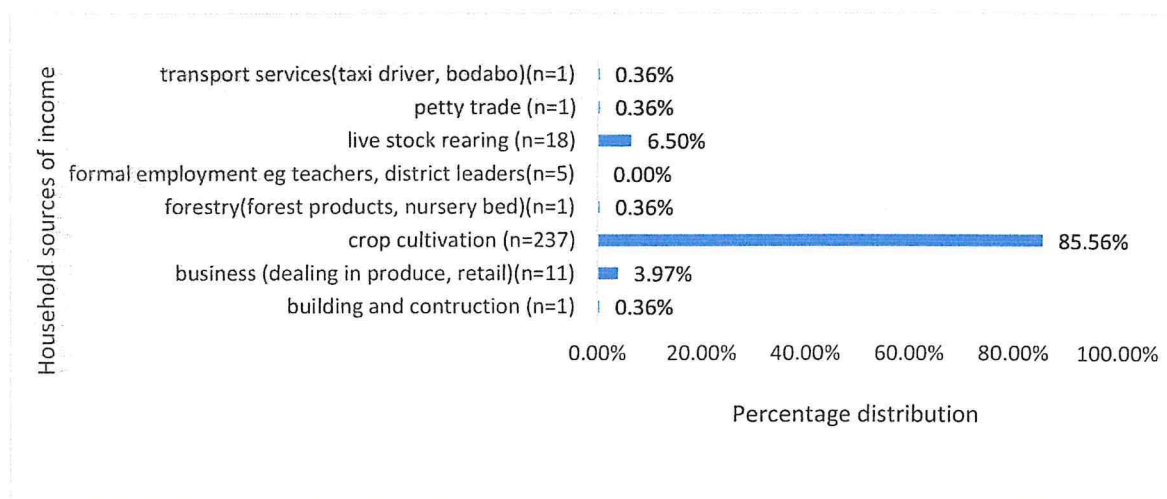


Figure 7 A graphical representation of various sources of household income

4.2 Farming practices and soil erosion risk

4.2.1 Extent of Soil Erosion Risk

The erosion risk was categorised into soil erosion risk maps with five different soil erosion risk levels according to (Bamutaze, 2021) The threshold for each of the soil erosion levels is presented in the table below.

Table 3 Categorisation of soil erosion risk (threshold).

Erosion risk	Threshold ($t\ ha^{-1}\ y^{-1}$)
Very high	Soil loss ≥ 100
High	$50 \leq \text{soil loss} \leq 100$
Moderate	$10 \leq \text{soil loss} \leq 50$
Low	$2 \leq \text{soil loss} \leq 10$
Very low	Soil loss ≤ 2

Results (Figure 8) depict that 2019, Bushika lost 59.93 tons per hectare per year of soil. The loss was largely in the areas close to Mt. Elgon National Park. By 2023, a significant decline in soil erosion rates to 14.43 tons per hectare per year was recorded, indicating significant improvement.

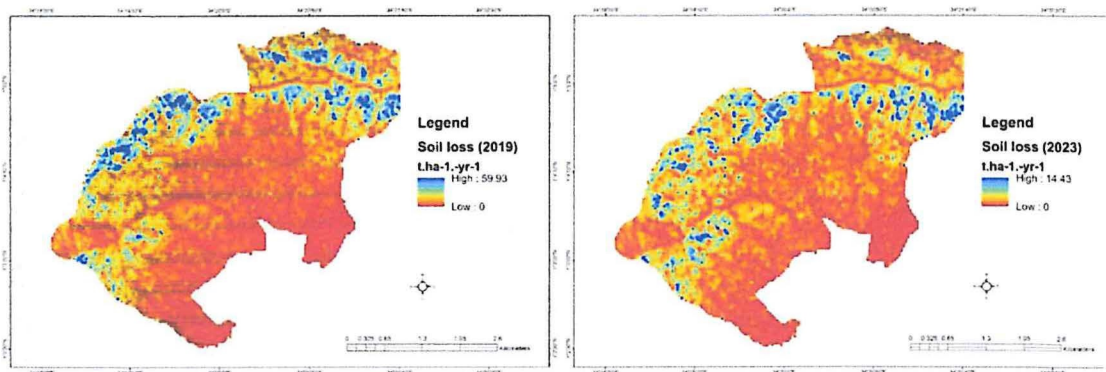


Figure 8: Soil erosion risk of Bushika sub-county.

The control site, Bumasheti (Figure 9), also revealed a high rate of soil of 93.38 tons per hectare per annum in 2019, which decreased to 56.10 tons per hectare per year by 2023. However, the soil loss decline in Bumasheti was still significantly higher by 41.67 tons per hectare per annum than in Bushika sub-county. Similarly, soil loss was mainly recorded in areas close to the park boundary.

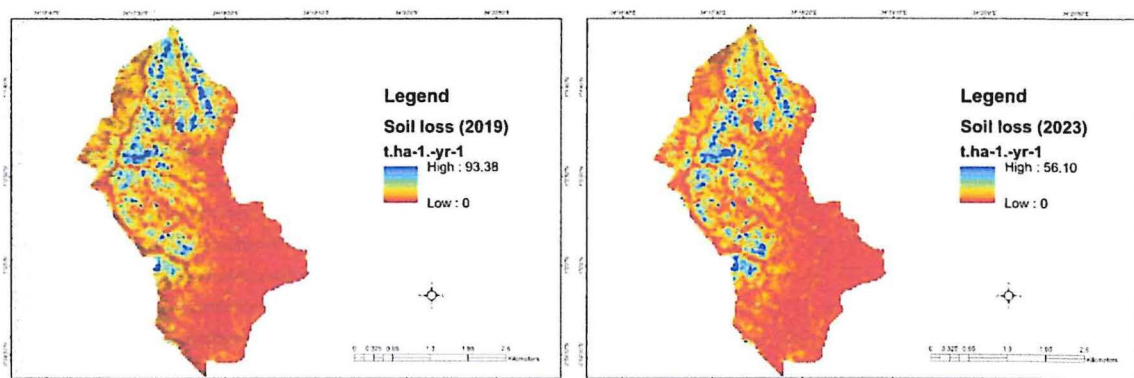


Figure 9: Soil erosion risk of Bumasheti sub county.

4.2.2 Model validation.

The validation of the RUSLE model was done using the Receiver Operating Curve (ROC). According to the curve/graph, the soil erosion risk estimated by the RUSLE model was related to the erosion hotspots taken with GPS coordinates. Bumasheti 2023's accuracy was 88.5%, 2019's was 88.8%, and Bushika 2023's was 80.5%, and 2019's was 79.7%.

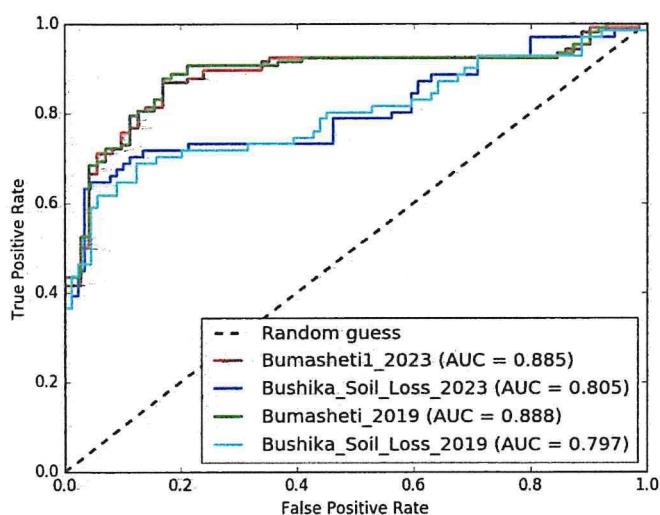


Figure 10: Receiver operating curve (ROC)

4.2.3 Perceived signs of soil erosion and extent

The majority of the respondents (farmers), both in Bushika and Bumasheti sub-counties, had knowledge of soil erosion, and there was no significant difference in the level of knowledge ($p < 0.05$). According to the survey data, farmers have similar perceptions of the extent of erosion. They both agreed that it takes place everywhere, from their gardens to the entire village or subcounty. When asked about the evidence of erosion, there was no difference in the signs of erosion in the control and intervention sub-counties. The commonly mentioned signs included rills (small channels), exposed tree roots, muddy runoff water, exposed rocks, and bare soil. This was further confirmed during the focus group discussions held in Munyende village, where a farmer provided testimony. *“The water, it is always clear, but when you see that the water is now brownish/dirty, you will know that this is soil erosion, the soil has gone into the water and another thing is that you may have planted your banana and then find out that the roots are on top and the water has carried away the soil.”*

Table 4: Extent of soil erosion risk.

Variable	Frequencies	Control	Intervention	P-value
Farmer knowledge of soil erosion	N/%			
No	5 (2%)	2 (2%)	3 (2%)	0.909
Yes	272 (98%)	102 (98%)	170 (98%)	
Signs of soil erosion experience				
Exposed rocks	89 (12%)	36 (37%)	53 (33%)	0.492
Exposed tree roots	138 (19%)	61 (63%)	77 (48%)	*0.019
Rills (small channels)	202 (28%)	83 (86%)	119 (74%)	*0.028
Bare soil	106 (15%)	47 (48%)	59 (37%)	0.062
Muddy runoff water	132 (19%)	52 (54%)	80 (50%)	0.542

Cracks along the slope	48 (8%)	18 (19%)	30 (19%)	0.988
Extent of soil erosion				
Plot or garden	121 (19%)	43 (44%)	78 (47%)	0.645
Specific slopes	62 (10%)	25 (26%)	37 (22%)	0.538
Village	143 (23%)	50 (51%)	93 (56%)	0.450
Parish	99 (16%)	43 (44%)	56 (33%)	0.094
Sub county	85 (14%)	35 (36%)	50 (30%)	0.335
Sporadic	120 (19%)	42 (43%)	78 (47%)	0.533

The following graphs represent the different signs and extent of erosion according to the farmers perception in the both the control and intervention sub counties.

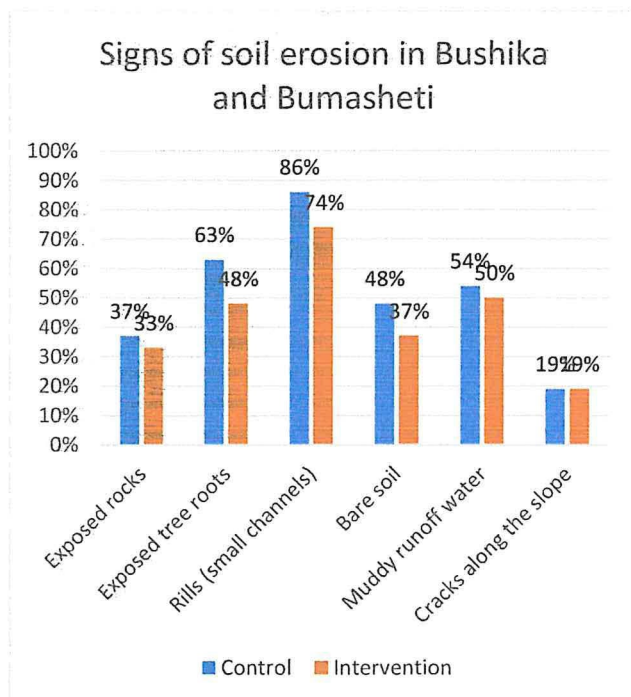


Figure 11 Farmers perception on extent of signs of soil erosion

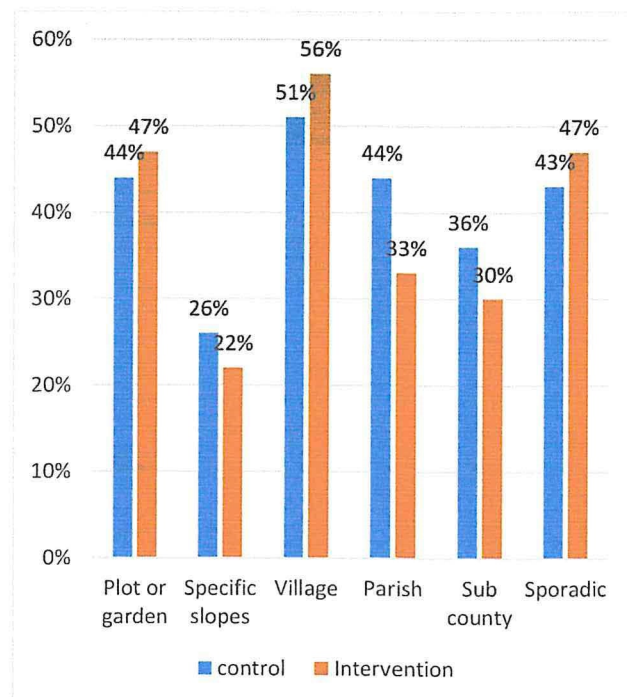


Figure 12 Farmers perception on extent of erosion

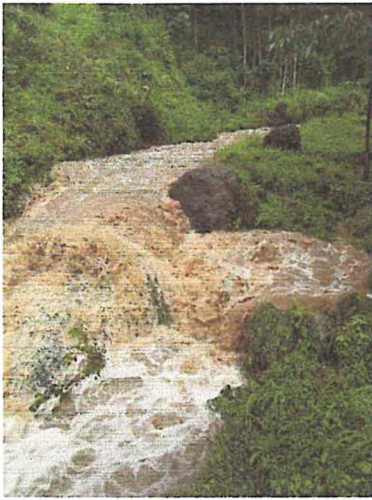


Figure 13: Dirty water of River Manafwa a sign of erosion up stream.



Figure 14: Exposed rocks in a farmer's garden in Bumasheti



Figure 15: Exposed tree roots in Bushika sub county a sign of erosion.

The perception of the farmers that erosion was everywhere and spread all over the villages and sub counties was validated by mapping erosion hotspots using GIS (Geographical Information System) and remote sensing and assessing the extent of erosion using the RUSLE model. However, although the knowledge of erosion is similar in both sub-counties, according to observation, the extent of erosion is higher in the control sub-county than in the intervention. This could be attributed to the use of soil erosion control measures. This was validated by soil erosion modelling.

4.2.4 Characterisation of farming practices implemented.

Findings revealed that farmers from both sub counties use similar farming practices, and these include agroforestry, monocropping, zero grazing, digging trenches, and planting Napier grass. However, there are significant statistical differences in the farming practices used between the two study groups. Farmers in the intervention sub-county practice more minimum tillage, planting cover crops, digging of trenches, planting of Napier grass and mulching compared to farmers in the control sub-county who practised more mixed farming, continuous cultivation, and intercropping than the farmers who received PIP intervention approaches. This was evidenced in the focus group discussions in Bumasheti sub-county when a farmer testified “*We are mostly digging our gardens up the slope. We know this is not a good practice, but we largely use it here because most farmers are not digging trenches in their gardens which makes those few with trenches fail to control erosion*”. This difference was also found to be statistically significant as demonstrated by the p-values in Table 5. The percentage implementation of farming practices by the farmers is shown in the table below.

Table 5: Farming Practices being implemented among the study groups.

Variable	Control	Intervention	P-value
Farming practices currently implemented			
Monocropping	9 (9%)	13 (8%)	0.734
Mixed farming	69 (66%)	87 (50%)	*0.009
Continuous cultivation	35 (34%)	12 (7%)	*0.000
Minimum tillage	7 (7%)	27 (16%)	*0.029
Zero grazing	52 (50%)	83 (48%)	0.744
Agroforestry	73 (70%)	120 (69%)	0.885
Intercropping	59 (57%)	42 (24%)	*0.000
Crop rotation	23 (22%)	55 (32%)	0.083
Planting cover crops	27 (26%)	84 (49%)	*0.000
Digging of trenches	62 (60%)	148(86%)	*0.000
Planting of Napier grass	57 (55%)	116 (67%)	*0.042
Mulching	48 (46%)	119 (69%)	*0.000
Fallowing	6 (6%)	4 (2%)	0.135

Data Source: Household survey of Smallholder farmer (P-vale less 0.05)

Findings revealed that the following farming practices contributed to high erosion risk according to the farmer's perception: continuous cultivation (high 76%) and monocropping (high 39%). Those that contributed to moderate erosion risk were minimum tillage 63%, intercropping 63%, following 63%, and mixed farming 59%. Low erosion risk was attributed to digging trenches at 80%, mulching at 71%, planting trees at 70%, planting Napier grass at 68%, crop rotation at 53%, and planting cover crops at 50%. According to Table 6, the differences in the extent of erosion may be attributed to the difference in the use of farming practices. The increased use of continuous cultivation and limited use of minimum tillage, fallowing, and crop rotation could have increased the erosion levels in the control sub-county compared to the reduced levels in the intervention sub-county as there was an increase in the use of agroforestry, digging of trenches, planting Napier grass and mulching.

Table 6 Farming practices and associated soil erosion risk.

Farming practices	Soil erosion risk		
	Variable	Frequencies	Percentages (%)
Monocropping	High	7	39%
	Low	5	28%
	Moderate	6	33%
Mixed farming	High	15	13%
	Low	39	35%
	Moderate	59	59%
Continuous cultivation	High	31	76%
	Low	3	7%
	Moderate	7	17%
	High	2	11%

Minimum tillage	Low	5	26%
	Moderate	12	63%
Zero grazing	High	11	12%
	Low	40	45%
	Moderate	38	43%
Agroforestry	High	8	6%
	Low	87	66%
	Moderate	36	27%
Intercropping	High	8	11%
	Low	20	27%
	Moderate	47	63%
Crop rotation	High	3	6%
	Low	26	53%
	Moderate	20	41%
Planting cover crops	High	6	7%
	Low	42	50%
	Moderate	36	47%
Digging trenches	High	5	4%
	Low	111	80%
	Moderate	23	17%
Planting Napier grass	High	4	3%
	Low	84	68%
	Moderate	36	29%
Mulching	High	4	4%
	Low	77	71%
	Moderate	27	25%
Planting trees	High	10	6%
	Low	124	70%
	Moderate	42	24%
Fallowing	High	1	13%
	Low	2	25%
	Moderate	5	63%

Data Source: Household survey of Smallholder farmer (P-value less 0.05)

Figures 16 to 21 shows the different farming practices implemented in Bushika and Bumasheti.



Figure 16: Mixed cropping in Bunamee in Bumasheti sub county



Figure 17: Digging up slope in one of the gardens in Bukibokolo in Bumasheti sub county.



Figure 18: *Mulching practiced in Munyende village to control erosion.*



Figure 19: *Trenches in a farmer's garden in Bushaki village*



Figure 20: *Elephant grass planted along the stretches to stabilise them.*

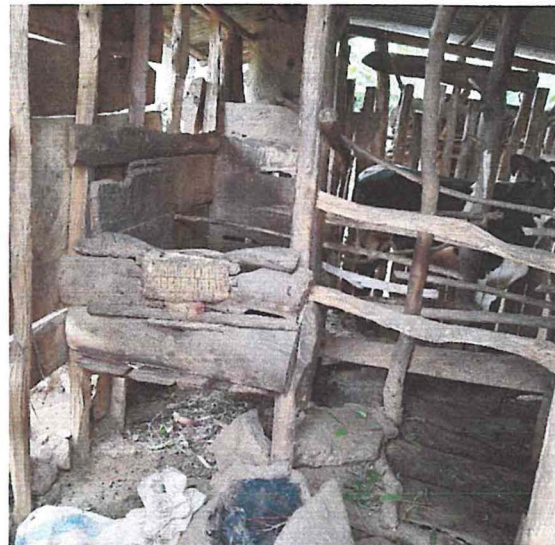


Figure 21: *Zero grazing practised by a farmer in Bunabutiti village in the Bushika sub county.*

4.3 Factors determining the adoption of the PIP approach by smallholder farmers

4.3.1 Major determinants for adoption

Findings revealed that the factors determining PIP approach adoption included, marital status where most of the adopters were married with a percentage of 92%, education levels, majority of the adopters had stopped at the primary level of education with a percentage of 89%, the approach was highly adopted by the farmers with low-incomes (less than 300,000 shillings a month), most

of the adopters were receiving extension services from the PIP trainers and this influenced them to adopt greatly with a percentage of 99%. Results in table 7 show that there is a significant statistical association between extension services, training, marital status, lev of education level, and farers age with the PIP approach adoption with a p-value less than 0.05, respectively. Other factors like household size, average household income, and knowledge about soil erosion, did not show an association which is significant with the adoption of the approach since their p-value was greater than 0.05 respectively. The Participatory Integrated Plan was predominantly adopted by the marrieds (92%), adoption was also determined by the attainment of education as most of the farmers who actively participated had only completed primary level (89%), majority of the adopters earned less than 300,000 shillings a monthly (89%), experiencing soil erosion on farm also determined adoption of majority of the farmers (90%), Receiving raining in the PIP approach also influenced 99% to adopt and farmers had knowledge about soil erosion (90%).

The table 7 and 8 below shows the use of soil erosion control practices emphasised by the PIP trainers. Those that used had adopted the approach and this was used to determine the factors for the adoption of the Participatory Integrated Planning approach.

Table 7: Association of study characteristics and use of soil erosion control practices

Use of soil erosion control measures					
Socio-demographic factors		Yes	No	Chi value	P value
Sex	Female	87.6 %	12.41%	2.9115	0.088
	Male	93.57%	6.43%		
Marital status	Divorced	100%	0.0	32.7295	0.000
	Married	91.89%	11%		
	Single	100%	0.0		
	Widowed	52.94%	47.06%		
Age				8.38	0.0038
Education level	No education	80%	20%	9.8533	0.02
	Primary	89.14%	10.86%		
	Secondary	98.44%	1.56%		
	Tertiary/ Uni	100%	0.0		
Household size				1.76	0.1848
Economic factors					
Land location	Gentle slope	89.66%	10.34%	0.3287	0.566
	Steep slope	91.61%	9.39%		
Average income	<300.000	88.94%	11.06%	2.755	0.252
	300.001-800.000	96.15%	3.85%		
	800.001+	95.35%	4.65%		
Extension services	No, we don't	84.11%	15.89%	16.5296	0.000
	Yes, we receive	98.41%	1.59%		
Knowledge factors					
Experience soil erosion	We don't	100%	0.00	2.1131	0.146
	Experience	89.92%	9.39%		
	No, I don't	80%	20%		

Know about soil erosion	Yes, I do	90.81%	9.19%	0.6744	0.412
Received training	Never received	57.14%	42.86%	54.6766	0.000
	Received training	99.32%	0.68%		

Data Source: Household survey of Smallholder farmer (P-vale less 0.05)

Table 8 Adoption of the PIP approach and other factors.

Variables		Frequ	Perce
Influenced you to adopt the above farming practices	Government/ extension workers	15	5.42%
	MWARES project/ PIP approach	144	51.99
	My neighbour	46	16.61
	Other projects/ development partners	10	3.61%
	Others(specify)	62	22.38
Receive extension services	Yes	126	45.49
	No	151	54.51
Extension services received	Seeds	40	31.75
	Fertilizers	8	6.35%
	Agronomic training	99	78.57
	Agribusiness training	52	41.27
	Information Sharing	96	76.19
	Livestock	29	23.02
	Advisory	77	61.11
Received training in agronomic practices from the MWARES project	No	14	8.70%
	Yes	147	91.30
Effect of training towards improved household income	Improved access to savings and credits	89	55.28
	Increased crop yields	125	77.64
	Engaged in income-generating activities	80	49.69
	Involved in household planning and	74	45.96
Activities engaged in as a result of PIP training	Establishment of tree nurseries	36	22.36
	Tree planting	133	82.61
	Agroforestry	91	56.52
	Holding community meetings about	40	24.84

Data Source: Household survey of Smallholder farmer (P-vale less 0.05)

4.3.2 Percentage distribution of the adoption of the practices controlling soil erosion and PIP approach.

The percentage distribution of Participatory integrated planning approach can be seen from the percentage distribution of the soil erosion control practices promoted by the approach. Most of the farmers who received training from the PIP extension workers adopted the approach, as evidenced by high levels of trenching, agroforestry, afforestation, planting of cover crops, and zero grazing. Those are the soil erosion control practices promoted by the approach. There is a higher adoption of stone bunds in the control than in the intervention. This is because the soils in the control were very rocky, and the only easiest way to reduce the stones and create land for cultivation was to collect them and line them in the farms. (Figure 22). The figure below shows the farming practices

promoted by the PIP approach extension workers. The adoption of the farming practices was clear evidence that the farmers highly adopted the approach in the control sub-county.

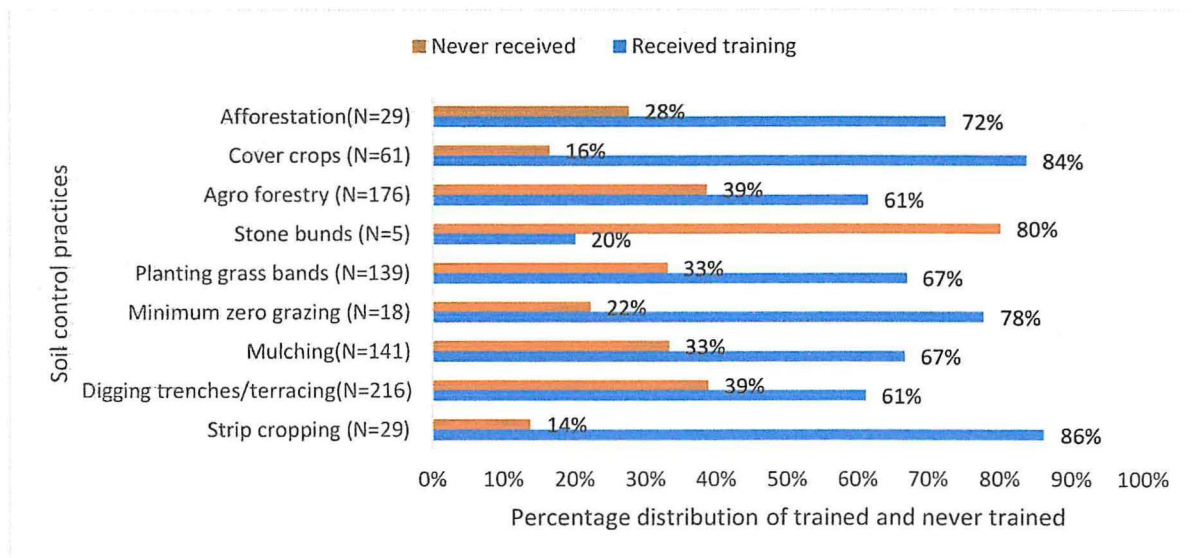


Figure 22: Influence of PIP training on the Adoption of soil erosion control practices

4.4 Effectiveness of the PIP approach on the use of soil erosion control practices

4.4.1 Smallholder farmer uptake and applicability of the PIP principles

According to the findings, empowerment (87%), collaboration (86%), and integration (90%) were the principles used by most of the farmers in intervention communities. When the farmers were asked about how they apply the principles of the PIP approach regarding soil conservation practices reveal that majority emphasized the importance of collective efforts within families (83%) and community collaboration (64%), 38% mentioned educating fellow farmers about soil conservation techniques, while 37% mentioned the value of diversifying income sources beyond agricultural production. This was confirmed through focus group discussions held in Munyende village, where a farmer provided testimony that... *“Mom, we understand PIP principles, one of them is empowerment, it means that I have authority in my home to do my work without asking for help from outside, I work with my family, secondly its integration, it means that cultivating many crops and also animal farming like I may rear a cow and it gives me cow dung as I apply it my cops for manure so that I get much yield to take my child to school, I may also rear my goats and they also give me manure, so it means that the cow dung I out in the bananas, the banana also gives me the banana stem and banana leaves to feed the cow so that means integration (yes) thirdly is collaboration, it means togetherness. Like today in Munyende, once we learned about PIP approach, from MWARES, we have got a lot of*

collaboration, from the sub counties, all zones have joined together and there is collaboration between us.”

During a Key Informant Interview, the Environmental Officer for the district of Bududa affirmed that the PIP principles have not only empowered farmers but also promoted the exchange of information, as she stated, *“We had the families would only wait for the season of beans or maize and when that season stops they also stop, but now we visited farms that had have passion fruits, cabbages, and basically hot cultural crops that were introduced and this an element that was brought on board by MWARES for diversification by being imparted with the knowledge of the three principle of the approach. And right now, I think they have been empowered”.*

Table 9: Effectiveness of PIP principles on the use of erosion control practices (N=173)

Variables	Frequencies (%)
Principles of the PIP approach	
Empowerment	133 (87%)
Integration	138 (90%)
Collaboration	131 (86%)
Stewardship	4 (2.61%)
Resilience	7 (4.58%)

Data Source: Smallholder farmer household survey

4.4.2 Perceived effectiveness of the PIP approach on the use of soil erosion control practices.

Results presented in figure 23 demonstrate that farmers in Bushika, which is the intervention subcounty, adopted more erosion control farming practices compared to those in Bumasheti the control subcounty. For example, the number of farmers practicing agroforestry increased from 54 (35%) to 108 (71%), farmers cultivating Napier grass has seen an increase from 35 (23%) to 104 (68%) following training in the Participatory Integrated Farming approach. In addition, before the training in 2019, 46 farmers (30%) were engaged in trench digging, this figure had an increase to 134 (88%) after they trained in PIP approach. The findings revealed that practices that were not ineffectively contributing to erosion control were abandoned by farmers after the training on the approach. For instance, Monocropping dropped and continuous cultivation dropped (16%) to (7%), and 41 (25%) to 11 (7%) respectively. These changes were attributed to the support and guidance provided by PIP training officers, leading to soil erosion control. This was confirmed by the SAS (Senior Assistant Secretary) of the sub county of Bushika during key informant interviews. *“When trenches are dug, the water sinks into the soil you see that this soil that would*

have been washed away is put back. Even the grass on the contour band they dug have helped to reduce the water runoff, the water gets trapped by the grass that is planted on the contours ”.

Under the category of those who never trained, there was less difference in the change of the farming practices before and after 2019. Therefore, training in the PIP approach is very good when it comes to soil conservation and soil erosion control. This was evident with an increase in the use of terracing, agroforestry, planting Napier grass which help in controlling erosion. The figure below shows the effectiveness of the PIP approach on erosion control by showing the increased use of farming practices geared towards erosion control after training in the PIP approach (before and after 2019).

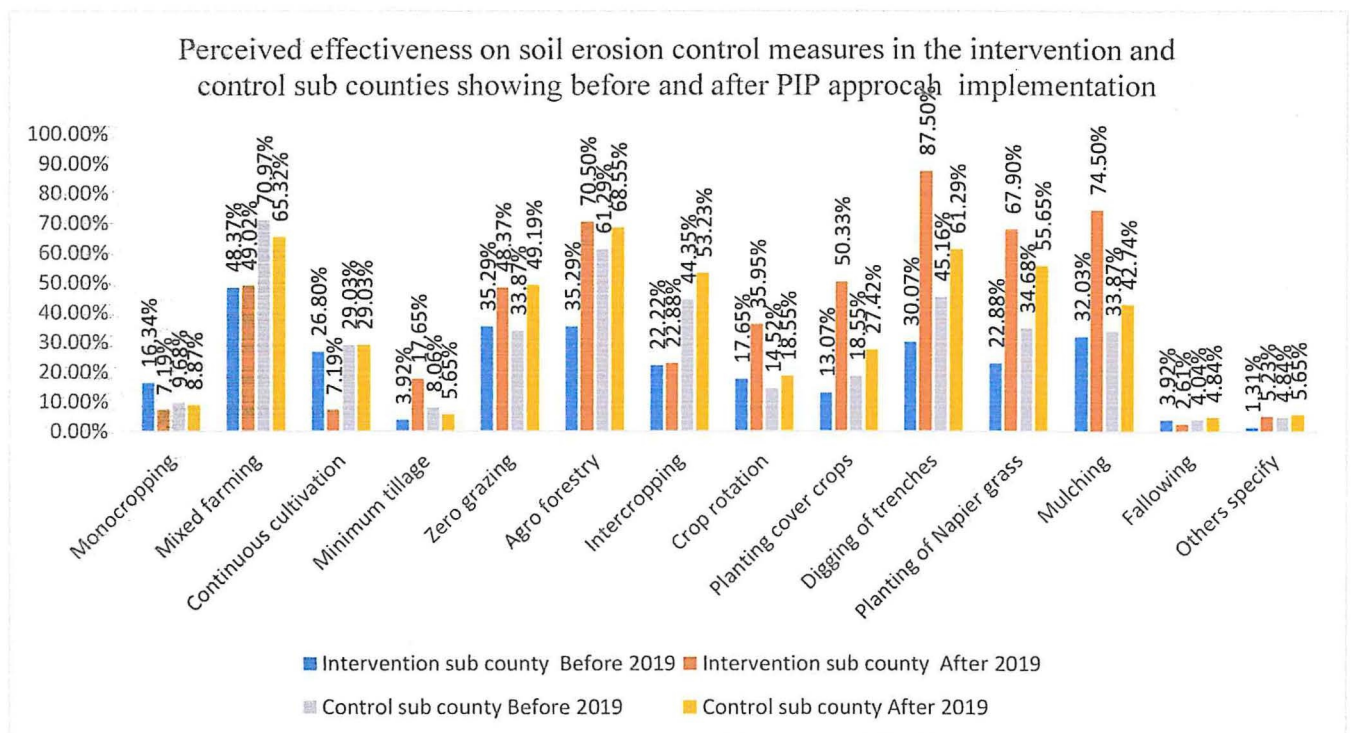


Figure 23 Perceived effectiveness of the PIP approach on the adoption of soil erosion control measure.

PIP extension workers encouraged the use of soil erosion control practices such as agroforestry, cover cropping, trenching, and mulching. The farmers in the intervention sub-county where the technologies were targeted had a high uptake of the practices. Consequently, there was a significant success in mitigating soil erosion within the region due to the increased adoption of these soil erosion control practices. This was validated during the Focus Group Discussions when farmers testified that “We are also practicing intercropping in our farms. This has increased the tree cover

which controls speedy rain drops hence controlling soil erosion. The trees also shade off their leaves which in turn act as mulches to our gardens”.

The graph below shows the uptake of the farming practices promoted by the PIP approach trainers.

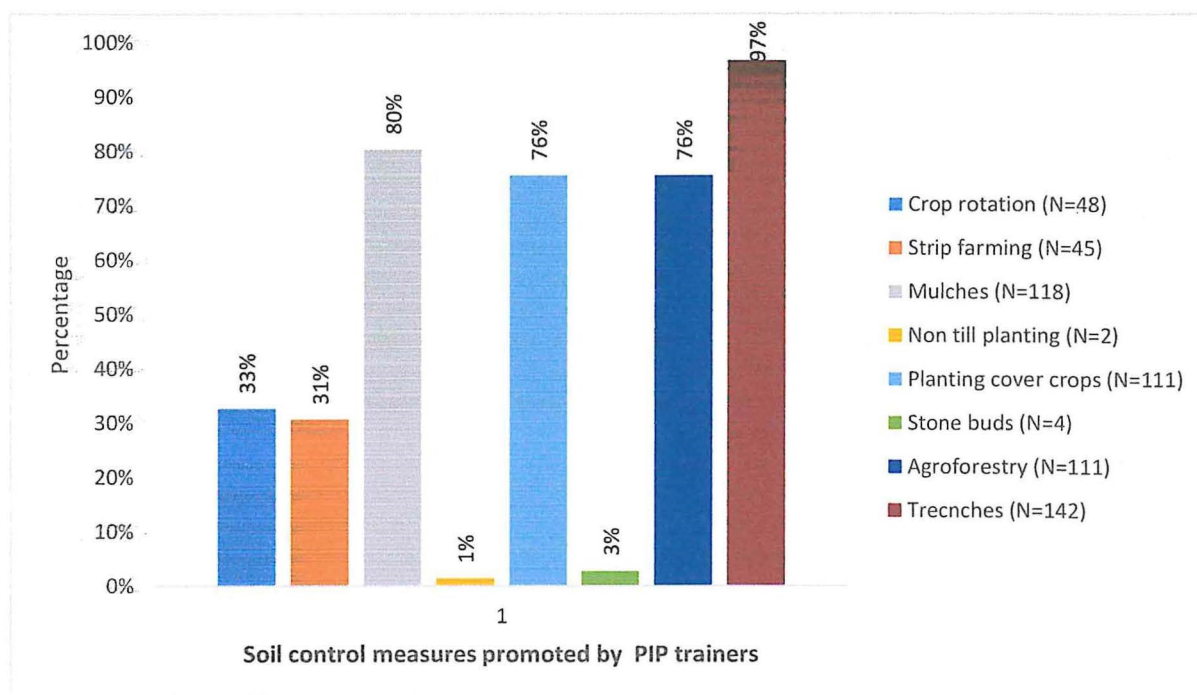


Figure 24: Percentage distribution of soil control measures promoted by PIP trainers (N=153)

Results in Table 11 indicate that most of the farmers were influenced to use soil erosion control practices by the PIP approach. This was through the agronomic training that was conducted by the PIP extension workers. Some of the activities that the farmers engaged in were tree planting, agronomic training, and information sharing, among others. As a farmer testified in the Focus Group Discussion, “After getting trained by the facilitator we started teaching other people in the villages and when they finished their training and graduated, they also began training others”.

The table below shows percentage of the farmers who testified have been influenced by the PIP trainers (MWARES project) and the activities they engaged in due to PIP training.

Table 10: PIP approach and its influence towards the use of soil erosion control practice the training offered.

Variables	Frequency (%)
Who influenced you to adopt the soil erosion	
Government/ extension workers	15 (5%)
MWARES project/ PIP approach	144 (52%)

My neighbor	46(17%)
Other projects/ development partners	10(5%)
Others(specify)	62(22%)
Activities engaged in because of PIP training?	
Agronomic training	99(79%)
Agribusiness training	52(41.3%)
Information Sharing	96(76.2%)
Agroforestry	91(57%)
Establishment of tree nurseries	40(25%)
Tree planting	133(83%)

Data Source: Smallholder farmer household survey

4.5 Challenge/ Constraints faced by farmers in the use of soil erosion control measures.

Results in table 11 show that the constraints faced by farmers in implementing soil erosion control measure were limited agricultural extension services (55%), and this led to limited knowledge on how to implement (30%), they were also limited by financial resources (18%), Limited labour (17%), inadequate tools to implement the practices (15%), limited time (7%), and limited materials (mulch) (6%).

In the intervention subcounty, farmer reported to be constrained by limited knowledge (65%), limited land (48%), limited materials for mulching (47%), limited financial resources (39%), in adequate tools to implement (38%), and limited labour (38%). Results for the control subcounty indicated that the farmers faced the constraints of limited agricultural extension services (68%), limited knowledge (68%), inadequate tools (62%), inadequate tools to implement (62%), limited labour (62%), limited financial services, (61%), and limited land (48%). These constraints were validated by farmers in the Focus Group Discussion in Bumasheti that *"we do not have knowledge on how to make and maintain good erosion control practices like terracing and trenching this is because we don't get trainings from the officers in charge of farming at the subcounty"*.

Table 11 Constraints faced by farmers in using soil erosion control measures.

(Knowledge of soil erosion (n=272))				
Factors related to soil control measures		Intervention	Control	Total
Challenges faced in implementing	Limited land	30 (48%)	33 (52%)	63 (8%)
	Limited labour	53 (38%)	87 (62%)	140 (17%)
	Limited financial resources	59 (39%)	92 (61%)	151 (18%)
	Limited materials (mulch)	22 (47%)	25 (53%)	47 (6%)
	Limited time to implement the	22 (38%)	36 (62%)	58 (7%)

	Limited knowledge of how to implement	53 (65%)	29 (35%)	251 (30%)
	Inadequate tools to implement the	48 (38%)	79 (62%)	127 (15%)
Do you receive agricultural extension	No	48 (32%)	103 (68%)	151 (55%)
	Yes	105 (83%)	21 (17%)	126 (45%)

Data Source: Smallholder farmer household survey

Results in Table 12 shows results of constraints faced by farmers depending on their location along the slope. Findings indicated that both farmers on gentle slopes and steep slopes faced a problem of limited finances (50%) and limited labour (45%) and (55%) respectively. Farmers on the steep slopes were mainly influenced to practice soil control measures by the MWARES project/PIP approach (93%) whereas those on gentle slopes were largely influenced by their neighbours (89%).

Table 12 Constraints faced by farmers in implementing soil erosion control measures along the slope.

Location of plots along the slope.

Factors related to soil control measures

		Gentle	Steep slopes	Total
Challenges faced in implementing	Limited labour	77 (55%)	63 (45%)	140 (23%)
	Limited financial resources	75 (50%)	76 (50%)	151 (25%)
	Limited materials (mulch)	23 (47%)	24 (51%)	47 (8%)
	Limited time	33 (57%)	25 (43%)	58 (10%)
	Limited knowledge	47 (57%)	35 (43%)	82 (14%)
	Inadequate tools	60 (47%)	52. 8(67%)	127 (21%)
Who mainly influenced you to adopt the above-mentioned farming practices	Government extension workers.	2 (13%)	13 (87%)	15 (5%)
	MWARES project/PIP approach	134 (93%)	10 (7%)	144 (52%)
	My neighbour	5 (50%)	41 (89%)	46 (17%)
	Other projects/development partners	5 (50%)	5 (50%)	10 (4%)
	Others specify	7 (11%)	55(89%)	62 (22%)

Data Source: Smallholder farmer household survey

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1 Demographic features of the study group

The findings indicate that the survey was principally gender-representative. Although a bigger number of females was surveyed in the Bushika sub-county (intervention group) and more males in the Bumasheti sub-county (control group), the gender distribution between the two groups did not show any significant difference. Thus, the study was principally representative of both genders. The mean marital status and age, of the control and intervention group no significant difference. Since the targeted respondents were household heads, this kind of results was expected from the survey. The education attendance was observed to be slightly lower in the control sub-county. According to the project staff in the KIIs, this was influenced by the methodology used in selecting the Farmer Innovators (PIs). Otherwise, the two sub counties where the study was conducted were drawn from communities with similar education attendance according to UDHS (2020). As expected, majority of the farming households from both intervention and control sub counties have agriculture as their main source of income. 43% of the households in the control earn between 100,000-300,000 Uganda shillings as monthly income compared to the 50% in the intervention. This result builds on existing evidence in the UDHS (2020) which shows that median monthly household income was 203,000.

5.2 Farming practices and soil erosion risk in the study area.

The results indicate that the commonly used farming practices in the intervention sub-county are digging trenches, agroforestry, planting of Napier grass, mulching, planting cover crops and zero grazing. According to the results, these are used by most farmers, and they help control soil erosion and improve soil quality. This is in line with what was stated by (Galnaityte, 2017) that organic farming practices improve soil quality. However, this depends on the level of how the practices are being used. In the control sub-county, the farmers testified that they used the above farming practices, but the levels of usage were lower than those in Bushika/intervention sub-county. This was observed in the gardens during the field survey as there was no evidence of the use of good farming practices in their gardens. There was a higher percentage (80%) of use of stone bands in the control sub-county compared to 20% in Bushika (intervention) sub-county. This was attributed to the presence of very many rocks in gardens in the control subcounty than in the intervention. Collecting stones as stone bands to create land for crop cultivation led to the adoption of this

farming practice. This explains why, according to the RUSLE, there was high risk of erosion in the control sub-county (56.10 tons per hectare) compared to that in the intervention sub-county (14.3 tons per hectare) in 2023. Therefore, this implies that farming practices, when used appropriately, can help reduce the erosion risk. There was a reduced erosion risk in the intervention sub-county, and this is attributed to the use of proper farming practices like agroforestry, trenching and stabilising the trenches with Napier grass, planting cover crops, strip farming, and mulching (Wairegi et al., 2016). This implies that training the farmers in good farming practices is crucial as it creates awareness and helps farmers to acquire knowledge. This was evidenced in the Bushika sub-county, as almost all gardens had trenches, agroforestry trees, and Napier grass. Therefore, in conclusion, when farming practices are used wrongly, they can accelerate erosion, and when the farmers get proper training on how to use the farming practices in a standard way, they can help reduce the erosion risk (Belachew et al., 2020).

4.6 Factors determining the adoption of the PIP approach by smallholder farmers

According to the findings that several factors influenced the farmers to adopt PIP approach, including marital status, age, educational attainment, income level, awareness of soil erosion and its signs, and received training. This aligns with the research conducted by Ntshangase et al. (2018), which identified similar determinants such as farmers' perceptions, age, educational background, and knowledge from extension services. Notably, married individuals demonstrated a higher adoption rate of 92% compared to those who were single, widowed, or divorced. Focus group discussions indicated that training sessions often included couples (husbands and wives), providing insight into the increased adoption among married participants. The approach was designed to engage households as a unit while promoting cooperation among members of the household plus the broader community.

A significant proportion of the farmers who embraced this method had only attained a primary education level (89%) (Rik Linssen, 2020). This observation was supported by the fact that many respondents struggled to communicate effectively in English. Furthermore, younger farmers predominantly occupied this educational bracket. Older farmers tended to adhere to traditional farming techniques and were less inclined to adopt new practices due to both familiarity and decreased physical stamina necessary for demanding activities like trenching. Conversely, younger farmers exhibited a strong desire for learning and were willing to travel considerable distances for training opportunities as well as to educate their peers. This was contrary to Ntshangase et al. (2018) conclusions that older individuals participated more in conservation agriculture training than youth

residing in urban areas, this study found different trends regarding participation in farmer education initiatives.

The data indicates that most adopters earned less than 300,000 Uganda shillings monthly. This is attributable to the PIP approach's focus on sustainable land use management aimed at enhancing crop yields and thereby increasing income levels. Consequently, many low-income earners adopted this strategy in hopes of improving their financial situation. The results also show that 91% of these adopters possessed knowledge about soil erosion and its signs, its various forms/types, and the negative effects associated with excessive erosion. Their experiences with negative outcomes fuelled their motivation to implement better farming methods and measure controlling soil erosion leading to the adoption of the PIP approach. according to Kessler et al., (2018) training plays a crucial role in facilitating this process of the adoption of the PIP approach. Among study participants who participated in training in the approach with PIP training officers, an impressive 99% subsequently adopted and utilized these methods at home. This finding collaborates Danso et al., (2018) assertion that extension services are instrumental in helping farmers address challenges while actively engaging them in agricultural knowledge acquisition.

5.3 Effects of the PIP approach on soil erosion control on the Mount Elgon slopes.

Research indicates that the PIP approach positively impacted on soil erosion control on the Mount Elgon slopes. A notable increase was realised in the adoption of practices that erosion control by (91%) plus a decrease in those that exacerbated soil erosion in Bushika sub-county which was the PIP intervention subcounty. It indicates very well that PIP's focus is on sustainable land use management. This outcome was aligned to Kessler et al. (2020), who emphasized that effective land management through improved and good conservation techniques is fundamental to the PIP approach. Farmers extensively used the principles such as empowerment, collaboration, and integration, which are crucial for implementing erosion control measures. As noted by Olabisi (2012), effective erosion management often stems from decisions made by individual farmers. The principle of working together (collaboration) (86%) has encouraged community members to unite and do things together in their homes and the community at large, fostering greater familial cohesion among the community members. Families have begun working collectively, sharing labour responsibilities on their farms rather than placing the entire burden on one person. This shared effort has not only boosted household productivity but also alleviated soil erosion by distributing labour-intensive tasks such as digging trenches, mulching, and terracing among family members. Empowerment instils in farmers a belief in their capability to achieve positive outcomes

without external help, this principle is closely linked with motivation principles. Farmers driven by intrinsic motivation take independent action to use better farming practices to conserve soil (Kessler, 2018). Moreover, these farmers are equipped to train others in effective agricultural practices, facilitating broader information exchange that further controls erosion. Integration (87%) enables farmers to engage in multiple complementary activities. For instance, a farmer practicing zero grazing can utilize cow dung as fertilizer while also feeding animals with elephant grass and *Caliandra* used for stabilizing trenches adds nutrients to the soil and provide food for lactating animals. This principle helps in maximizing outputs from limited land.

The data revealed a decline in soil erosion levels within the sub-county where PIP was implemented a moderate reduction of 62%, with 35% of farmers reporting significant decreases. This improvement is partly attributed to diversifying income sources beyond agriculture. In addition, establishing nursery beds for tree planting was also taken on by the farmers. Indigenous species such as *Markhamia*, *Cordia*, and *Musizi* were planted. These trees help bind soil particles together and mitigate surface runoff. These initiatives followed training sessions conducted by PIP extension workers stressing the advantages of planting local-indigenous trees. Socio-economic benefits derived after training in this approach contributed significantly to reducing erosion over time. Farmers received training through Village Savings and Loans Associations (VSLAs), empowering them to invest in alternative income-generating enterprises like beekeeping, retail businesses, and transportation services. Such diversification reduced over cultivation and reliance on agriculture for sustenance which subsequently led to a decline in over cultivation hence reduced soil erosion.

This suggests that adhering to PIP principles can profoundly influence farmers' ability to assess challenges within their communities and households effectively; they can devise solutions and plan varied activities aimed at resolving issues related to sustainable development and soil conservation.

5.4 Constraints faced by farmers in the use of soil erosion control measures.

Findings revealed that the farmers are primarily constrained by economic challenges, including insufficient financial resources, inadequate tools, and limited labour for implementing soil conservation practices this is because money is need for investment, yet the small holder farmers are low-income earners. This aligns with the observations of Ataei (2021), who noted that limited labour and limited finances hinder farmers' ability to adopt soil erosion control methods. As per the national population census conducted in 2014, 69% of the households in Bududa District were

subsistence farmers. These farmers grow food for home consumption and are not economically stable hence the inadequate finances to hire labour and buy farm equipment to be used in the practice of soil erosion control. *“We have welcomed the approach to our community, but we are facing a big challenge of poverty/limited income to implement activities like terracing, planting modern hybrid seeds, buying fertilizers for crops like onions”*. Another constraint was the scarcity of extension services provided by the government. Consequently, many farmers in the Bushika sub-county did not have adequate knowledge regarding the proper ways of implementing soil erosion control techniques. In contrast, those who received extension services and training were from the intervention sub-county and credited this support to PIP extension workers. As a result, many farmers remain unaware of essential guidelines such as the appropriate trench size or spacing requirements between bananas and coffee in agroforestry systems. This observation is supported by Barungi et al., (2013) who indicated the importance of enhanced and increased extension services in the improvement in agricultural knowledge leading to adoption of conservation technology among farmers. In addition, farmers in the Elgon region face land shortages as a significant constraint. The results showed that many do not engage in trench digging due to space limitations where they would rather allocate land for additional crop cultivation. Thus, they contend with small landholdings. This finding is consistent with research conducted by Chinseu et al. (2019). *“Limited land given the high population in our area makes it difficult to implement the approach. This heavily affected the principle of integration, which may require many activities in one piece of land”*.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS.

6.0 Conclusion.

Based on the above results and discussions, the following conclusions were drawn:

The farming practices like mono cropping and over cultivation can expose the soil to erosion since Elgon is a mountainous area with high surface water runoff. And farming practices like trenching, mulching, agroforestry, planting of cover crops and Napier grass help on reducing the soil erosion risk in the area. This is because they reduce speed of runoff, cover the soil to reduce its exposure to erosion, among others. However, when used un appropriately, they can lead to increase in erosion the erosion risk. For example, when trenches are dug without following the right procedures and with out stabilising the soils on the trench boundaries, it can instead trap water that will later saturate the soil and cause more damage. Therefore, the standard procedures of implementing the practices should be followed.

PIP approach adoption is determined mainly by training and awareness raising most of the farmers can easily adopt a method that they are aware of. Therefore, it should be done properly and vigorously to help spread the approach. Although it was highly adopted by the low-income earners, it is a good approach for everyone, and it applies even in business because it help an individual to assess their current situation and plan better for the future. Therefore, it should be also emphasized among the business holders.

Participatory Integrated Planning approach has been effective in use of erosion control practices. It is a bottom-up and fosters change in mindset among farming households and farming communities leading to Sustainable Land Management. This is in comparison with the control subcounty which had visible evidence of erosion with a lot of erosion hotspots. Also, according to RUSLE, this sub-county had the highest erosion risk. In the farmer's gardens, there were limited erosion control practices on the ground and those that had were not up to the standard of the required practices. The PIP approach has demonstrated positive effects on soil conservation, and this is through its foundation and guiding principles. Through awareness-raising workshops by the PIP trainers, farmers realised the problems in their areas and were motivated to act. One of these problems was soil erosion and land degradation. Due to the principle of motivation, farmers are

motivated intrinsically to train other farmers (farmer-farmer training) without any external incentives. This has spread awareness from one village to another, hence the need to use practices that soil erosion to conserve the soil.

The principle of collaboration has promoted collaboration and trust among households and communities. The farmers were able to work collectively and provide labour for fellow farmers. For example, in the FGD, the farmers testified that they help fellow farmers dig trenches in their gardens to control erosion. They do this collectively and move from one garden to another, hence soil conservation in a community.

Through integration, the farmers can have alternative income sources instead of solely depending on agriculture. This has reduced cultivation, hence soil conservation. For instance, when a farmer practices animal rearing by zero grazing, the manure from the animal is used in the garden and the banana stems provide food for the cows and at the same time, the cow products are a source of alternative income. This reduces over-dependence on farming, hence soil conservation. In addition to this, the approach also promotes agri-business, savings and loans through Village Savings and Loan Associations (VSLAs) and Integrated Group Plans (IGPs) which offer alternative livelihoods.

However, although the approach has promoted the use of erosion control measures, the rate at which they are used is still low. This is because these measures are laborious, and most households cannot afford hired labour to dig trenches and establish nursery beds, among other things. In addition, the PIs that train fellow farmers tend to neglect their farms due to limited time as they move long distances to train fellow farmers with no external incentives. This, in the long run, demotivates the farmers.

6.1 Recommendations

The following are the recommendations depending on the findings:

The number of extension workers in the communities should be increased by the local government to train on agronomy and Sustainable Land Use Management. The farmers had knowledge of the different soil erosion control practices, but they did not know how to implement the different methods in a standard way. This was evidenced in the digging of trenches that were not standard and mulching. The recommendation is that as awareness is done, the farmers should be given all the necessary knowledge hand in hand with the PIP training.

There should be increased awareness-raising workshops and PIP training among the farming communities by the project staff and government extension workers. This is because it is the main determinant of the adoption of the approach. When the farmers get knowledge on the application of the approach, they will adopt the approach because its principles are eye catching. When the government extension workers are involved, it will promote continuity even after the project.

The approach is effective in soil conservation. However, there should be a check on the flow of information from farmer to farmer by the project implementers. This is because during the first awareness-raising meetings, the farmers are trained by a PIP field officer, and they get concrete knowledge. It was noticed that the PIs (innovative farmers) and first-generation farmers had good knowledge, but it was diluted as we interviewed the second and third-generation farmers. Even the trenches in these generations were not standard compared to the PIs and first-generation farmers.

The approach has a principle of motivation where farmers do everything without expecting any external incentives. The farmer's trainers should at least be facilitated by the project or local government in case the project has ended to keep them motivated. This is because they leave their homes and farms to train other farmers in other villages. This facilitation would help them hire labour on their farms. They will be able to work effectively without worry of their own load of work.

REFERENCES

- Alewell, C., Borrelli, P., Meusburger, K., & Panagos, P. (2019). Using the USLE: Chances, challenges and limitations of soil erosion modelling. *International Soil and Water Conservation Research*, 7(3), 203–225. <https://doi.org/10.1016/j.iswcr.2019.05.004>
- Angima, S. D., Stott, D. E., Neill, M. K. O., Ong, C. K., & Weesies, G. A. (2003). *Soil erosion prediction using RUSLE for central Kenyan highland conditions*. 97, 295–308. [https://doi.org/10.1016/S0167-8809\(03\)00011-2](https://doi.org/10.1016/S0167-8809(03)00011-2)
- Asten, P. J. A. Van, Wairegi, L. W. I., Mukasa, D., & Uringi, N. O. (2011). *Agronomic and economic benefits of coffee – banana intercropping in Uganda ' s smallholder farming systems*. 104, 326–334. <https://doi.org/10.1016/j.agsy.2010.12.004>
- Asten, P. Van, Ochola, D., Wairegi, L., Nibasumba, A., Jassogne, L., & Mukasa, D. (2015). *Coffee-Banana Intercropping : Implementation guidance for policymakers and investors*.
- Atoma, H., Suryabagavan, K. V., & Balakrishnan, M. (2020). Soil erosion assessment using RUSLE model and GIS in Huluka watershed , Central Ethiopia. *Sustainable Water Resources Management*, February. <https://doi.org/10.1007/s40899-020-00365-z>
- Barungi, M., Ng'ong'ola, D. H., Edriss, A., Mugisha, J., Waithaka, M., & Tukahirwa, J. (2013). Factors Influencing the Adoption of Soil Erosion Control Technologies by Farmers along the Slopes of Mt. Elgon in Eastern Uganda. *Journal of Sustainable Development*. 6(2), 9–25. <https://doi.org/10.5539/jsd.v6n2p9>
- Belachew, A., Mekuria, W., & Nachimuthu, K. (2020). International Soil and Water Conservation Research Factors in fl uencing adoption of soil and water conservation practices in the northwest Ethiopian highlands. *International Soil and Water Conservation Research*, 8(1), 80–89. <https://doi.org/10.1016/j.iswcr.2020.01.005>
- Borrelli, P., Robinson, D. A., Fleischer, L. R., Lugato, E., Ballabio, C., Alewell, C., Meusburger, K., Modugno, S., Schütt, B., Ferro, V., Bagarello, V., Oost, K. Van, Montanarella, L., & Panagos, P. (2017). land use change on soil erosion. *Nature Communications*. <https://doi.org/10.1038/s41467-017-02142-7>
- Buyinza, M., & Mugagga, F. (2010). *Economics of land degradation in mid-hills of mt. elgon watershed, eastern uganda*. 1978(August), 1–6.
- Chang, K. (2019). *Geographic information system*.

<https://doi.org/10.1002/9781118786352.wbieg0152.pub2>

- Chapman, S., Birch, C. E., Chapman, S., Birch, C. E., Galdos, M. V., Pope, E., Davie, J., Bradshaw, C., Eze, S., & Marsham, J. H. (2021). *Assessing the impact of climate change on soil erosion in East Africa using a convection-permitting climate model* *Assessing the impact of climate change on soil erosion in East Africa using a convection-permitting climate model*.
- Danso-Abbeam, G., Ehiakpor, D. S., & Aidoo, R. (2018). Agricultural extension and its effects on farm productivity and income: Insight from Northern Ghana. *Agriculture and Food Security*, 7(1), 1–10. <https://doi.org/10.1186/s40066-018-0225-x>
- Dhiman, V. (2020). Organic Farming for Sustainable Environment : Review of Existed Policies and Suggestions for Improvement Organic Farming for Sustainable Environment : Review of. *International Journal of Research and Review*, 7(2), 2454–2237.
- Galnaityté, A. (2017). *EVALUATION OF TECHNOLOGICAL , ECONOMIC AND SOCIAL INDICATORS OF DIFFERENT*. 10(4), 189–202. <https://doi.org/10.14254/2071-789X.2017/10-4/15>
- Ganasri, B. P., & Ramesh, H. (2016). Geoscience Frontiers Assessment of soil erosion by RUSLE model using remote sensing and GIS - A case study of Nethravathi Basin. *Geoscience Frontiers*, 7(6), 953–961. <https://doi.org/10.1016/j.gsf.2015.10.007>
- Ghosal, K. (2020). A Review of RUSLE Model. *Indian Society of Remote Sensing*.
- Giller, K. E., Delaune, T., Vasco, J., Wijk, M. Van, Hammond, J., Descheemaeker, K., Ven, G. Van De, Schut, A. G. T., Taulya, G., & Chikowo, R. (2021). Small farms and development in sub - Saharan Africa : Farming for food , for income or for lack of better options ? *Food Security*, 1431–1454. <https://doi.org/10.1007/s12571-021-01209-0>
- Ighodaro, I. D., Lategan, F. S., & Mupindu, W. (2016). The Impact of Soil Erosion as a Food Security and Rural Livelihoods Risk in South Africa. *Journal of Agricultural Science*, 8(8), 1. <https://doi.org/10.5539/jas.v8n8p1>
- Jamie Anderson, Collen E.Learch, S. T. G. (2016). *National Survey and Segmentation of Smallholder Households in Uganda Understanding Their Demand for Financial .. April*.
- Jiang, B., Bamutaze, Y., & Pilesjö, P. (2014). Climate change and land degradation in Africa: A

- case study in the Mount Elgon region, Uganda. *Geo-Spatial Information Science*, 17(1), 39–53. <https://doi.org/10.1080/10095020.2014.889271>
- Kaňara, A., Conteh, A., Rhodes, E. R., Cooke, R. A., & Kamara, A. (2019). The relevance of smallholder farming to african agricultural growth and development. *AFRICAN JOURNAL OF FOOD.AGRICULTURE.NUTRITION AND DEVELOPMENT*, 19(1), 14043–14065. <https://doi.org/10.18697/ajfand.84.BLFB1010>
- Karamage, F., Zhang, C., Liu, T., Maganda, A., & Isabwe, A. (2017). Soil erosion risk assessment in Uganda. *Forests*, 8(2), 1–20. <https://doi.org/10.3390/f8020052>
- Kessler, A., Reemst, L. Van, & Nsabimana, F. (2018). *PIP manual*. September, 52.
- Kessler, A., van Reemst, L., Beun, M., Slingerland, E., Pol, L., & De Winne, R. (2021). Mobilizing farmers to stop land degradation: A different discourse from Burundi. *Land Degradation and Development*, 32(12), 3403–3414. <https://doi.org/10.1002/ldr.3763>
- Kessler, C. A., van Duivenbooden, N., Nsabimana, F., & van Beek, C. L. (2016). Bringing ISFM to scale through an integrated farm planning approach: a case study from Burundi. *Nutrient Cycling in Agroecosystems*, 105(3), 249–261. <https://doi.org/10.1007/s10705-015-9708-3>
- Larionov, G., Gorobets, A., & Maksimova, I. A. (2018). *Experimental Study of Factors Affecting Soil Erodibility*. March. <https://doi.org/10.1134/S1064229318030067>
- Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A., Chen, M., Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A., & Chen, M. (2019). Reflections and speculations on the progress in Geographic Information Systems (GIS): a geographic perspective. *International Journal of Geographical Information Science*, 33(2), 346–367. <https://doi.org/10.1080/13658816.2018.1533136>
- Meliho, M., Khattabi, A., & Mhammdi, N. (2020). Spatial assessment of soil erosion risk by integrating remote sensing and GIS techniques : a case of Tensift watershed in Morocco. *Environmental Earth Sciences*, 79(10), 1–19. <https://doi.org/10.1007/s12665-020-08955-y>
- Mugagga, F., Kakembo, V., & Buyinza, M. (2012). Land use changes on the slopes of Mount Elgon and the implications for the occurrence of landslides. *Catena*, 90(March), 39–46. <https://doi.org/10.1016/j.catena.2011.11.004>
- Mwanake, H., Mehdi-Schulz, B., Schulz, K., Kitaka, N., Olang, L. O., Lederer, J., & Herrnegger,

- M. (2023). Agricultural Practices and Soil and Water Conservation in the Transboundary Region of Kenya and Uganda: Farmers' Perspectives of Current Soil Erosion. *Agriculture (Switzerland)*, 13(7). <https://doi.org/10.3390/agriculture13071434>
- Nakileza, B. R., Majaliwa, M. J., Wandera, A., & Nantumbwe, C. M. (2017). Enhancing resilience to landslide disaster risks through rehabilitation of slide scars by local communities in Mt Elgon, Uganda. *Jamba: Journal of Disaster Risk Studies*, 9(1), 1–11. <https://doi.org/10.4102/jamba.v9i1.568>
- Ntshangase, N. L., Muroyiwa, B., & Sibanda, M. (2018). Farmers' perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in Zashuke. KwaZulu-Natal province. *Sustainability (Switzerland)*, 10(2). <https://doi.org/10.3390/su10020555>
- Obalum, S. E., Buri, M. M., Nwite, J. C., Hermansah, Watanabe, Y., Igwe, C. A., & Wakatsuki, T. (2012). Soil degradation-induced decline in productivity of sub-saharan african soils: The prospects of looking downwards the lowlands with the sawah ecotechnology. *Applied and Environmental Soil Science*, 2012. <https://doi.org/10.1155/2012/673926>
- Olabisi, L. S. (2012). *Uncovering the Root Causes of Soil Erosion in the Philippines Society & Natural Resources Uncovering the Root Causes of Soil Erosion in the Philippines*. January 2012. <https://doi.org/10.1080/08941920.2011.563435>
- Pandey, S., Kumar, P., Zlatic, M., Nautiyal, R., & Panwar, V. P. (2021). Recent advances in assessment of soil erosion vulnerability in a watershed. *International Soil and Water Conservation Research*, 9(3), 305–318. <https://doi.org/10.1016/j.iswcr.2021.03.001>
- Peter F. Ffolliot, Daniel G. Neary, Kenneth N. Brooks, Roberto Pizarro Tapia, P. G. C. (2013). *Soil Erosion and Sediment Production on Watershed Landscapes : Processes and Control Soil Erosion and Sediment Production on Watershed Landscapes : Processes , Prevention , and Control*.
- Pimentel, David H. Hurni, Wen Dazhong, R. Lal, L. McLaughlin, T.N. Khoshoo, K.G. Tejwani, K. Edwards, J. S. M. (2009). *world soil erosion and conservation* (I. David Pimentel (study group of world soil conservation, commission on ecology (ed.)). Cambridge university press.
- R.P.C.Morgan. (2005). *soil erosion and conservation* (Third edit). Blackwell Publishing Ltd.

- Rik Linssen, M. M. (2020). *From drawing to reality : The Impact-of the PIP-approach on farmers ' motivation , resilience and stewardship in rural Burundi . July.*
- Semalulu, O., Kasenge, V., Nakanwagi, J., Wagoire, W., Chemusto, S., & Tukahirwa, J. (2014). Financial losses due to soil erosion in the Mt . Elgon hillsides , Uganda : a need for action. *Sky Journal of Soil Science & Environmental Management*, 3(3), 29–35.
<http://www.skyjournals.org/SJSSEM>
- Thapa, P. (2020). Spatial estimation of soil erosion using RUSLE modeling : a case study of Dolakha district , Nepal. *Environmental Systems Research*. <https://doi.org/10.1186/s40068-020-00177-2>
- Tian, P., Zhu, Z., Yue, Q., He, Y., Zhang, Z., Hao, F., Guo, W., Chen, L., & Liu, M. (2021). *International Soil and Water Conservation Research Soil erosion assessment by RUSLE with improved P factor and its validation : Case study on mountainous and hilly areas of Hubei . 9.* <https://doi.org/10.1016/j.iswcr.2021.04.007>
- Turinawe, A. (2019). *Impact of soil and water conservation technology adoption on smallholder farms in . 11*(September), 217–233. <https://doi.org/10.5897/JDAE2018.0918>
- Uganda Bureau of Statistics. (2017). *National Housing and Population Census of Uganda. Area Specific Profiles - Bududa.* (Issue April).
- Vibhute, A. (2017). *Analysis and Modeling of Agricultural Land use using Remote Sensing and Geographic Information System : a Review.* November.
- Wairegi, L., Asten, P. Van, Giller, K., & Fairhurst, T. (2016). *Banana-coffee system cropping guide.* African Soil Health Consortium.
- Woniala, J., & Nyombi, K. (2014). *Soil fertility management by smallholder farmers and the impact on soil chemical properties in Sironko district , Uganda Soil Fertility Management by Smallholder Farmers and the Impact on Soil Chemical Properties in Sironko District , Uganda.* August.
- Wuepper, D., Borrelli, P., & Finger, R. (2020). Countries and the global rate of soil erosion. *Nature Sustainability*, 3(1), 51–55. <https://doi.org/10.1038/s41893-019-0438-4>
- Xiong, M., Sun, R., & Chen, L. (2018). Science of the Total Environment Effects of soil conservation techniques on water erosion control : A global analysis. *Science of the Total*

Environment, 645, 753–760. <https://doi.org/10.1016/j.scitotenv.2018.07.124>

Mwanake H, Mehdi-Schulz B, Schulz K, Kitaka N, Olang LO, Lederer J, Herrnegger M. Agricultural Practices and Soil and Water Conservation in the Transboundary Region of Kenya and Uganda: Farmers' Perspectives of Current Soil Erosion. *Agriculture*. 2023; 13(7):1434. <https://doi.org/10.3390/agriculture13071434>

<https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-17981>

APPENDICES

Appendix I: Household Survey Questionnaire

Date (dd/mm/yyyy).

Dear respondent,

My name is _____, from Kyambogo University. I am conducting a study on **the effects of PIP approach on soil erosion control on the mount Elgon slopes**. Your participation is voluntary, but it is very crucial to participate because you are a representative of many other people in this village. There are no wrong and right answers to the questions. Your answers will be used strictly for research purposes and will be treated as confidential. I will ask you a series of questions that should take about 30 minutes. Your answers are important, and we hope that you participate.

At this time, do you want to ask any questions about the survey?

Do you agree to participate in the survey? 1. Yes, 2. No

Appendices

SECTION 1: GEOGRAPHICAL AND SOCIAL DEMOGRAPHICS

1. Sub County of location	
2. Parish	
3. Village	
4. Name of the respondent	
5. Sex	1. Male 2. Female
6. Age	
7. Marital status	1. Single /never married. 2. Cohabiting 3. Married 4. Divorced 5. Widowed/widower

8. What is your highest level of education?	1. Never attended school 2. Primary 3. Secondary 4. College/tertiary/vocational 5. University		
9. Are you the household head?	1. Yes 2. no		
10. If no, how are you related to the household head?	1. Spouse 2. Son 3. Daughter 4. Others, specify		
11. GPS coordinates			
	Easting	Northing	Altitude
12. Time of the interview	Start _ _ : _ _		End _ _ : _ _
Interviewers name			Code
Signature of supervisor.			

SECTION 2: SOIL EROSION

13. Do you experience soil erosion in your plot/farm?	1. Yes 2. No
14. If yes, what are the manifestations of soil erosion.	1. Exposed rocks 2. Exposed tree roots 3. Rills (small channels) 4. Bare soil 5. Muddy runoff water 6. Cracks along the slope 7. Others specify

15. What is the spatial extent of soil erosion?	<ol style="list-style-type: none"> 1. Plot level 2. Community level 3. Village level 4. Parish level 5. Suc county level
16. What are the causes of soil erosion?	<ol style="list-style-type: none"> 1. Clearance of vegetation 2. Poor farming practices 3. Increased population 4. Poverty 5. Steep nature of the landscape 6. Others specify.
17. What effects of soil erosion do you experience?	<ol style="list-style-type: none"> 1. Loss of soil nutrients 2. Reduced crop productivity 3. Silting of rivers 4. Others specify.
18. Do you use any soil erosion control measure in your farm?	<ol style="list-style-type: none"> 1. Yes 2. No
19. When did you start using soil erosion control measures?	<ol style="list-style-type: none"> 1. Before 2019 2. After 2019
20. If yes, what soil erosion control measures do you use on your farm?	<ol style="list-style-type: none"> 1. Crop rotation 2. Strip cropping 3. Contour ploughing 4. Terraces 5. Mulches 6. Non-till planting 7. Ridge planting 8. Rock hedges 9. Agroforestry 10. Trenches 11. Others specify

21. What challenges do you face while implementing these soil erosion control measures?	<ol style="list-style-type: none"> 1. Limited land 2. Limited labour 3. Limited finances 4. Others specify.
---	---

SECTION 3: FARMING PRACTICES.

22. What farming practices have you adopted and implementing in your farm?	<ol style="list-style-type: none"> 1. Monocropping 2. Mixed cropping 3. Agro forestry 4. Intercropping 5. Crop rotation 6. Planting cover crops 7. Others specify
23. When did you adopt the farming practices above?	<ol style="list-style-type: none"> 1. Before 2019 2. After 2019
24. Why did you adopt the farming practices above?	<ol style="list-style-type: none"> 1. To control soil erosion 2. Limited land 3. To increase on crop production 4. For manure production 5. It's suitable for the soil type 6. Steep nature of the land scape 7. Other specify
25. Do you experience soil erosion in the farming practices you have mentioned above?	<ol style="list-style-type: none"> 1. Ye 2. No
26. If yes, how does soil erosion affect each farming practice mentioned above?	<ol style="list-style-type: none"> 1. Reduces the crop yields 2. Leads to stunted growth of crops 3. Reduces soil nutrients and quality 4. Other specify
27. Among all the farming practices, which one	<ol style="list-style-type: none"> 1. Monocropping 2. Mixed cropping

<p>contributes to high rates of soil erosion?</p>	<ol style="list-style-type: none"> 3. Agro forestry 4. Intercropping 5. Crop rotation 6. Planting cover crops 7. Other specify.
<p>28. In which of the farming practices have you experienced moderate soil erosion?</p>	<ol style="list-style-type: none"> 1. Monocropping 2. Mixed cropping 3. Agro forestry 4. Intercropping 5. Crop rotation 6. Planting cover crops 7. Other specify.
<p>29. In which of the farming practices do you experience less soil erosion?</p>	<ol style="list-style-type: none"> 1. Monocropping 2. Mixed cropping 3. Agro forestry 4. Intercropping 5. Crop rotation 6. Planting cover crops 7. Other specify.
<p>30. What soil erosion control measures are you implementing in your farm?</p>	<ol style="list-style-type: none"> 1. Crop rotation 2. Strip cropping 3. Contour ploughing 4. Terraces 5. Mulches 6. Non-till planting 7. Ridge planting 8. Rock hedges 9. Agroforestry 10. Trenches 11. Others specify
<p>31. Which of the farming practices has the best crop/livestock yields?</p>	<ol style="list-style-type: none"> 1. Monocropping 2. Mixed cropping 3. Agro forestry

	<ol style="list-style-type: none"> 4. Intercropping 5. Crop rotation 6. Planting cover crops 7. Other specify.
32. Which of the farming practices has less crop/livestock yields	<ol style="list-style-type: none"> 1. Monocropping 2. Mixed cropping 3. Agro forestry 4. Intercropping 5. Crop rotation 6. Planting cover crops 7. Other specify.

SECTION 3: PIP APPROACH AND SOIL CONSERVATION.

33. Do you have any training on the PIP approach?	<ol style="list-style-type: none"> 1. Yes 2. No
34. In your own words explain what you understand by the term PIP approach.	
35. Were you using any soil conservation practice before training in the PIP approach or before 2019?	<ol style="list-style-type: none"> 1. Yes 2. No
36. If yes, which soil conservation practices were you using?	<ol style="list-style-type: none"> 1. Crop rotation 2. Strip cropping 3. Contour ploughing 4. Terraces 5. Mulches 6. Non-till planting 7. Ridge planting 8. Rock hedges 9. Agroforestry

	<ul style="list-style-type: none"> 10. Trenches 11. Others specify.
37. Did you have any challenges /problems while using the practices?	<ul style="list-style-type: none"> 1. Yes 2. No
38. If yes, what were the challenges?	<ul style="list-style-type: none"> 1. Limited knowledge 2. In adequate finances 3. Limited labour force 4. Limited land 5. Limited extension services 6. Limited agro-inputs 7. Others specify
39. What principles have you learnt from the PIP approach that have helped you adopt soil erosion control practices?	<ul style="list-style-type: none"> 1. Empowerment 2. Integration 3. Collaboration 4. Motivation 5. Stewardship 6. Resilience
40. How have you applied the PIP approach principles to control soil erosion/soil conservation.	<ul style="list-style-type: none"> 1. Doing things together as a family 2. Doing things together as a community 3. Involving in other sources of income other than agriculture 4. Training fellow farmers on soil conservation 5. Others specify
41. Have these principles helped solve the challenges in (18 above)	<ul style="list-style-type: none"> 1. Yes 2. No
42. If no, in your own opinion what do you think is lacking in the approach that should be addressed in order to help	

farmers in the best way possible?	
43. Have you ever received training on good agronomic practices from the MWARES project or between 2019-2022?	<ol style="list-style-type: none"> 1. No 2. Yes
44. If yes, which soil erosion control practices are promoted by the PIP trainers?	<ol style="list-style-type: none"> 1. Crop rotation 2. Strip cropping 3. Contour ploughing 4. Terraces 5. Mulches 6. Non-till planting 7. Ridge planting 8. Rock hedges 9. Agroforestry 10. Trenches 11. Others specify.
45. Have you experienced any changes in your farms in regard to reduction in soil erosion after these training or after 2019?	<ol style="list-style-type: none"> 1. Yes 2. No
46. If yes, what changes in regard to reduction in soil erosion have taken place in your farm as a result of PIP training or after 2019?	<ol style="list-style-type: none"> 1. Reduced soil erosion 2. Increase in crop and livestock yields. 3. Implementing sustainable farming practices 4. Others specify
47. How have you benefited from the PIP training economically?	<ol style="list-style-type: none"> 1. Knowledge on saving from VSLAs. 2. Involving in other income generating activities other than agriculture 3. Increased family income 4. Increased crop yields 5. Other specify

48. What environmental benefits have you got from the PIP approach training	<ol style="list-style-type: none"> 1. Knowledge on tree planting 2. Knowledge on soil and water conservation 3. Sustainable farming practices 4. Reduction in soil erosion 5. Knowledge on tree nursery establishment 6. Others specify
49. What social/institutional benefits have you got from PIP training?	<ol style="list-style-type: none"> 1. Bridged the gap between communities and local government. 2. Improved harmony in households 3. Promoted togetherness in communities. 4. Promoted hygiene. 5. Others specify

SECTION 4: CONSTRAINTS OF IMPLEMENTING PIP APPROACH

50. Are all members of this village PIP farmers?	<ol style="list-style-type: none"> 1. Yes 2. No
51. If no, what do you think stops/limits these community members from implementing the PIP approach?	<ol style="list-style-type: none"> 1. Mindset/ attitude 2. Poverty/limited income 3. Lack of extension support 4. Limited land 5. The approach limits participants 6. Others specify
52. Do you encounter any challenges while implementing the approach?	<ol style="list-style-type: none"> 1. Yes 2. No
53. If yes, what challenges/constraints stop you from implementing the approach fully?	<ol style="list-style-type: none"> 1. Poverty/limited income 2. Limited land 3. Limited extension services 4. Limited labour 5. Scaling/coverage of the approach 6. Landslides 7. Poor mindset/ attitude

	8. Limits from the approach itself. 9. Others specify
--	--

SECTION 5: SOLUTION TO MITIGATE THE CONSTSRAITS

54. What do you think should be done to solve the above challenges in section (4) above?	1. Credit/loans 2. Form farmer groups 3. Putting up demonstration farms 4. Provide farm in puts (seedlings. Fertilizers etc.) 5. Creating market for produce 6. Improving extension services 7. Others specify.
--	---

Appendix II: Focus Group Discussion Guide

Day/Date:

Time:

Number of participants:

Consent:

Hello, we are team from Kyambogo University (each facilitator introduces themselves) and we are here to have a brief discussion with you about soil conservation, livelihood diversification and PIP approach. You have been identified as key PIP farmers in the project, hence the information you provide is important to assess the PIP approach relevance, impact, sustainability, practices and learnings you have experienced or observed while implementing the approach. So please feel free to answer the few questions that I have. There is no wrong answer, everything you say is valuable to us.

No.	Name	Sex	Telephone number
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Questions:

Farming practices and soil erosion risk.

1. What are the different farming practices you are involved in?
2. How do these farming practices regulate soil erosion?
3. How do these farming practices contribute to soil erosion?
4. What are the evidence and signs of soil erosion?

Soil conservation.

5. Explain what you understand by the term PIP approach.
6. What principles are within the PIP approach that help in soil conservation?
7. How have you applied these principles to control soil erosion/soil conservation?
8. What practices/activities have you undertake to control soil erosion as a result of the PIP approach trainings.
9. Has there been an improvement in crop and livestock productivity? If yes, what are different changes have you experienced?

Recommendations.

10. What challenges do you experience while implementing the approach?
11. How do you suggest we improve the approach?

Appendix III: Key Informant Interview Guide

Date (dd/mm/yyyy)

What is the mode of interview? Virtual () or Physical ()

Name of the respondent

Title:

Telephone Number:

Email:

Consent:

Hello, my name is..... from Kyambogo University I am conducting a study on the effects of PIP approach on soil conservation and I am here to have a brief discussion with you about soil conservation, livelihood diversification and PIP approach. You have been identified as key stakeholder in the project, hence the information you provide is important to assess the PIP approach relevance, impact, sustainability, practices and learnings you have experienced or observed while implementing the approach. So please feel free to answer the few questions that I have. There is no wrong answer, everything you say is valuable to us.

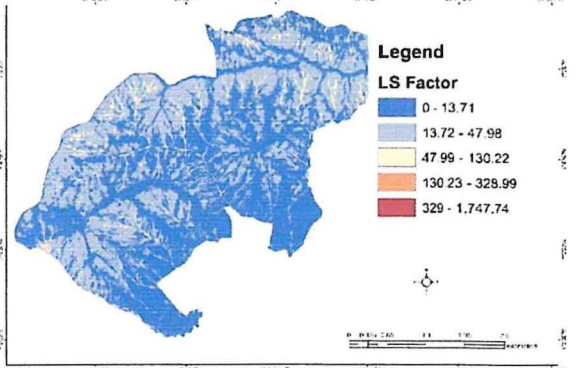
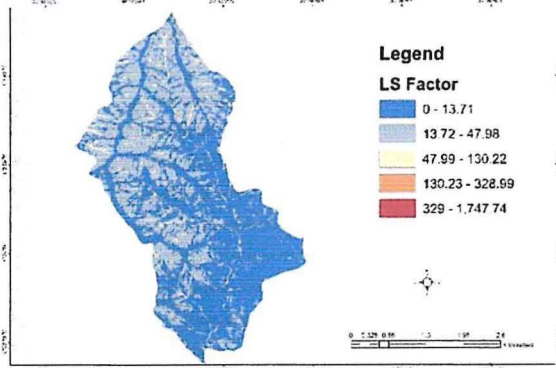
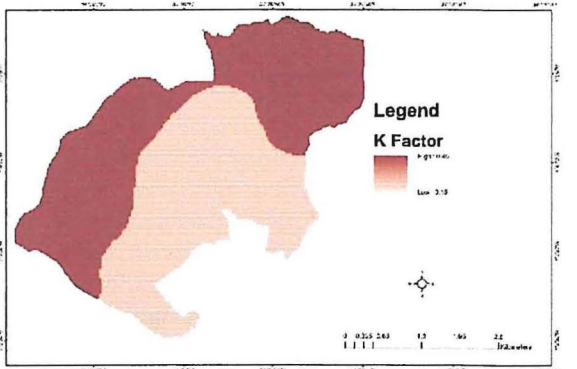
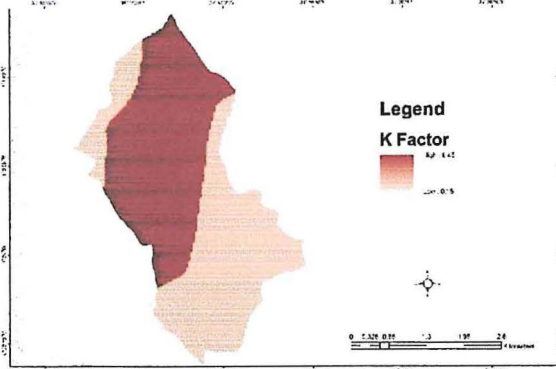
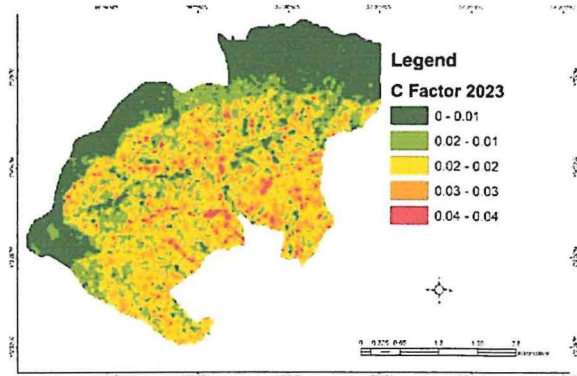
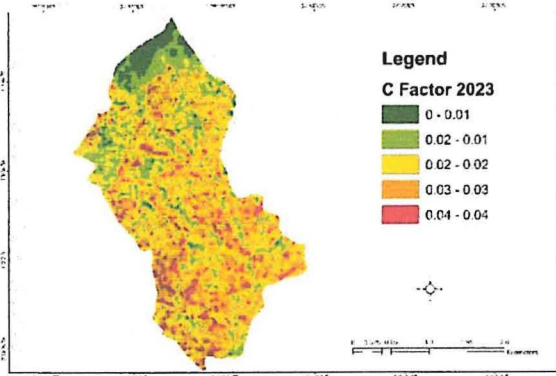
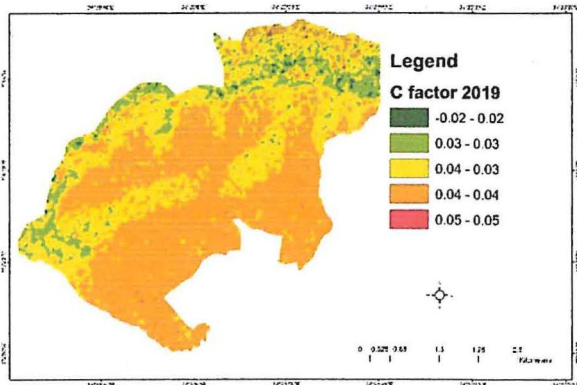
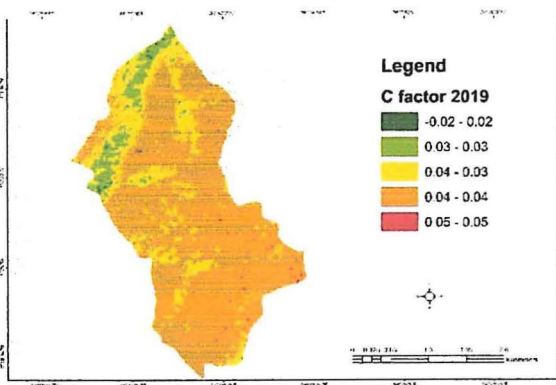
Questions

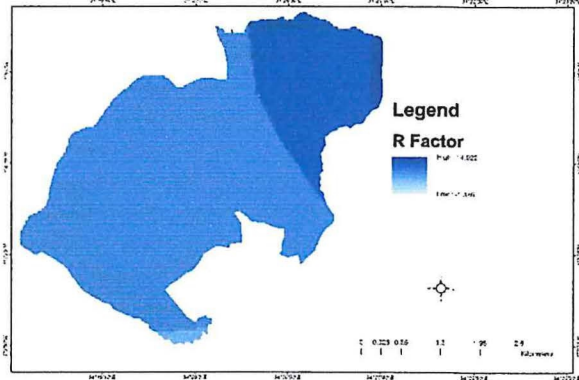
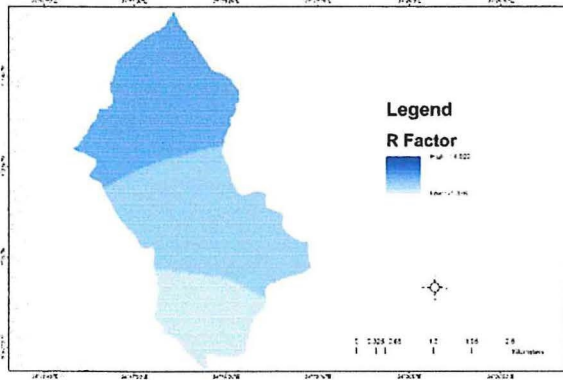
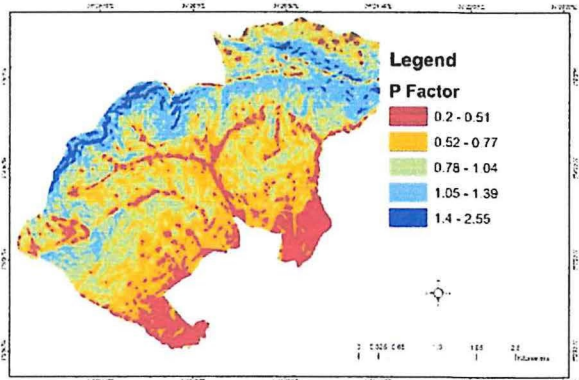
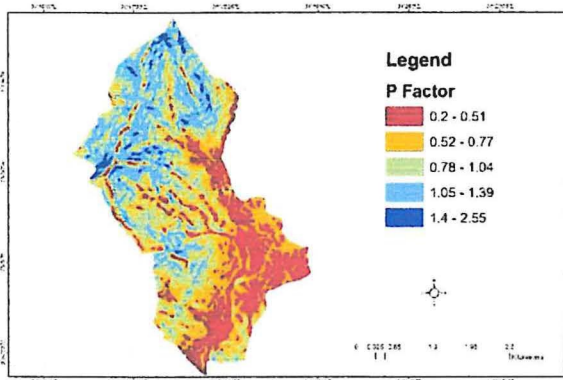
1. What do you understand by the term farming practices?
2. What are different farming practices in Bushika/Bumasheti sub counties.
3. In your own opinion, how do these different practices contribute to soil erosion?
4. What do you understand by the term PIP approach?
5. How have farmers applied the principles of PIP approach in their farms?
6. What changes are visible (in regard to soil conservation) in the farmers farms as a result of PIP approach training?
7. In your own opinion, what has been the impact of PIP approach on adoption of soil conservation practices in the farming communities?
8. What do you think is the spatial extent of soil erosion?
 - i. Village level
 - ii. Community level
 - iii. Parish level
 - iv. Subcounty level.

What are the signs/evidence of soil erosion?

9. What are the causes of soil erosion among farmers?

Appendix IV: RUSLE model.





Budget

Funded by Africa 2000 Network Uganda (A2N)

S/N	Particulars	Unit of Measure	Quantity	Unit Price	Freq	Amount
	PRE-TESTING TOOLS					
1	Wage for Research Assistants	Person	3	90,000	1	270,000
2	Digitalization of data collection tools (kobo collect)	Person	1	300,000	1	300,000
	Sub Total					570,000
	Training of research assistants					
3	Transport refund for the RAs	Person	6	15,000	1	90,000
4	Break tea for the RAs	Person	6	5,000	1	30,000
5	Lunch	Person	6	15,000	1	90,000
6	Evening tea	Person	6	5,000	1	30,000
7	Stationery	Lumpsum	1	40,000	1	40,000
	Sub Total					280,000
	Pre-test Data Collection					
8	Transport for Ras	Person	3	30,000	1	90,000
9	Transport for student	Person	1	30,000	1	30,000
10	Airtime for Coordination	Load	1	20,000	1	20,000
11	Supervisors Professional fee & Accommodation	Person	2	125,000	1	250,000
	Sub Total					390,000
	DATA COLLECTION					
18	Wage for Research Assistants	Person	6	90,000	12	6,480,000
19	Transport refund for RAs	Person	6	15,000	1	90,000
20	Transport for RAs	Person	6	30,000	12	2,160,000
21	Transport for student	Lumpsum	1	30,000	12	360,000
22	Airtime for Ras	Load	6	10,000	1	60,000

23	Airtime for Coordination	Load	1	100,000	1	100,000
24	Supervisors	Person	2	125,000	15	3,750,000
25	Lunch allowance for student	Person	1	25,000	12	300,000
	Refreshments for FGDs	person	4	5,000	10	200,000
	Airtime for LCI chairpersons	persons	8	10,000	1	80,000
	Sub Total					13,580,000
	Post Data Collection					
26	Data Analysis	Person	1	600,000	1	600,000
27	Printing and Binding of draft and final reports	Lumpsum	4	200,000	1	800,000
	Sub Total					1,400,000
	Grand total					16,220,000