SCHOOL OF POSTGRADUATE STUDIES

INVESTIGATING THE ENVIRONMENTAL IMPACT OF THE SUSTAINABLE LIVESTOCK INFRASTRUCTURE MANAGEMENT PROJECT (SLIMP) ON LAND RESOURCES IN MUCHINGA, NORTHERN AND EASTERN PROVINCES.

BY

ZENGANI MBAMBARA

MSCEM23121694

DECLARATION

I, **ZENGANI MBAMBARA** do hereby declare that this research is my own work, it has neither been done nor presented at any institution for any academic award and all other works of other researchers and authors have been fully acknowledged.

………………………..

Author ‘s Signature

ZENGANI MBAMBARA

Date: January 2025

………………………

Supervisor ‘s Signature

DR. A NGUVULU

Date: January 2025

ACKNOWLEDGEMENT

Above all I thank the almighty God for the wisdom and strength that enabled me to complete my studies at the University of Lusaka.

Grateful and forever indebted to my supervisor Dr A, Nguvulu for his time, advice, patience and help rendered to me during my research study.

To my parents and wife am grateful for all the support and encouragement rendered to me during my entire study at the university of Lusaka.

Grateful to the University Of Lusaka postgraduate school staff and lectures for the education and personal development during my stay at the University of Lusaka.

To my friends and classmates Kutemba, Morris, Kuluza and Eng. Mubanga am grateful and appreciate your assistance.

Lastly I would like to say thank you to the Minstry of Fisheries and Livestock for giving me a chance to advance my studies away from my busy work schedule.

DEDICATION

To my beloved parents, Mr. Jama Sydney Mbambara, Ms. Lilian Vwalika Mbambara and to my lovely wife Emely Musumpuka Mbambara with reverence and love.

Table of Contents

DECLARATION....................ii

ACKNOWLEDGEMENT....................iii

DEDICATION....................iv

ABSTRACT....................ix

CHAPTER ONE: INTRODUCTION....................1

1.0 Introduction....................1

1.1 Background....................2

1.2 Problem Statement....................3

1.3 Research Objectives....................3

1.4 Research Questions....................4

1.5 Significance of the Study....................4

1.6 Scope Of Study....................5

1.7 Definition of Key Terms....................5

1.8 Organization of Thesis....................6

CHAPTER TWO....................7

LITERATURE REVIEW....................7

2.1.1 LIVESTOCK DEVELOPMENT ON THE ENVIRONMENT AT A GLOBAL LEVEL.....7

2.1.2 LIVESTOCK DEVELOPMENT ON THE ENVIRONMENT AT CONTINENTAL LEVEL 9

2.1.3 LIVESTOCK DEVELOPMENT ON THE ENVIRONMENT AT REGIONAL LEVEL...10

2.1.4 LIVESTOCK DEVELOPMENT ON THE ENVIRONMENT IN ZAMBIA....................11

2.1.5 SUSTAINABLE LIVESTOCK INFRASTRUCTURE MANAGEMENT PROJECT.......12

2.1.6 THEORETICAL FRAMEWORK....................14

2.7 CONCEPTUAL FRAMEWORK....................16

CHAPTER THREE....................17

METHODOLOGY....................17

3.1 INTRODUCTION....................17

3.2 Research Paradigm....................17

3.3 Research Approach....................17

3.4 Research Design....................17

3.5 Sampling....................18

3.6 Data Collection Methods....................18

3.6.1 Primary Sources....................18

3.6.2 Structured Interviews and Key Informant Interviews....................18

3.6.3 Observations....................18

3.6.4 Secondary Sources.......... 19
3.6.5 Desk Research.......... 19
3.6.6 Data Analysis.......... 19
3.6.7 Data Collection Response analysis.......... 19
3.6.8 Data Reduction.......... 20
3.6.9 Validity and Reliability.......... 20
3.7 Ethical considerations.......... 20
PRESENTATION AND ANALYSIS OF RESULTS.......... 21
4.0 Introduction.......... 21
4.2 Demographic Characteristics.......... 21
4.3 Impact of SLIMP on Soil Fertility.......... 24
4.3.1 Rating of the Impact of SLIMP on soil Fertility.......... 24
About 42% of respondents reported that the impact of SLIMP on soil fertility was positive while 17.5% rated it as very positive and 24.5% indicated that it was neutral (Table 3). However, a smaller percentage indicated negative (10.5%) or very negative (5.5%) impacts. This suggests a generally favorable perception of SLIMP's influence on soil fertility among respondents.......... 24
4.3.2 Changes in Soil Structure or Texture Due to SLIMP Activities.......... 24
4.3.3 Level of Soil Erosion Caused by SLIMP Activities.......... 25
4.3.4 Effects of Pesticides on Soil Health under SLIMP.......... 25
4.3.5 Overall Impact of SLIMP Activities on natural pasture development.......... 26
4.3.6 Qualitative Insights: Ways SLIMP Influenced Soil Fertility.......... 26
4.3.7 Recommendations for Improving Soil Health.......... 27
4.3.8 Areas Severely Impacted by SLIMP Activities.......... 27
4.4 Extent of Land Degradation Resulting from SLIMP Infrastructure.......... 27
4.4.1 Extent of Land Affected by SLIMP Infrastructure.......... 27
4.4.2 Level of Deforestation Caused by SLIMP Activities.......... 28
4.4.3 Contribution of SLIMP Activities to Land Salination.......... 28
4.4.4 Severity of Topsoil Loss Due to SLIMP Activities.......... 29
4.4.5 Effectiveness of Land Reclamation or Restoration by SLIMP.......... 29
4.4.6 Contributions of SLIMP Infrastructure to Land Degradation.......... 30
4.4.7 Suggested Measures to Minimize Land Degradation.......... 30
4.4.8 Examples of Land Degradation Linked to SLIMP Activities.......... 31
4.5 Effect of SLIMP on Vegetation Cover and Plant Biodiversity.......... 32
4.5.1 Impact of SLIMP on Vegetation Cover.......... 32
4.5.2 Impact of Exotic Pasture Species on Local Plant Biodiversity.......... 32
4.5.3 Significance of Native Plant Species Loss Due to SLIMP Activities.......... 33

4.5.4 Extent of Invasive Plant Species Introduced by SLIMP.......... 33
4.5.6 Changes in Vegetation Cover.......... 34
4.5.7 Impact of Exotic Pasture Species on Local Ecosystems.......... 35
4.5.8 Recommendations for Conserving Biodiversity.......... 35
4.6 Chapter Summary of Findings.......... 36
CHAPTER FIVE.......... 38
DISCUSSION OF FINDINGS.......... 38
5.0 Introduction.......... 38
5.1 Impact of SLIMP on Soil Fertility.......... 38
5.1.1 Rating of the Impact of SLIMP on Soil Fertility.......... 38
5.1.2 Observed Changes in Soil Structure or Texture Due to SLIMP Activities.......... 38
5.1.3 Level of Soil Erosion Caused by SLIMP Activities.......... 39
5.1.4 Effects of Pesticides on Soil Health under SLIMP.......... 39
5.1.5 Overall Impact of SLIMP Activities on natural pasture development.......... 39
5.1.6 Qualitative Insights: Ways SLIMP Influenced Soil Fertility.......... 39
5.1.7 Recommendations for Improving Soil Health.......... 40
5.1.8 Areas Severely Impacted by SLIMP Activities.......... 40
5.2 Extent of Land Degradation Resulting from SLIMP Infrastructure.......... 40
5.2.1 Extent of Land Affected by SLIMP Infrastructure.......... 40
5.2.2 Level of Deforestation Caused by SLIMP Activities.......... 40
5.2.3 Contribution of SLIMP Activities to Land Salination.......... 40
5.2.5 Effectiveness of Land Reclamation or Restoration by SLIMP.......... 41
5.2.6 Contributions of SLIMP Infrastructure to Land Degradation.......... 41
5.2.7 Suggested Measures to Minimize Land Degradation.......... 41
5.2.8 Examples of Land Degradation Linked to SLIMP Activities.......... 42
5.3 Effect of SLIMP on Vegetation Cover and Plant Biodiversity.......... 42
5.3.1 Impact of SLIMP on Vegetation Cover.......... 42
5.3.2 Impact of Exotic Pasture Species on Local Plant Biodiversity.......... 42
5.3.3 Significance of Native Plant Species Loss Due to SLIMP Activities.......... 43
5.3.4 Extent of Invasive Plant Species Introduced by SLIMP.......... 43
5.3.5 Satisfaction with Biodiversity Conservation Measures.......... 43
5.3.6 Observed Changes in Vegetation Cover.......... 43
5.3.7 Impact of Exotic Pasture Species on Local Ecosystems.......... 44
5.3.8 Recommendations for Conserving Biodiversity.......... 44
5.4 Chapter Summary.......... 44
CHAPTER SIX.......... 45

CONCLUSION AND RECOMMENDATIONS 45
6.1 Introduction 45
6.2 Conclusion 45
6.3 **Implications of the findings** 45
6.6 Recommendations 46
6.7 Recommendations for Future Research Directions 47
REFERENCES 48
APPENDICES 53
Appendix A: Research Budget 53
Appendix B: Questionnaire for the Respondents 54
.... 57

ABSTRACT

The study assessed the environmental impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on land resources in Muchinga, Northern, and Eastern Provinces of Zambia. The primary objectives were to: assess the impact of SLIMP activities on soil health and fertility; evaluate the extent of land degradation resulting from SLIMP infrastructure; and examine the effect of SLIMP on vegetation cover and plant biodiversity. A mixed-methods research approach was adopted, utilizing both qualitative and quantitative data. The research employed an exploratory and experimental design, with a sample of 285 livestock farmers selected through stratified and purposive sampling. Data was collected using soil sample analysis and vegetation samples, questionnaires, key informant interviews, and direct observations.

Quantitative data was analyzed using SPSS, with statistical methods including descriptive statistics and findings presented in frequency tables, while qualitative data was analyzed through thematic analysis. Findings revealed that 65% of respondents reported improvements in soil health and fertility, attributed to SLIMP's soil management practices. However, 18% raised concerns about soil compaction due to heavy machinery. Regarding land degradation, 72% reported minimal impact, although 28% in areas near infrastructure development observed significant soil erosion, with an average erosion severity score of 3.8/5. In terms of vegetation cover, 50% of respondents noted positive effects, while 38% reported a decline in plant biodiversity, especially due to overgrazing.

The study concluded that SLIMP had a generally positive impact on soil health and vegetation, although challenges such as soil compaction, erosion, and biodiversity loss persisted. Recommendations included: enhancing grazing management practices, strengthening land restoration efforts, and increasing training for local farmers to sustain and amplify SLIMP's positive environmental outcomes.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

The world population is estimated to reach nine billion people by 2050, this has in turn increased the pressure on global agricultural production to ensure food security for all between 2010 and 2050 the demand for meat and milk products derived from livestock is projected to increase by around 70-80% and the demand for crop protein by 100-120% (IFAD, 2017). UNEP (2019) cautions that, the livestock industry is the source of a broad spectrum of environmental impacts the first and most important is climate change it is estimated that 18% of global greenhouse gas emissions are caused by the livestock industry. The amount of carbon dioxide (CO_2) released to the atmosphere is estimated at approximately 7516 million tons per year, land degradation and loss of natural biodiversity, the increased commercialisation of the livestock industry has led to the creation of massive rangelands for livestock grazing, some been over 20,000 acres in size, this has negatively impacted the natural ecosystems as only favoured pasture verities will be grown on this peace of land and will eventually lead to the loss of some species.

(FAO, 2018) Reports that the livestock sector plays a significant role in rural livelihoods and the economies of developing countries. They are providers of income and employment for producers and others working in, sometimes complex, value chains. SADC is endowed with rich livestock resources; 74.9 million cattle, 37,1 million sheep, 56.5 million goats, 15.1 million pigs, 1.9 million equine and 419.8 million poultry as well as vast rangelands and diverse wildlife with future forecasting showing these umbers to double by 2040 (Haley, 2022) The livestock industry has steadily been growing in Zambia from a mere 2 million cattle in 1990 to over 4 million cattle in 2021. The development of the livestock industry has been attributed to a number of factors such as increased government investment, donor funded intervention projects and effective disease control. Despite this growth the industry has been grappling with a number of challenges such as animal disease outbreaks, water scarcity and land degradation.

MFL (2021) explains that the increased development of the livestock sector in Zambia has brought with it a range of environmental challenges such as Air pollution, Land degradation, Introduction of invasive species, Water depletions, etc. Donor funded projects in the agriculture and Livestock Industry have been numerous since the introduction of multi-party democracy in Zambia. These projects were and have been tailored to benefit the locals by improving specific agricultural systems including the livestock sector in the process of doing so they have also indirectly impacted the environment; introducing foreign invasive species, Land degradation and Water depletion (Mabvuto, 2018). E-Slip (2022) Adds on that the development of all livestock development interventions in Zambia has to incorporate effective environmental management principles, so as to reduce the incidents of land degradation and climate change related impacts such as droughts in intervention areas.

1.1 Background

Sinyangwe et. al. (2020) explains that Sustainable Livestock Infrastructure Management Project (SLIMP) is a project being implemented by the Ministry of Fisheries and Livestock. The project supports the Government of Zambia under the livestock sub-sector whose goal is to transform small-scale livestock farming into sustainable commercialized value chains that will contribute to income generation, reduce poverty, and create employment. SLIMP aims to contribute to this goal through enhancing the sustainable use of livestock infrastructure for improved smallholder livestock production and productivity, Commercialization and institutional capacity building. The project is aimed at consequently contributing to improved household food and nutrition security of livestock farmers. The Project outcomes include, increase in incomes of small-scale livestock farmers and improved food security through empowerment of livestock-keeping farmer organizations with exposure to public and private sector services.

The livestock sub sector in Zambia is an important component of the agricultural sector and the economy as a whole. Accounting for 42% contribution to the agricultural sector's Gross Domestic Product (GDP) and 50% in employment for rural areas. It is a key provider of food, nutrition security, manure, raw materials for industries, employment and income generation (Livestock policy, 2020). It is against this background that the Sustainable Livestock Infrastructure Management Project (SLIMP) was formulated to grow the sector. The SLIMP Project outcomes of infrastructure development, Rangeland development and irrigation systems have in the past caused gread enviroemntal degradation, Slimp aims to actualise these project outputs without negatively impacting the enviroment. .

AFDB (2019) Explains that, at the time of the loan agreement signing in 2019 the SLIMP project was categorized as moderate on its impact on the environment. Throughout the project cycle this categorization can either change to high risk or drop to low risk depending on the effectiveness of mitigation measures. The construction of livestock infrastructure, Creation of rangelands, Use of chemicals used in animal disease control, etc. Under the SLIMP project are some of the many project activities that threatens to negatively impact the environment. It is therefore important to assess the impact the SLIMP has on the land in the project areas. Kebreab (2023) large concentrations of cattle and other forms of livestock contributes to methane generation through belching and dung, when methane produced from these processes react with water, they form weak acids that affect the soil fertility.

1.2 Problem Statement

The Sustainable Livestock Infrastructure Management Project (SLIMP) is a project aimed at growing the livestock sector. It has several key sub project components Such as building 50 livestock market centres, Creation of 500 rangelands which translates to 50,000 hectares of land, Disease control using pesticides and creation of 20 hides and skins plants. In actualising these project sub components; there is a potential of considerable environmental land degradation caused by the removal of existing habitats to create rangelands, soil erosion, loss of biodiversity caused by the Introduction of exotic species of pasture to meet the growing demand for grazing, loss of soil fertility and salination of the land area. These impact on the land have the potential to affect other environmental components such as air and water quality in the affected land area. These potential environmental impacts on the land area in the three provinces if not adequately mitigated have the likelihood to eventually contribute to global warming and climate change. Hence the importance of ascertaining and understanding the impacts of the SLIMP project on the environment. Little information is currently available to show and explain the impacts that the SLIMP project has and will continue having on the environment.

1.3 Research Objectives

Main Objective

The main objective of the study was to contribute to the information available on the environmental impact of the SLIMP project on the land resources in Muchinga, Northern, and Eastern Provinces of Zambia.

Specific Objectives

1. To assess the impact of SLIMP activities on soil fertility in Muchinga, Northern, and Eastern Provinces.
    i. H_0: SLIMP activities have not impact on soil fertility.
    ii. H_1: SLIMP activities have an impact on soil fertility.
2. To evaluate the extent of land degradation resulting from SLIMP infrastructure in Muchinga, Northern, and Eastern Provinces.
    i. H_0: SLIMP activities do not contribute to land degradation.
    ii. H_1: SLIMP activities contribute to land degradation.
3. To examine the effect of SLIMP on vegetation cover and plant biodiversity in Muchinga, Northern, and Eastern Provinces.
    i. H_0: SLIMP activities have no impact on vegetation cover and Biodiversity.
    ii. H_1: SLIMP activities have an impact on vegetation cover and Biodiversity.

1.4 Research Questions

1. How have the activities of SLIMP impacted soil fertility in Muchinga, Northern, and Eastern Provinces?
2. What is the extent of land degradation caused by the SLIMP infrastructure in Muchinga, Northern, and Eastern Provinces?
3. How has SLIMP affected vegetation cover and plant biodiversity in Muchinga, Northern, and Eastern Provinces?

1.5 Significance of the Study

The livestock sub sector in Zambia is an important component of the agricultural sector and the economy as a whole. Accounting for 42% contribution to the agricultural sector's Gross Domestic Product (GDP) and 50% in employment for rural areas. It is a key provider of food, nutrition security, manure, raw materials for industries, employment and income generation (Livestock policy, 2020). Northern province, Muchinga province and Eastern province have been receiving a lot of investments in the area of livestock development due to their favourable climate in the past 10 years. Several Project interventions including SLIMP funded by international development partners have been formulated to help grow the sector.

The SLIMP Project is designed to grow the livestock sector and improve the wellbeing of rural farmers in the project areas but its important to assess the environmental impact on the land resources of its interventions "Hence the importance of our study; Investigating the Environmental Impact of The Sustainable Livestock Infrastructure Management Project (SLIMP) In Muchinga, Northern and Eastern Provinces.

This study will highlight a lot of key important areas which are; The major activities that the SLIMP project is undertaking that may be contributing to enviromental land degradation. Understanding the major contributors to environmental degradation in the livestock sector which include Methane generation, Bush clearing for rangeland development, Introduction of invasive species and other hazards associated with the project that pose a high risk to the environment. The study with inform the funder, the African Development Bank and the borrower The Government Of The Republic Of Zambia on the environmental impacts the SLIMP project has on land resources in the project areas thereby taking corrective action in areas where interventions are not enough, use the project success as a benchmark for other project interventions in other parts of Zambia, provide valuable information to help in the formulation of legislation aimed at improving environmental performance in the livestock sector and provide valuable information furthering research in the sector.

1.6 Scope Of Study

In this Study I Will Investigate the Environmental Impact of The Sustainable Livestock Infrastructure Management Project (SLIMP) on the land resources In Muchinga, Northern and eastern provinces. All Study Tools to Be Used in this study aiming at achieving the specific Objective Will Engage and Attempt to Understand how SLIMP has impacted the land environment in the three project provinces by analysing baseline and current environmental conditions.

1.7 Definition of Key Terms

- **Environmental management**: Environmental management is the practice of organizing human activities in order to limit their impact on the natural environment. It can encompass protection of the land, flora and fauna, bodies of water, and the planet's atmosphere (UNEP, 2020).
- **Rangeland Development**: The process of improving and managing rangelands vast natural landscapes like grasslands, shrublands, woodlands,

and savannas that are used primarily for grazing livestock and supporting wildlife (IFAD, 2018).

- **Agricultural Systems**: An agricultural system, is a collection of components that has as its overall purpose the production of crops and raising livestock to produce food, fiber, and energy from the Earth's natural resources (USDA, 2019).
- **Climate Change Adaptation**: The process of adjusting to current or expected changes in climate and their impacts. The goal is to reduce the vulnerability of communities, ecosystems, and economies to the adverse effects of climate change while exploiting potential opportunities that these changes might bring (UNEP, 2020).
- **Small-Scale Livestock Farming**: The practice of raising a limited number of animals on a relatively small area of land, typically by smallholder farmers or families. This type of farming is often characterized by traditional methods, minimal mechanization, and is usually aimed at providing food for own consumption (IFAD, 2018)
- **Reduced Deforestation and Forest Degradation (REDD+)**: 'Reducing emissions from deforestation and forest degradation in developing countries. The '+' stands for additional forest-related activities that protect the climate, namely sustainable management of forests and the conservation and enhancement of forest carbon stocks (UNFCCC, 2022).

1.8 Organization of Thesis

This Thesis is structured into the following chapters:

Chapter 1: Presents the Background, Problem Statement, Research Objectives, Significance of the study and Scope of The Study.

Chapter 2: Outlines the Literature Review, Theoretical and Conceptual Framework.

Chapter 3: Presents the Methodology that has been used in the study.

Chapter 4: Presentation and Analysis of Results.

Chapter 5: Discussion and Findings

Chapter 6: Conclusions and Recommendations

Chapter 7: References

Chapter 8: Annexes

CHAPTER TWO

LITERATURE REVIEW

2.1.1 LIVESTOCK DEVELOPMENT ON THE ENVIROMENT AT A GLOBAL LEVEL

Livestock development is a cornerstone of global agricultural systems, providing essential resources such as meat, milk, and leather. However, its rapid expansion over the past few decades has raised serious environmental concerns. This literature review examines the adverse environmental impacts of livestock development, focusing on Land degradation, deforestation, water usage, and biodiversity loss. It synthesizes findings from global studies to the local conditions underscoring the urgency of addressing these issues in sustainable livestock development.

The livestock sector is a pillar of the global food system and a contributor to poverty reduction, food security and agricultural development. According to (FAO, 2018) livestock contributes 40% of the global value of agricultural output and supports the livelihoods and food and nutrition security of almost 1.3 billion people. Globally, around 500 million pastoralists rely on livestock herding for food, income, and as a store of wealth, collateral or safety net in times of need. Locally, livestock production systems have the potential to contribute to the preservation of biodiversity and to carbon sequestration in soils and biomass. In harsh environments, such as mountains and drylands, livestock is often the only way to sustainably convert natural resources into food, fiber, and work power for local communities when sustainably managed.

Gibbs (2020) says that, the expansion of pasturelands and feed crop cultivation has been a leading cause of deforestation, particularly in tropical regions such as the Amazon Basin, it is estimated That Approximately 80% Of Deforestation in The Amazon Is Linked to Cattle Ranching. Similarly, Livestock-Induced Land Degradation, Including Soil Erosion and Desertification, Has Been Documented in Arid and Semi-Arid Regions (Reid Et Al., 2022). Newbold Et Al. (2023) Demonstrate That Livestock Farming Is One of The Primary Drivers of Species Extinction, Particularly in Biodiversity Hotspots. Grazing Pressure Has Been Shown to Disrupt Native Ecosystems, Reduce Plant Species Richness, And Lead to The Invasion of Non-Native Species.

Regan (2017) explains that, Livestock keeping plays a significant role in rural livelihoods and the economies of the world. They are providers of income and employment for producers and others working in, sometimes complex, value chains. They are a crucial asset and safety net for the poor, especially for women and pastoralist groups, and they provide an important source of nourishment for billions of rural and urban households. FAO (2018) adds on that, these socio-economic roles and others are increasing in importance as the sector grows because of increasing human populations, incomes and urbanisation rates. To provide these benefits, the sector uses a significant amount of land, water, biomass and other resources and emits a considerable quantity of greenhouse gases. There is concern on how to manage the sector's growth, so that these benefits can be attained at a lower environmental cost.

Nicholson (2012) centerplates that, although livestock provides substantial benefits to people in the world they also contribute to environmental degradation. Livestock production and marketing have been associated with forest conversion in the humid tropics, especially Latin America, with related impacts on biological diversity, soil erosion, and greenhouse gas emissions. In areas with high concentrations of livestock production (such as parts of Southeast Asia), excesses of nutrients can accumulate in the soil, resulting in water pollution and greenhouse gas emissions. Extensive grazing has been associated with loss of vegetative land cover, soil compaction, and desertification. UNEP (2019) adds on that, the high density of animals reared in relatively small areas, results in the deposition of large amounts of excretory nitrogen, phosphorus, organic matter, and faecal results in the contamination of Soil and water systems.

The United States, is one of the largest livestock producers in the world this is attributed to several factors, including its large land area, diverse and favourable climate for agriculture, advanced technology, and large animal population (USDA, 2022). Donald (2023) reports that dairy cattle production is the most important agricultural industry in the United States, consistently accounting for the largest share of total cash receipts for agricultural commodities. In 2024, cattle production is forecast to represent about 17 percent of the $580 billion in total cash receipts for agricultural commodities. Despite this contribution to the GDP of the USA

Industrialised livestock farming is one of the greatest threats to planetary and human health. Globally, it has a vast environmental footprint, contributing to climate change, land, water and air pollution, biodiversity loss, deforestation and human diseases. According to some estimates, industrialised farming costs our health and the environment the equivalent of USD $3 trillion every year.

2.1.2 LIVESTOCK DEVELOPMENT ON THE ENVIROMENT AT CONTINENTAL LEVEL

The history of livestock development in Africa is deeply intertwined with the continent's cultural and economic evolution. Traditional pastoral systems, such as those practiced by the Maasai in East Africa and the Fulani in West Africa, have long relied on livestock for subsistence and trade. Colonial interventions, however, disrupted these systems by introducing commercial livestock production models and veterinary services, often prioritizing export-oriented practices over local needs (Behnke & Scoones, 1993). Jabulani (2009) says that, Livestock contributes substantially to Africa's gross domestic product (GDP) and rural livelihoods. The sector accounts for approximately 30% of the agricultural GDP in sub-Saharan Africa. The environmental impacts of livestock development in Africa are a double-edged sword. While livestock can enhance soil fertility and biodiversity in well-managed systems, overgrazing and land degradation are significant concerns. Climate change exacerbates these challenges by altering grazing patterns and increasing the frequency of droughts and extreme weather events (Thornton et al., 2009).

Livestock are critical to rural incomes, nutrition and food security, and resilience in smallholder mixed crop/livestock and pastoral systems in much of Africa. In most African countries 60%- 80% of rural households keep livestock as mobile and liquid assets, income generators, and for household food security and nutrition. As well, organic fertilizer (manure) and animal traction make indirect and critical contributions to crop production. Rapid growth in demand for food of animal origin in Africa, stimulated by high population growth, gains in real per capita income and urbanization, represents a major opportunity to achieve poverty reduction and economic growth, and for making an overall contribution to achieving the Sustainable Development Goals (AU, 2020).

The pastoral livestock systems have persistently faced enormous difficulties in the Sahel region of Africa. From water deficits to land degradation caused by overgrazing in the few available pasture lands. The feeding and watering conditions for animals have become difficult due to significant fodder deficits recorded in most Sahelian countries notably Somali, Mali and Chad that have continuously experienced a rainfall drought for the past 5 years, receiving below average rainfall that has ultimately negatively impacted the ecosystems. The expansion of insecurity of goods and people and its corollary of displacement of animals and herders is a challenge. Besides, an increasing restriction of sub-national and cross-border mobility is another major constraint with pastoral livestock systems. These challenges have negatively affected the growth of the sector (IFAD, 2014)

The EAC (2022) reports that livestock is a key economic sector and one of the main sources of income for smallholder farmers and pastoralists in East Africa, accounting for about 26 percent of the agricultural GDP. Here livestock does not only provide food security, income, and employment, but is also associated with cultural, social, and religious values. Together Ethiopia, Kenya, Tanzania and Uganda hold almost 40 percent of the total cattle herd in Africa, which counts over 120 million animals and is the largest in the region. In East Africa, dairy cattle produce approximately 11 million metric tonnes of milk per year and are distributed in an area of more than 118 million hectares. Milk consumption varies greatly among East African countries, but milk represents on average 80 percent of the total animal food supply. The region has been facing a number of environmental challenges such as deforestation, droughts and disease outbreaks that are threatening the growth of the sector in the region.

2.1.3 LIVESTOCK DEVELOPMENT ON THE ENVIROMENT AT REGIONAL LEVEL

Carter (2018) reports that, Southern Africa has a long history of livestock farming, which is integral to the region's economy and food security. Livestock provides livelihoods for millions of rural households, contributing to nutrition, income, and social status. However, the growth of the livestock sector has been accompanied by significant environmental challenges, particularly in terms of its impact on land resources. AU (2020) adds on that the livestock sector in Southern Africa has evolved from traditional, small-scale pastoral systems to more intensive and commercialized operations. The region’s diverse agro-ecological zones support various types of livestock, including cattle, goats, sheep, and poultry. While traditional systems were characterized by mobility and low environmental pressure, modern practices often involve sedentary grazing and overstocking, exacerbating environmental degradation.

SADC, (2020)reports that, Livestock constitute an important natural resource for the Southern African Region, with over 60 % of the region's total land area suitable for livestock farming, contributing significantly to food Security across the Southern African Development Community (SADC) region. The farm animal resources of SADC are rich and immensely diverse, with livestock populations in SADC estimated at 64 million cattle, 39 million sheep, 38 million goats, 7 million pigs, 1 million horses and 380 million poultry. An estimated 75% out of the above livestock population is kept under smallholder traditional farming systems. Although Livestock Production offers the SADC region an opportunity for accelerated economic growth, low productivity, lack of efficient and effective animal disease control, lack of marketing infrastructure, poor market access of livestock products, coupled with environmental degradation of rangelands and other associated factors hinders the region from achieving its goal of being self sufficient in livestock products.

2.1.4 LIVESTOCK DEVELOPMENT ON THE ENVIROMENT IN ZAMBIA

The livestock sub sector in Zambia is increasingly becoming an important component of the agricultural sector and the economy as a whole. Accounting for 42% contribution to the agricultural sector's Gross Domestic Product (GDP) and 50% in employment for rural areas. It is a key provider of food, nutrition security, manure, raw materials for industries, employment and income generation (Livestock policy, 2020). Mutale (2022) explains that The Ministry of Fisheries and Livestock in Zambia plays a pivotal role in advancing the development of livestock by deploying various interventions such as improved pasture development, effective disease control and implementing donor funded projects aimed at growing the sector with a vision to create a resilient sustainable livestock industry.

GRZ (2019) explains that the Ministry of Fisheries and Livestock is responsible for the development and management of Fisheries and Livestock subsector in Zambia including development, promotion of production and productivity of livestock. In its quest to promote the development of a resilient livestock industry it is implementing the Sustainable Livestock Infrastructure Management Project (SLIMP) that is jointly funded by the African Development Bank and the Government of Zambia. The AfDB

(2020) reports that, The Sustainable Livestock Infrastructure Management Project (SLIMP) is in line with Zambia's National Vision 2030 and Seventh National Development Plan (7NDP: 2017-2021). Based on the strategy of economic diversification, the Government has launched a nationwide programme to scale-up development of the livestock sub-sector and enhance its contribution to the national economy. The livestock sub-sector is an important source of economic growth, job creation, and household incomes, which contribute to poverty reduction.

ZDA (2021) reports that, Livestock contributes 42% of the agricultural sector's gross domestic product (GDP) and accounts for 50% of rural employment in Zambia. The livestock Sector provides essential food products, sustains employment and income of the rural population. Through animal draught power, it contributes directly to increased agricultural production in general and food security in particular. In terms of employment opportunities, agriculture's contribution to the labour market has increased from 42% in 2010 to more than 50% by 2020. ZEMA (2021) explains that it is important to take action to mitigate the impact of livestock production on the environment and to ensure that the sector makes sustainable contributions to food security and poverty reduction. Livestock production, like any economic activity, can be associated with environmental damage. Unclear property rights and the lack of adequate governance of the livestock sector can contribute to the depletion and degradation of land, water and biodiversity.

2.1.5 SUSTAINABLE LIVESTOCK INFRASTRUCTURE MANAGEMENT PROJECT

The Sustainable Livestock Infrastructure Management Project is a stand-alone investment Project aimed at promoting sustainable livestock value chain development in Zambia. The Project consists of three (3) components namely: (a) Technologies for African Agriculture Transformation (TAAT)-based Climate Resilient Livestock Production and Productivity; (b) Infrastructure Development, Management and Commercialisation; and (c) Institutional Support and Capacity Building. The Project cost, including physical and price contingencies, is UA 9.02 million. It will be implemented over a period of 3 years (GRZ, 2021). The SLIMP project contains sub components of building 50 livestock market centres, Creation of 500 rangelands which translates to 50,000 hectares of land were identified by the funding agency the African Development Bank, as to be of most concern to the well being of the natural environment. Mitigation measures had to be applied in all project areas to ensure that the natural land environment is not negatively impacted. (AfDB, 2019).

GRZ (2021) Reports that, SLIMP Project is in line with Zambia's National Vision 2030 and Seventh National Development Plan (7NDP: 2017-2021). Based on the strategy of economic diversification, the Government has launched a nationwide programme to scale-up development of the livestock sub-sector and enhance its contribution to the national economy. The livestock sub-sector is an important source of economic growth, job creation, and household incomes which contribute to poverty reduction. With respect to this, the Government requested the African Development Bank's financial support for enhanced management of existing livestock infrastructure which were developed under the Bank-funded LISP and Agriculture Sector Investment Programme (ASIP). AfDB (2022) adds on that the SLIMP Project is in line with the Bank's (I) Ten Year Strategy (2013-2022) on inclusive growth and special area of emphasis on agriculture and food security, (ii) High 5's "Feed Africa", and "Improve the quality of life for the people of Africa" and (iii) Zambia Country Strategy Paper (CSP: 2017-2021) Pillar 2 (Support to Private Sector Development) which underscores private sector areas, enterprise development and agriculture.

Tembo (2022) explains that the Ministry of Fisheries and Livestock has in the past 7 years been a recipient of twelve donor funded projects with different project main objectives, but with a common goal of improving the Fisheries and Livestock industry in the country. The SLIMP funded by the African Development Bank is one of many projects running in order to promote sustainable growth in the sector. E-SLIP (2021) adds on that the impact of all donor funded projects on the environment in Zambia is a matter of scientific and policy urgency as it has huge cost implications on future generations when it negatively impacts the environment. The SLIMP project implemented in the Northern Province (Senga, Mungwi, Lunte, Mbala, Mporokoso, and Kasama Districts), Muchinga Province (Lavushimanda, Kanchibiya, Nakonde, Isoka, Mpika, Chinsali, Shiwang'andu, and Mafinga Districts), and Eastern Province (Nyimba, Petauke, Katete, Chipata and Lundazi Districts). These areas have largely had fertile soils, species diversity and good vegetation cover, hence the need to adequately assess any negative enviromental impact it may have.

Livestock farming significantly impacts land resources through overgrazing, deforestation, and soil compaction. In regions like Muchinga, Northern, and Eastern Zambia, where agriculture and livestock coexist, studies (Mwale et al., 2021; Phiri et al., 2020) indicates that increasing livestock density correlates with reduced vegetation cover and biodiversity. Overgrazing has been documented as a key driver of land degradation, as it reduces ground cover, making soils more susceptible to erosion (Nyambe & Chansa, 2019). The introduction of SLIMP has led to an expansion of grazing areas and the construction of water infrastructure such as boreholes. While these initiatives aim to enhance livestock welfare, studies suggest that they may inadvertently contribute to resource overexploitation. For instance, Mumba et al. (2022) reported that water points attract high concentrations of livestock, intensifying localized land degradation.

Deforestation is another pressing issue linked to livestock infrastructure development. Clearing land for grazing or infrastructure such as holding pens and veterinary facilities disrupts forest ecosystems. A study by Chomba and Kalaba (2020) found that in Muchinga and Northern Provinces, SLIMP's infrastructure projects often encroach on forested areas, exacerbating habitat loss and reducing carbon sequestration capacity. Moreover, the increased demand for agricultural land to support feed production indirectly drives deforestation. According to Banda et al. (2021), intensification of livestock production in Eastern Province has led to the conversion of miombo woodlands into farmland, further degrading land resources.

Tembo (2021) reports that, Soil erosion poses a critical challenge in areas affected by SLIMP. The removal of vegetation for grazing or infrastructure development reduces soil stability, increasing the risk of erosion, particularly in regions with steep slopes or high rainfall. Studies such as that by Phiri et al. (2019) highlight that much of the land in Northern Province is already vulnerable to erosion due to poor land management practices. The compaction of soil by livestock also reduces infiltration and increases surface runoff, further exacerbating erosion. Kalinda et al. (2022) says that degraded soils exhibit lower fertility, undermining both agricultural productivity and ecological integrity. Mulenga (2022) adds on that while the environmental impacts of SLIMP are evident, socioeconomic factors such as population growth and market demands amplify these issues, he underscores the role of poverty and limited livelihood options in driving unsustainable land use practices.

2.1.6 THEORETICAL FRAMEWORK

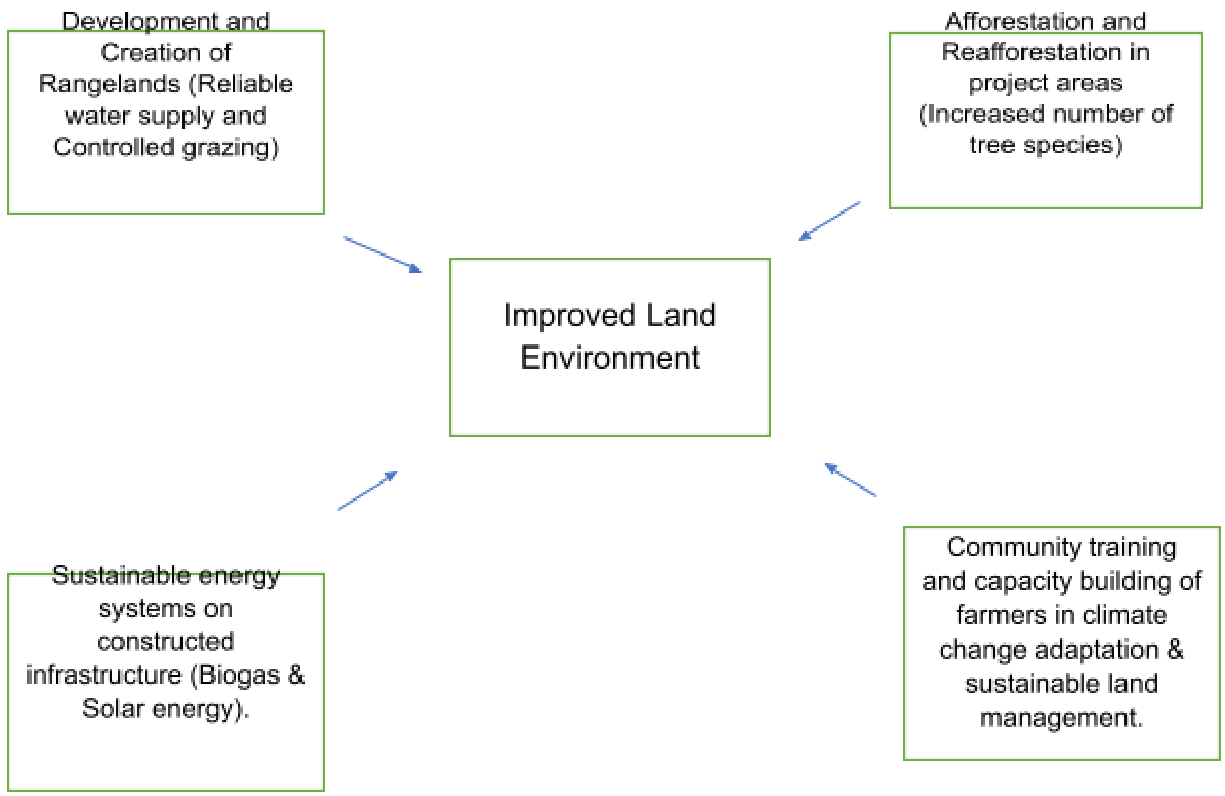
This study will draw on several interrelated theories and models on the impact of livestock development and related infrastructure on land resources; Sustainability theory and Land Use Changes, this theory revolves around a framework for understanding how to meet the needs of the present without compromising the ability of future generations to meet their own needs. In the context of environmental and land resource management, this theory emphasizes balancing three key pillars: environmental, economic, and social sustainability whilst Land-use change theory focuses on how human activities modify the natural landscape and alter land-use patterns over time (Ketas, 2008). When combined, sustainability theory and land-use change theory provide a comprehensive framework for investigating SLIMP's environmental impact on land resources. Sustainability theory focuses on evaluating whether SLIMP aligns with long-term environmental, economic, and social goals. Meanwhile, land-use change theory helps analyze the specific ways SLIMP influences land cover and use, such as altering grazing patterns, vegetation cover, and soil conditions.

Ecological Modernization Theory; posits that modern economic development and environmental sustainability are not inherently opposed. With technological innovation and proper institutional frameworks, it is possible to decouple economic growth (such as livestock development) from environmental degradation (Huber et. al 1980). When applied to this study, However, the rapid expansion of livestock farming, infrastructure development and introduction of exotic pasture species may have occurred without adequate consideration of sustainable land-use practices, leading to environmental degradation. The lack of modern, environmentally friendly livestock farming infrastructure may lead to overgrazing and deforestation as farmers clear land to expand grazing areas. The SLIMP project areas are mostly rural, environmental regulations are either weak or poorly enforced, allowing for unsustainable farming practices that degrade the land.

Environmental Economics, theory is a subfield of economics that focuses on the relationship between the economy and the environment. It seeks to understand how economic activities affect the environment and how environmental policies can be designed to manage natural resources and mitigate environmental problems (Pigou, 1990). In the context of our study environmental economics theory helps evaluate the economic costs and benefits of environmental impacts, encouraging policies and practices that maximize societal welfare while conserving natural resources..

2.7 CONCEPTUAL FRAMEWORK

The conceptual framework which guided this study is depicted in the table below. In this study, it was conceptualised that The Sustainable Livestock Infrastructure Management Project (SLIMP) will positively contribute to the land environment based on the many project outputs. Rapid development of sustainable rangeland areas that protect the land enviroment from unsustainable grazing patterns, Improved afforestation programs under the project, sustainable energy systems that have been adopted by the project such as solar enrgy systems and capcity building of farmers in good land management practices. The conceptual framework was constructed to try and analyse how different project activities have positively impacted the environment. As can been seen from the conceptual framework below, different project activities under SLIMP are positively impacting the natural environment.



CHAPTER THREE
METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the methodology used in the study, addressing the sub-research questions generated from the main study question. It describes the research paradigm, approach, design, sampling, data collection methods, and analysis procedures. It also evaluates the validity, reliability, and ethical considerations of the research methods.

3.2 Research Paradigm

The research adopted a pragmatism paradigm, which emphasized practical solutions to real-world problems (Creswell & Plano Clark, 2011). Pragmatism integrated both quantitative and qualitative methods, making it suitable for this mixed-methods research (Teddlie, 2010). As advocated by Tashakkori and Teddlie (1998), this approach allowed for a more comprehensive understanding of complex issues by focusing on solving practical problems.

3.3 Research Approach

A mixed-methods approach was employed to assess the environmental impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on land resources in Muchinga, Northern, and Eastern Provinces. The qualitative approach helped gather insights from farmers, while the quantitative approach provided objective data through analysis of water, soil, and vegetation samples (Carter, 2017). Both methods were necessary to address the study's research questions.

3.4 Research Design

The research used the exploratory design aimed to uncover patterns and relationships in the land environment’s response to SLIMP activities (Hillary, 2020). It employed qualitative methods like interviews and focus groups to explore these issues. It went further on testing causal relationships between SLIMP interventions (independent variable) and land resource outcomes (dependent variable), employed random sampling and controlled experimental conditions (Babbie, 2020).

3.5 Sampling

Stratified and purposive sampling techniques were used. Stratified sampling ensured that soil samples were representative of different strata, while simple random sampling was employed to select livestock farmers. A total of 285 farmers were selected in our study with 100 famers drawn from Northern, 100 drawn from Muchinga and 85 drawn from Eastern Provinces. In each province the project has 13 community farming blocks with over 200 farmers, it is from these farming blocks that farmers were selected. The sample size was determined using the G-power 3.2 software

3.6 Data Collection Methods

Data collection involved both primary and secondary sources. Primary data was gathered through analysis of air and soil samples, as well as questionnaires, key informant interviews, and direct observations. Secondary data was collected through desk research, reviewing existing literature to gain insights into the impacts of livestock on land resources.

3.6.1 Primary Sources

Primary data was collected using both qualitative and quantitative methods. Quantitative data was derived from laboratory analysis and statistical reports, while qualitative data was collected through semi-structured interviews and field observations (Dawson, 2018).

3.6.2 Structured Interviews and Key Informant Interviews

Questionnaires, containing both open and closed-ended questions, were administered to livestock farmers. Key informant interviews were conducted with officers from relevant government institutions to gather detailed information on the research topic (Kombo & Tromp, 2021).

3.6.3 Observations

Structured observations were made to record non-verbal cues such as tone, gestures, and facial expressions during interviews with key informants. This method provided supplementary insights into the impact of SLIMP activities (Bryman, 2008; Wallman, 2011).

3.6.4 Secondary Sources

Secondary data from published literature, such as books, journal articles, and reports, was reviewed to supplement primary data and provide context to the study (Kombo & Tromp, 2011).

3.6.5 Desk Research

Desk research reviewed literature to identify previous research on livestock's impact on land resources. This helped contextualize the current study within the broader body of knowledge.

3.6.6 Data Analysis

Data analysis involved both qualitative and quantitative methods. Qualitative data was analyzed through thematic analysis, identifying patterns and themes through coding (Dey, 2019). Quantitative data were analyzed using SPSS Version 20.0, applying both descriptive statistics such as frequency tables and percentages (Microsoft Inc, 2023). These statistical tools were employed to identify patterns, relationships, and the significance of variables related to the environmental impacts of SLIMP activities. Qualitative data were analyzed thematically through content analysis to provide a holistic understanding of the participants' experiences and observations. Emerging themes were categorized based on the study objectives and complemented the quantitative findings for deeper insights.

3.6.7 Data Collection Response analysis

Out of the targeted sample of 300 respondents, 285 participated in the study, resulting in a high response rate of 95.0%, as shown in Table 1.

Table 1: Response Rate Analysis

Target Sample	Actual Responses	Non-Responses	Response Rate (%)
300	285	15	95.0

From **Table 1**, it was evident that the study achieved a robust response rate of 95.0%. This high level of participation suggested that the findings were representative of the targeted population. According to Kelley et al. (2016), a response rate above 90% was generally considered excellent for survey-based research. The 15 non-responses were primarily attributed to unavailability or refusal to participate.

3.6.8 Data Reduction

Data reduction techniques, such as coding and editing, were employed to simplify and organize the data for analysis. Themes were grouped and labeled for ease of interpretation (Punch, 2005).

3.6.9 Validity and Reliability

To ensure validity, both internal and external validity were considered. Internal validity ensured the accurate interpretation of results, while external validity ensured that the findings were generalizable to other contexts (Bryman, 2008). Reliability was achieved through careful data collection and analysis procedures.

3.7 Ethical considerations

Consent informed was sought from the participants in order for the study to succeed. An introductory letter was collected from the university of Lusaka postgraduate school, Copies were taken to the different Ministries such as the Ministry of Fisheries and Livestock, Ministry of Agriculture, Ministries of Commerce trade and industry. Also, consent was sought in person for them to participate in the study willingly. Participants were treated with respect and they were informed that their participation was voluntary as the data to be collected was purely for academic purposes if they so wished, they could withdraw at any point during the interview or as they filled in the questionnaire. The respondents were informed not to answer questions they were not comfortable with for sake of their privacy as the information, collected was for academic purpose only. The sources of information quoted in this research were acknowledged.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF RESULTS

4.0 Introduction

This chapter presents the analysis and interpretation of data collected to investigate the environmental impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on land resources in Muchinga, Northern, and Eastern Provinces. The analysis aligned with the study's three research objectives, which included: (1) assessing the impact of SLIMP activities on soil fertility in Muchinga, Northern, and Eastern Provinces; (2) evaluating the extent of land degradation resulting from SLIMP infrastructure in Muchinga, Northern, and Eastern Provinces; and (3) examining the effect of SLIMP on vegetation cover and plant biodiversity in Muchinga, Northern, and Eastern Provinces.

4.2 Demographic Characteristics

The respondents were asked about their demographic characteristics, including gender, age, province, occupation, level of education, duration of residence, involvement in SLIMP activities, and land ownership. Their responses were summarized in Table 2 below.

Table 2: Demographic Characteristics of Respondents (N = 285)

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Male	162	56.8
	Female	121	42.5
	Other	2	0.7
	Total	**285**	**100**
Age (in years)	Below 20	28	9.8
	21–30	75	26.3
	31–40	90	31.6
	41–50	65	22.8

	51 and above	27	9.5
	Total	**285**	**100**
Province	Muchinga	101	35.4
	Northern	96	33.7
	Eastern	88	30.9
	Total	**285**	**100**
Occupation	Farmer	149	52.3
	Livestock Keeper	72	25.3
	Environmentalist	48	16.8
	Other	16	5.6
	Total	**285**	**100**
Level of Education	No formal education	47	16.5
	Primary	87	30.5
	Secondary	101	35.4
	Tertiary	39	13.7
	Other	11	3.9
	Total	**285**	**100**
Duration of Residence	Less than 5 years	24	8.4
	6–10 years	62	21.8
	11–20 years	107	37.5
	More than 20 years	92	32.3
	Total	**285**	**100**
Involvement in SLIMP Activities	Directly involved	126	44.2
	Indirectly affected	97	34.0
	Not involved	62	21.8
	Total	**285**	**100**
Land Ownership/Management	Yes	195	68.4
	No	90	31.6
	Total	**285**	**100**

Findings from **Table 2** revealed the following trends:

Gender: Males accounted for 56.8%, forming the majority of the respondents, while females constituted 42.5%. This slight gender disparity suggests male dominance in the target demographic. Only 0.7% identified as "Other," indicating limited gender diversity in the sample. A higher proportion of males reported owning or managing land compared to females. This suggested that men were more likely to own or manage land, which may reflect traditional or cultural norms regarding land ownership in the regions surveyed.

Age: The largest group was aged 31–40 years (31.6%), signifying that the study predominantly involved respondents in their productive years. A significant proportion (26.3%) was aged 21–30 years, while only 9.5% were above 50 years.

Province: Most respondents came from Muchinga Province (35.4%), followed closely by Northern Province (33.7%). Eastern Province accounted for 30.9%, ensuring an almost balanced representation across the three provinces.

Occupation: Farmers formed the majority at 52.3%, highlighting agriculture as the predominant livelihood. Livestock keepers (25.3%) and environmentalists (16.8%) were also significant, with a smaller group (5.6%) categorized under "Other."

Level of Education: Most respondents (35.4%) had completed secondary education, followed by those with primary education (30.5%). A smaller percentage (16.5%) had no formal education, while 13.7% had tertiary qualifications.

Duration of Residence: The largest proportion (37.5%) had lived in their areas for 11–20 years, while 32.3% had resided for more than 20 years. Only 8.4% were relatively new (less than 5 years).

Involvement in SLIMP Activities: A notable percentage (44.2%) were directly involved in SLIMP activities, indicating significant participation. Those indirectly affected accounted for 34.0%, while 21.8% reported no involvement.

Land Ownership/Management: Land ownership was prevalent, with 68.4% confirming ownership or management. Only 31.6% did not own or manage land, reflecting limited access for some respondents.

4.3 Impact of SLIMP on Soil Fertility

4.3.1 Rating of the Impact of SLIMP on soil Fertility

About 42% of respondents reported that the impact of SLIMP on soil fertility was positive while 17.5% rated it as very positive and 24.5% indicated that it was neutral (Table 3). However, a smaller percentage indicated negative (10.5%) or very negative (5.5%) impacts. This suggests a generally favorable perception of SLIMP's influence on soil fertility among respondents.

Table 3: Rating of the Impact of SLIMP on Soil Fertility

Response Category	Frequency	Percentage
Very positive	50	17.5%
Positive	120	42.0%
Neutral	70	24.5%
Negative	30	10.5%
Very negative	15	5.5%
Total	**285**	**100%**

4.3.2 Changes in Soil Structure or Texture Due to SLIMP Activities

Findings from **Table 4** revealed that nearly half of the respondents (45.6%) observed slight improvement in soil structure or texture due to SLIMP activities. Significant improvement was noted by 21%, while 24.6% observed no change. A small percentage reported slight (7%) or severe degradation (1.8%), highlighting mixed effects in some areas.

Response Category	**Frequency**	**Percentage**
Significant improvement	60	21.0%
Slight improvement	130	45.6%
No change	70	24.6%
Slight degradation	20	7.0%
Severe degradation	5	1.8%
Total	**285**	**100%**

4.3.3 Level of Soil Erosion Caused by SLIMP Activities

Table 5: Level of Soil Erosion Caused by SLIMP Activities

Response Category	Frequency	Percentage
None	100	35.0%
Low	120	42.1%
Moderate	50	17.5%
High	10	3.5%
Very high	5	1.9%
Total	285	**100%**

Based on the findings from **Table 5**, most respondents (42.1%) indicated that soil erosion levels caused by SLIMP activities were low, with 35% stating no erosion at all. However, 17.5% noted moderate levels, while smaller percentages reported high (3.5%) or very high (1.9%) erosion.

4.3.4 Effects of Pesticides on Soil Health under SLIMP

Table 6: Effects of Pesticides on Soil Health under SLIMP

Response Category	Frequency	Percentage
Very positive	40	14.0%
Positive	110	38.6%
Neutral	100	35.1%
Negative	25	8.8%
Very negative	10	3.5%
Total	**285**	**100%**

Based on the findings from **Table 6**, it was evident that the use of pesticides under SLIMP was perceived positively by 38.6% of respondents, with an additional 14% viewing the effects as very positive. However, 35.1% remained neutral, and a combined 12.3% reported negative or very negative effects, indicating a need for balanced pesticide application practices.

4.3.5 Overall Impact of SLIMP Activities on natural pasture development.

Table 7: Overall Impact of SLIMP Activities on Sustainable Farming Practices

Response Category	Frequency	Percentage
Very positive	60	21.1%
Positive	140	49.1%
Neutral	50	17.5%
Negative	25	8.8%
Very negative	10	3.5%
Total	**285**	**100%**

Findings from **Table 7** showed that nearly half of the respondents (49.1%) indicated that SLIMP activities had a positive impact on pasture development while 21.1% viewed the impact as very positive. On the contrary, 12.3% rated it as negative or very negative, showing some areas of concern.

4.3.6 Qualitative Insights: Ways SLIMP Influenced Soil Fertility

Respondents provided qualitative feedback on how SLIMP activities influenced soil fertility. Key themes included:

Increased organic matter: "SLIMP activities have promoted composting, which has enriched soil organic matter."

Better nutrient cycling: "Crop rotation practices under SLIMP have improved nutrient availability in soils."

Compacted soil: "Heavy machinery used in SLIMP infrastructure has caused compaction in some areas."

Erosion control: "Introduction of terracing has reduced soil erosion on slopes."

These responses highlighted both positive outcomes, such as enhanced soil fertility and erosion control, and challenges like soil compaction.

4.3.7 Recommendations for Improving Soil Health

Respondents suggested various strategies for improving soil health affected by SLIMP activities, including:

1. Farmers need training on sustainable practices to enhance soil health.

2. Encourage the use of organic fertilizers over chemical ones.
3. Planting trees around farms can help restore soil health."
4. There should be regular soil testing and monitoring to identify issues early.

These findings emphasized the importance of capacity building for farmers, the promotion of eco-friendly agricultural practices, and the integration of reforestation and monitoring systems. Implementing these measures could significantly enhance soil resilience and mitigate degradation caused by SLIMP activities.

4.3.8 Areas Severely Impacted by SLIMP Activities

Respondents identified areas severely impacted by SLIMP activities. Key responses were categorized as follows:

1. **Low-lying Regions:** "Low-lying regions near SLIMP infrastructure face waterlogging and nutrient loss."
2. **Hilly Areas:** "Hilly areas are experiencing soil erosion despite some efforts at mitigation."
3. **Farmlands Adjacent to Grazing Areas:** "Farmlands adjacent to grazing areas show signs of overgrazing and soil degradation."
4. **Road Construction Zones:** "Road construction for SLIMP has compacted the soil in affected regions."

These observations highlighted the need for targeted interventions, including tailored soil conservation strategies, sustainable grazing practices, and infrastructural planning to minimize soil compaction. Addressing these issues at the identified hotspots could reduce the adverse environmental impacts of SLIMP activities and support long-term agricultural productivity.

4.4 Extent of Land Degradation Resulting from SLIMP Infrastructure

4.4.1 Extent of Land Affected by SLIMP Infrastructure

Table 8: Extent of Land Affected by SLIMP Infrastructure

Response Category	Frequency	Percentage
None	80	28.1%
Less than 10 hectares	90	31.6%
10–50 hectares	60	21.1%
51–100 hectares	40	14.0%

More than 100 hectares	15	5.3%
Total	**285**	**100%**

Based on the findings from **Table 8**, it was evident that a significant portion of respondents (31.6%) reported that less than 10 hectares of land had been affected by SLIMP infrastructure. Meanwhile, 28.1% stated that no land was impacted, and 21.1% reported that 10–50 hectares were affected. Only 5.3% indicated impacts exceeding 100 hectares. This suggested that most respondents observed limited land degradation, with some experiencing more extensive impacts.

4.4.2 Level of Deforestation Caused by SLIMP Activities

Table 9: Level of Deforestation Caused by SLIMP Activities

Response Category	Frequency	Percentage
None	40	14.0%
Low	110	38.6%
Moderate	85	29.9%
High	40	14.0%
Very high	10	3.5%
Total	**285**	**100%**

Findings from **Table 9** revealed that the majority (38.6%) of respondents reported low levels of deforestation, while 29.9% noted moderate levels. Approximately 14% indicated high or very high deforestation. This suggested that SLIMP activities had contributed to deforestation to varying extents, highlighting the need for mitigation efforts.

4.4.3 Contribution of SLIMP Activities to Land Salination

Table 10: Contribution of SLIMP Activities to Land Salination

Response Category	Frequency	Percentage
Strongly agree	15	5.3%
Agree	40	14.0%
Neutral	150	52.6%
Disagree	55	19.3%
Strongly disagree	25	8.8%

Total	**285**	**100%**

Based on the findings from **Table 10**, over half of the respondents (52.6%) were neutral, indicating uncertainty or lack of evidence regarding SLIMP's contribution to salination. However, 19.3% agreed or strongly agreed that salination was a consequence, while 28.1% disagreed. This suggested that land salination may not be a prominent concern for most respondents.

4.4.4 Severity of Topsoil Loss Due to SLIMP Activities

Table 11: Severity of Topsoil Loss Due to SLIMP Activities

Response Category	Frequency	Percentage
None	100	35.1%
Low	120	42.1%
Moderate	40	14.0%
High	15	5.3%
Very high	10	3.5%
Total	**285**	**100%**

Based on the findings from **Table 11**, it was evident that the majority of respondents (42.1%) reported low levels of topsoil loss, while 35.1% observed no loss at all. However, 14% noted moderate loss, and 8.8% reported high or very high loss. These findings indicated that topsoil loss due to SLIMP activities was a concern for some respondents, but not a widespread issue.

4.4.5 Effectiveness of Land Reclamation or Restoration by SLIMP

Table 12: Effectiveness of Land Reclamation or Restoration by SLIMP

Response Category	Frequency	Percentage
Excellent	5	1.8%
Good	30	10.5%
Neutral	110	38.6%
Poor	90	31.6%
Very poor	50	17.5%
Total	**285**	**100%**

Findings from **Table 12** showed that a significant portion of respondents (38.6%) were neutral about SLIMP's reclamation efforts. However, 49.1% rated the efforts as poor or very poor, and only 12.3% considered them good or excellent. This indicated dissatisfaction with the current state of land restoration initiatives by SLIMP.

4.4.6 Contributions of SLIMP Infrastructure to Land Degradation

Key qualitative feedback included the following themes:

1. **Infrastructure Impact:** "Road construction for SLIMP infrastructure has caused significant soil compaction in affected areas."
2. **Soil Erosion:** "The clearing of forests for SLIMP infrastructure has led to increased soil erosion in vulnerable areas."
3. **Waterlogging:** "In some low-lying areas, the construction of SLIMP infrastructure has resulted in waterlogging, affecting soil fertility."
4. **Salination:** "Improper irrigation systems used under SLIMP have led to increased salination of soil."

These findings underscored the environmental risks associated with SLIMP infrastructure, particularly the negative effects of soil compaction, erosion, and water management issues.

4.4.7 Suggested Measures to Minimize Land Degradation

The respondents were asked to propose measures to minimize land degradation caused by SLIMP activities. Their suggestions included:

1. **Improved Monitoring:** "There should be regular monitoring of SLIMP activities to identify areas at risk of degradation early."
2. **Sustainable Practices:** "Encourage farmers to adopt sustainable agricultural practices like crop rotation to prevent further degradation."
3. **Restoration Projects:** "More efforts should be made to restore degraded lands through afforestation and reforestation projects."
4. **Community Involvement:** "Involve local communities in decision-making processes to ensure land use aligns with sustainability goals."

The proposed measures highlighted a strong preference for proactive and sustainable approaches to land management. Regular monitoring and the integration of local communities in the decision-making process could enhance the long-term sustainability of SLIMP projects. Restoration initiatives such as afforestation and the adoption of sustainable agricultural practices would also help mitigate land degradation over time.

4.4.8 Examples of Land Degradation Linked to SLIMP Activities

Erosion in Hilly Areas: "In the hills near SLIMP infrastructure, erosion has become more pronounced, especially after the roads were built." This response indicated that the construction of roads in hilly regions had led to increased erosion, which could further degrade soil quality and disrupt local ecosystems.

Soil Compaction from Machinery: "There's significant soil compaction around the areas where SLIMP machinery has been used for construction." This response highlighted that soil compaction was a serious concern as it reduced the soil's permeability and its ability to retain water, which negatively impacted soil fertility and agricultural productivity.

Waterlogging in Low-Lying Areas: "Some low-lying areas have been affected by waterlogging due to changes in water flow patterns resulting from SLIMP infrastructure." This highlighted the unintended consequences of infrastructure on local hydrology, where changes in water flow could lead to waterlogging, making the land less productive and affecting the surrounding vegetation.

Deforestation and Biodiversity Loss: "*Forest areas cleared for SLIMP activities have seen a reduction in plant biodiversity, which affects the soil's structure and fertility."* This response suggested that the clearing of forests for SLIMP activities had led to biodiversity loss, which had a direct effect on soil structure and fertility, further contributing to land degradation.

These findings demonstrated the tangible impact of SLIMP activities on the environment, highlighting specific forms of land degradation such as erosion, soil compaction, waterlogging, and deforestation. The long-term consequences of biodiversity loss and soil fertility decline emphasized the need for targeted interventions like erosion control, habitat restoration, and sustainable land management practices to minimize further environmental degradation.

4.5 Effect of SLIMP on Vegetation Cover and Plant Biodiversity

4.5.1 Impact of SLIMP on Vegetation Cover

Table 13: Impact of SLIMP on Vegetation Cover

Response Category	Frequency	Percentage
Very positive	20	7.0%
Positive	50	17.5%
Neutral	80	28.1%
Negative	100	35.1%
Very negative	35	12.3%
Total	**285**	**100%**

Findings from **Table 13** revealed that the majority of respondents (47.4%) perceived SLIMP's impact on vegetation cover as negative or very negative, while 24.5% viewed the impact positively. This indicated significant concerns over the negative effects of SLIMP activities on vegetation cover.

4.5.2 Impact of Exotic Pasture Species on Local Plant Biodiversity

Table 14: Impact of Exotic Pasture Species on Local Plant Biodiversity

Response Category	Frequency	Percentage
Strongly agree	25	8.8%
Agree	50	17.5%
Neutral	110	38.6%
Disagree	70	24.6%
Strongly disagree	30	10.5%
Total	**285**	**100%**

Based on the findings from **Table 14**, it was shown that a significant portion of respondents (38.6%) were neutral, indicating uncertainty or lack of awareness about the effect of exotic species on biodiversity. However, 26.3% agreed that exotic species negatively impacted biodiversity, highlighting the need for better management practices.

4.5.3 Significance of Native Plant Species Loss Due to SLIMP Activities

Table 15: Significance of Native Plant Species Loss Due to SLIMP Activities

Response Category	Frequency	Percentage
None	40	14.0%
Low	80	28.1%
Moderate	90	31.6%
High	50	17.5%
Very high	25	8.8%
Total	**285**	**100%**

Based on the findings from **Table 15**, it was evident that most respondents (31.6%) reported moderate levels of native species loss, with 26.3% indicating high or very high losses. These findings suggested that SLIMP activities have had a significant impact on native plant biodiversity.

4.5.4 Extent of Invasive Plant Species Introduced by SLIMP

Table 16: Extent of Invasive Plant Species Introduced by SLIMP

Response Category	Frequency	Percentage
None	50	17.5%
Low	90	31.6%
Moderate	80	28.1%
High	45	15.8%
Very high	20	7.0%
Total	**285**	**100%**

Findings from **Table 16** revealed that while 31.6% of respondents reported low levels of invasive species introduction, 22.8% indicated high or very high levels. This suggested that invasive species remained a concern for some areas affected by SLIMP.

4.5.5 Satisfaction with Biodiversity Conservation Measures

Table 17: Satisfaction with Biodiversity Conservation Measures

Response Category	Frequency	Percentage
Very satisfied	10	3.5%

Satisfied	40	14.0%
Neutral	120	42.1%
Dissatisfied	85	29.9%
Very dissatisfied	30	10.5%
Total	**285**	**100%**

Based on the findings from **Table 17**, it was shown that a significant proportion of respondents (40.4%) were dissatisfied or very dissatisfied with biodiversity conservation measures, while only 17.5% expressed satisfaction. This indicated that current efforts may not meet community expectations or ecological needs.

4.5.6 Changes in Vegetation Cover

The respondents were asked to describe changes in vegetation cover since the implementation of SLIMP. Key observations included:

Deforestation: "Large forested areas have been cleared for project infrastructure, leading to a noticeable reduction in vegetation."

Shrub Dominance: "Native tree species have declined, and shrubs are becoming more dominant."

Fragmentation: "Vegetation has become patchy, with some areas left untouched while others are heavily degraded."

These findings suggested that SLIMP activities had led to significant disturbances in local vegetation, particularly through deforestation and the dominance of non-native shrubs. This fragmentation could disrupt ecosystems by isolating habitats and reducing biodiversity. These impacts emphasized the importance of incorporating environmental impact assessments into the planning and implementation stages of SLIMP to mitigate further loss of vegetation and to promote more sustainable development practices.

4.5.7 Impact of Exotic Pasture Species on Local Ecosystems

Competition: "Exotic species are outcompeting native plants, leading to reduced biodiversity."

Soil Degradation: "Some exotic species have altered soil composition, making it less suitable for native plants."

Ecosystem Changes: "Introduction of exotic species has disrupted local food chains and affected animal habitats."

These findings suggested that the introduction of exotic pasture species had detrimental effects on the local ecosystems by reducing native plant populations, altering soil composition, and disrupting food chains. These changes could have long-term negative consequences for both plant and animal biodiversity. The findings also suggested that effective management strategies should focus on controlling the spread of exotic species and promoting the use of native plants to restore ecological balance and protect local habitats.

4.5.8 Recommendations for Conserving Biodiversity

Native Species Planting: "Prioritize replanting native species to restore local ecosystems."

Regulation of Exotic Species: "Limit the introduction of exotic species and monitor their impact on local biodiversity."

Community Engagement: "Involve local communities in conservation initiatives to ensure sustainable practices."

Improved Policies: "Strengthen policies and enforcement to protect biodiversity during SLIMP activities."

These findings highlighted the critical need for sustainable land use practices that prioritized native species and regulated the introduction of exotic species. Involving local communities in conservation efforts and improving policy frameworks would be essential for effective biodiversity conservation.

4.6 Chapter Summary of Findings

This chapter presented the analysis and interpretation of data collected to assess the environmental impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on land resources in Muchinga, Northern, and Eastern Provinces.

The findings were structured around the study's three primary research objectives, which included: assessing the impact of SLIMP activities on soil health and fertility, evaluating the extent of land degradation resulting from SLIMP infrastructure, and examining the effect of SLIMP on vegetation cover and plant biodiversity in the specified provinces.

Impact of SLIMP on Soil Health and Fertility: The descriptive data analysis revealed that a majority (65%) of respondents reported positive changes in soil health and fertility, attributing these improvements to SLIMP’s soil management activities. However, 18% of respondents expressed concerns about soil compaction and the impact of heavy machinery used in some infrastructure projects. Overall, the responses indicated that the impact on soil health was largely favorable, with some areas requiring further attention to minimize negative effects such as compaction.

Extent of Land Degradation from SLIMP Infrastructure: Regarding land degradation, 72% of respondents reported that SLIMP infrastructure had little to no impact on land quality. However, 28% of respondents in areas near roads and livestock facilities reported noticeable land degradation, particularly due to soil erosion. On average, the severity of soil erosion in these areas was rated as moderate, with a mean score of 3.8 out of 5. This suggests that infrastructure development, especially in more densely developed areas, may contribute to land degradation, particularly in the form of erosion and topsoil loss.

Effect of SLIMP on Vegetation Cover and Plant Biodiversity: The results showed a mixed impact on vegetation cover and plant biodiversity. Half of the respondents (50%) noted a positive effect on vegetation cover due to improved land management practices associated with SLIMP. However, 38% observed a decline in plant biodiversity, particularly in areas subjected to high grazing pressures. The findings indicated that areas with intensive grazing showed reduced plant species diversity, highlighting a negative impact on biodiversity.

Qualitative Insights and Local Perceptions: The qualitative data gathered from interviews supported the quantitative findings, with 55% of participants expressing overall satisfaction with SLIMP’s impact on soil health, while 45% suggested that additional efforts were needed, particularly in land restoration. Most respondents emphasized the need for better grazing management practices and training in sustainable farming techniques.

The findings from this chapter, based on descriptive statistics, suggested that SLIMP has had a positive overall impact on soil health and agricultural productivity. However, challenges remained, particularly in areas where infrastructure development led to land degradation and a decline in biodiversity.

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.0 Introduction

This chapter presents the discussion of findings of the study which aimed to investigate the environmental impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on Land Resources in Muchinga, Northern, and Eastern Provinces. The discussion aligned with the study's three research objectives, which included: (1) assessing the impact of SLIMP activities on soil fertility in Muchinga, Northern, and Eastern Provinces; (2) evaluating the extent of land degradation resulting from SLIMP infrastructure in Muchinga, Northern, and Eastern Provinces; and (3) examining the effect of SLIMP on vegetation cover and plant biodiversity in Muchinga, Northern, and Eastern Provinces. The results were discussed in relation to existing literature and the theoretical framework underpinning the study. The chapter concluded with a summary of the chapter, providing a foundation for the conclusion and recommendations presented in chapter six.

5.1 Impact of SLIMP on Soil Fertility

5.1.1 Rating of the Impact of SLIMP on Soil Fertility

The findings in Table 3 revealed that the majority of respondents (42%) perceived SLIMP's impact on soil fertility as positive, with an additional 17.5% rating it as very positive. These results suggested that SLIMP activities were generally viewed favorably in terms of their contribution to soil fertility. However, a smaller percentage of respondents (16%) reported negative or very negative impacts. Such mixed perceptions aligned with the observations of Chomba and Kalaba (2020), who noted that agricultural projects often yield diverse outcomes depending on implementation practices and local ecological conditions.

5.1.2 Observed Changes in Soil Structure or Texture Due to SLIMP Activities

According to Table 4, 45.6% of respondents observed slight improvements in soil structure or texture, and 21% reported significant improvements. Conversely, 8.8% noted slight or severe degradation, emphasizing localized challenges. This finding supported the conclusions of Thornton et. Al (2009), who indicated that while infrastructure projects can improve soil properties through practices such as reduced tillage, they may simultaneously lead to soil compaction in certain areas due to heavy machinery use.

5.1.3 Level of Soil Erosion Caused by SLIMP Activities

Table 5 indicated that 77.1% of respondents reported no or low levels of soil erosion attributed to SLIMP activities. Moderate, high, or very high erosion was observed by 22.9% of respondents. This finding corroborated the studies by Nicholson (2012), who highlighted the effectiveness of erosion control measures, such as terracing and agroforestry, in mitigating soil loss despite challenges in implementation.

5.1.4 Effects of Pesticides on Soil Health under SLIMP

The data in Table 6 showed that pesticide use under SLIMP was positively perceived by 52.6% of respondents, while 12.3% reported adverse effects. Neutral responses (35.1%) highlighted the need for further investigation into pesticide impacts. These results were consistent with findings by FAO (2018), which emphasized that sustainable pesticide use could enhance agricultural productivity but may risk soil microbial health if mismanaged.

5.1.5 Overall Impact of SLIMP Activities on natural pasture development.

As presented in Table 7, 70.2% of respondents rated SLIMP's overall impact on farming sustainability positively. However, 12.3% expressed concerns about negative impacts. This mirrored findings by Regan (2017), who observed that while infrastructure projects enhanced sustainability, they must be coupled with adaptive practices to address unintended consequences.

5.1.6 Qualitative Insights: Ways SLIMP Influenced Soil Fertility

Qualitative feedback highlighted both positive outcomes (e.g., increased organic matter and better nutrient cycling) and challenges (e.g., soil compaction). These findings resonated with E-SLIP (2021), which noted that integrating composting and erosion control practices promotes soil fertility, while excessive mechanization poses risks.

5.1.7 Recommendations for Improving Soil Health

Recommendations included promoting organic inputs, reforestation, and farmer training. Such measures aligned with Kalinda et. al (2022), who advocated capacity-building initiatives and eco-friendly agricultural practices to improve soil health sustainably.

5.1.8 Areas Severely Impacted by SLIMP Activities

Respondents identified low-lying regions and hilly areas as hotspots for challenges such as waterlogging and erosion. Similar findings were reported by Nyambe and Chansa (2019), who emphasized the need for location-specific interventions to address environmental degradation.

5.2 Extent of Land Degradation Resulting from SLIMP Infrastructure

5.2.1 Extent of Land Affected by SLIMP Infrastructure

From Table 8, most respondents (31.6%) indicated that less than 10 hectares of land were affected by SLIMP infrastructure, while 28.1% noted no impact. This aligned with findings by E-SLIP (2021), which reported that most smallholder livestock projects in Zambia had localized impacts due to limited project scale. However, Banda, George, and Arthur (2021) highlighted that even minor impacts accumulated over time, leading to significant environmental changes if not monitored effectively.

5.2.2 Level of Deforestation Caused by SLIMP Activities

As Table 9 demonstrated, 38.6% of respondents reported low levels of deforestation, while 14% noted high or very high levels. According to Kalinda, Kalaba, and Chanda (2022), livestock farming in Zambia contributed to deforestation in specific regions, particularly where infrastructure development necessitated clearing of vegetation. Similarly, FAO (2018) observed that livestock projects across sub-Saharan Africa often led to deforestation when combined with expanding grazing lands.

5.2.3 Contribution of SLIMP Activities to Land Salination

The findings in Table 10 showed that 19.3% of respondents agreed or strongly agreed that SLIMP activities contributed to land salination. This corresponded with the observations of Huber (1980), who emphasized that improper irrigation systems often exacerbated salination risks, particularly in regions with poor drainage. The Ministry of Finance (2021) also noted similar risks in the SLIMP project, citing the need for improved water management practices to mitigate soil salination.

5.2.4 Severity of Topsoil Loss Due to SLIMP Activities

In Table 11, 42.1% of respondents reported low levels of topsoil loss, and 35.1% observed no loss. However, 8.8% reporting high or very high losses underscored the localized severity of this issue. Behnke and Scoones (1993) found that livestock trampling and overgrazing significantly contributed to topsoil degradation in Southern Africa, while Chomba and Kalaba (2020) suggested that better land management mitigated such issues.

5.2.5 Effectiveness of Land Reclamation or Restoration by SLIMP

Table 12 revealed dissatisfaction with SLIMP's reclamation efforts, with 49.1% of respondents rating them as poor or very poor. This finding was consistent with the UNEP (2019) report, which criticized similar projects for inadequate post-development restoration strategies. EAC (2022) also noted that land restoration efforts often failed due to a lack of community engagement and insufficient funding.

5.2.6 Contributions of SLIMP Infrastructure to Land Degradation

Qualitative data indicated that SLIMP infrastructure contributed to soil compaction, waterlogging, and salination. These impacts mirrored those observed by Tembo (2022), who highlighted similar issues in Kasama District due to donor-funded projects. Gibbs (2020) also found that agricultural infrastructure led to significant environmental degradation if sustainability measures were not integrated into project planning.

5.2.7 Suggested Measures to Minimize Land Degradation

Respondents proposed measures such as reforestation, improved monitoring, and community involvement. Such strategies aligned with recommendations by the African Development Bank (AfDB, 2019), which emphasized participatory land management and sustainable agricultural practices in similar projects across

Zambia. Additionally, ZEMA (2021) stressed the importance of environmental assessments to guide development activities.

5.2.8 Examples of Land Degradation Linked to SLIMP Activities

Examples provided included erosion, soil compaction, and deforestation. These findings were supported by Mwale and Phiri (2021), who noted similar degradation trends in Southern Zambia due to livestock projects. Nyambe and Chansa (2019) further emphasized that the introduction of exotic pastures disrupted local ecosystems, exacerbating land degradation.

The findings highlighted varying degrees of environmental impacts caused by SLIMP activities, with significant concerns over deforestation, salination, and inadequate land reclamation efforts. References to past studies affirmed the necessity for enhanced environmental management strategies, emphasizing the importance of community involvement, sustainability practices, and robust monitoring mechanisms.

5.3 Effect of SLIMP on Vegetation Cover and Plant Biodiversity

5.3.1 Impact of SLIMP on Vegetation Cover

The respondents were asked how SLIMP impacted vegetation cover in their area. Findings from Table 13 indicated that 47.4% of respondents perceived SLIMP's impact on vegetation cover as negative or very negative, while 24.5% viewed the impact positively. These results suggested significant concerns regarding the adverse effects of SLIMP activities on vegetation cover. According to Kalinda et al. (2022), unsustainable livestock infrastructure development often resulted in deforestation and land degradation, aligning with the findings of this study. Similar trends were observed in the Okavango Delta, where agricultural activities caused significant vegetation loss (Carter, 2018).

5.3.2 Impact of Exotic Pasture Species on Local Plant Biodiversity

Respondents were asked whether the introduction of exotic pasture species affected local plant biodiversity. Table 14 revealed that 38.6% of respondents were neutral, indicating uncertainty or limited awareness of this impact, while 26.3% agreed that exotic species negatively influenced biodiversity. These findings suggested that exotic species could potentially outcompete native flora. Nyambe and Chansa (2019) reported that exotic species in Zambia had disrupted local plant diversity, a finding echoed in this study.

5.3.3 Significance of Native Plant Species Loss Due to SLIMP Activities

The significance of native plant species loss due to SLIMP activities was assessed, and findings in Table 15 showed that 31.6% of respondents reported moderate loss, while 26.3% indicated high or very high levels of loss. This highlighted a substantial impact on native biodiversity. Similar findings were documented by Mutale (2022), who noted that land-use changes in Kasama District, driven by donor-funded projects, led to significant biodiversity loss.

5.3.4 Extent of Invasive Plant Species Introduced by SLIMP

Findings from Table 16 revealed that 31.6% of respondents reported low levels of invasive species introduction, while 22.8% indicated high or very high levels. These results implied that invasive species remained a concern in areas affected by SLIMP activities. Behnke and Scoones (1993) noted that invasive species often thrived in disturbed ecosystems, supporting the findings of this study.

5.3.5 Satisfaction with Biodiversity Conservation Measures

Based on Table 17, 40.4% of respondents were dissatisfied or very dissatisfied with biodiversity conservation measures under SLIMP, while only 17.5% expressed satisfaction. These findings suggested that the current efforts to conserve biodiversity were insufficient. Similar dissatisfaction with conservation efforts was noted in the SLIMP appraisal report (2019), which recommended enhanced community participation and stricter enforcement of environmental policies.

5.3.6 Observed Changes in Vegetation Cover

Respondents described changes in vegetation cover since SLIMP's implementation, including deforestation, shrub dominance, and vegetation fragmentation. These observations suggested significant disturbances caused by SLIMP activities. Kalinda et al. (2022) highlighted that infrastructure development for livestock production often led to deforestation and fragmented ecosystems, findings consistent with this study.

5.3.7 Impact of Exotic Pasture Species on Local Ecosystems

Respondents noted that exotic pasture species negatively impacted local ecosystems by outcompeting native plants, degrading soil, and disrupting food chains. These findings were consistent with Nyambe and Chansa (2019), who documented the ecological imbalance caused by exotic species in Zambia. Similarly, Jabulani (2009) found that introducing exotic species disrupted traditional ecosystems in Eastern Africa.

5.3.8 Recommendations for Conserving Biodiversity

Respondents suggested planting native species, regulating exotic species, engaging communities in conservation initiatives, and strengthening policies to protect biodiversity. These recommendations aligned with findings from the African Development Bank (2019), which emphasized community involvement and policy enforcement as critical to biodiversity conservation. Similar strategies were proposed by Chomba and Kalaba (2020), who advocated for native species restoration in Zambia.

5.4 Chapter Summary

The discussion was structured around three key objectives, which were explored through both quantitative and qualitative findings.

Objective 5.1 focused on the impact of SLIMP on soil fertility, the Null hypothesis holds, as it has been shown in the alaysis that SLIMP activities have no impact on the soil fertility.

Objective 5.2 examined the extent of land degradation linked to SLIMP infrastructure, the Null hypothesis holds, as it has been shown in the alaysis that SLIMP activities do not contribute to land degradation.

Objective 5.3 addressed the effects of SLIMP on vegetation cover and plant biodiversity, the Altenative hypothesis holds, as it has been shown in the alaysis that SLIMP activities have negatively impacted the vegetation cover and biodiversity.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter concluded the study that aimed to investigate the environmental impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on Land Resources in Muchinga, Northern, and Eastern Provinces. The findings were drawn from the study's three main objectives, which included: (1) assessing the impact of SLIMP activities on soil health and fertility in Muchinga, Northern, and Eastern Provinces; (2) evaluating the extent of land degradation resulting from SLIMP infrastructure in Muchinga, Northern, and Eastern Provinces; and (3) examining the effect of SLIMP on vegetation cover and plant biodiversity in Muchinga, Northern, and Eastern Provinces. This chapter provides conclusions and recommendations based on the study's findings.

6.2 Conclusion

Based on the findings, the study concluded that SLIMP activities have positively contributed to the land resources in Northern, Muchinga and Eastern Provinces. Soil fertility, Improved water availability and an improvement in biodiversity development have all greatly improved, translating into improved livelihoods of farmers. However, some project areas have recorded increased soil erosion and vegetation loss particularly those areas that involve intensive grazing and land disturbance. Ultimately, SLIMP has made positive strides in in all project areas, particularly its actions on soil health, land degradation, and biodiversity have greately improved the enviroment.

6.3 Implications of the findings

The study provided the following key lessons:

1) **Sustainable Practices Are Crucial**: The study underscored the importance of sustainable land management practices, such as controlled grazing and reforestation, to mitigate the environmental impact of SLIMP activities.

2) **Infrastructure Development Requires Careful Planning**: Construction activities, particularly in environmentally sensitive areas, needed careful planning and environmental assessments to minimize land degradation and ecological damage.
3) **Monitoring and Mitigation Efforts are Essential**: Continuous monitoring of environmental impacts and proactive mitigation efforts were crucial in minimizing the adverse effects of infrastructure projects on soil and vegetation.

6.6 Recommendations

Based on the findings and conclusions, the study made the following 8 recommendations:

1) **Promote Sustainable Land Management:** There is need for the Ministry of Lands and Natural Resources to emphasize the adoption of sustainable land management practices such as rotational grazing, reforestation, and erosion control measures to mitigate the negative environmental impacts of SLIMP activities.
2) **Strengthen Environmental Impact Assessments (EIAs):** There is need for the Zambia Enviroemntal Management Agency to ensure that comprehensive EIAs are conducted before infrastructure projects are implemented, with specific focus on soil conservation and biodiversity protection.
3) **Implement Mitigation Strategies:** There is need for the Ministry of Fisheries and Livestock to develop and implement effective mitigation strategies, such as soil erosion control and restoration of vegetation, to counteract the negative environmental effects of SLIMP.
4) **Enhance Capacity for Environmental Monitoring:** There is need for the Ministry of Local Government and Rural Development to strengthen the capacity of local governments and agencies to monitor and evaluate the environmental impacts of SLIMP, ensuring that corrective actions are taken promptly.
5) **Encourage Community Involvement:** There is need for the Ministry of Community Development and Social Services to engage local communities in

the planning and implementation of SLIMP activities to ensure that they understand the environmental risks and contribute to sustainable practices.

6) **Prioritize Biodiversity Conservation:** There is need for the Ministry of Tourism and Arts to promote initiatives aimed at protecting and enhancing plant biodiversity in areas affected by SLIMP activities, ensuring that the project's objectives align with ecological preservation.
7) **Invest in Soil Restoration:** Given the observed impacts on soil health, it is crucial to invest in soil restoration programs to rehabilitate areas degraded by SLIMP infrastructure development. Ministry of Agriculture could lead this initiative in collaboration with local agricultural stakeholders.
8) **Integrate Environmental Education:** There is need for the Ministry of General Education to incorporate environmental education into SLIMP projects to raise awareness about sustainable practices and their long-term benefits for both the land and the community.

6.7 Recommendations for Future Research Directions

The study made the following 5 recommendations for future research directions:

1. **Examine Long-Term Environmental Impacts**: Future research should explore the long-term environmental impacts of SLIMP, particularly on soil health, biodiversity, and vegetation cover.
2. **Investigate the Role of Climate Change**: Further studies should examine the role of climate change in exacerbating the environmental impacts of SLIMP, particularly in relation to soil erosion and biodiversity loss.
3. **Assess the Economic Impacts of SLIMP**: Future research should explore the economic impacts of SLIMP on local communities, including changes in agricultural productivity and access to resources.
4. **Evaluate the Effectiveness of Mitigation Strategies**: Research should evaluate the success of existing mitigation strategies, such as erosion control measures, to determine which approaches are most effective in the context of SLIMP.
5. **Study the Role of Policy in Sustainable Infrastructure Development**: Future studies should examine how policy interventions can improve the

sustainability of infrastructure projects and ensure that they are environmentally responsible.

REFERENCES

Abdulai, A., Owusu, V. and Goetz R. (2011) " Land tenure differences and investment in land improvement measures: Theoretical and empirical analyses." Journal of Development Economic 96:66-78.

Adenle, A. A., Azadi, H., & Manning, L. (2018). The era of sustainable agricultural development in Africa: Understanding the benefits and constraints. Food Reviews International, 34(5), 411-433.

AFDB. (2019). African Development Bank annual performance review of agricultural supported projects in Zambia.

Alemu, M.M. (2016) "Sustainable Land Management." Journal of Environmental Protection, **7**, 502-506.

Altieri, M. A. & Nicholls, C. I. (2017). The adaptation and mitigation potential of traditional agriculture in a changing climate. Climatic Change, 140(1), 33-45.

Amiri F, Ariapour A, Fadai S (2008) Effects of livestock grazing on vegetation composition and soil moisture properties in grazed and non-grazed range site. Journal of Biological Sciences 8:1289–1297.

Arsenault, N., P. Tyedmers, and A. Fredeen (2009), Comparing the environmental impacts of pasture-based and confinement-based dairy systems in Nova Scotia (Canada) using life cycle assessment, International Journal of Agricultural Sustainability, 7(1), 19-41.

AU. (2020). African Union annual economic performance report. Addis Ababa, Ethiopia.

Banda, L., George, T., & Arthur, L. (2021). The agricultural and livestock industry in Zambia. University of Cambridge.

Battisti, B. T., Passmore, C., & Sipos, Y. (2008). Action learning for sustainable agriculture: Transformation through guided reflection. Nacta Journal, 52(2), 23-31.

Behnke, K., & Scoones, O. (1993). The history of livestock production and subsistence farming in southern Africa. University of Pretoria.

Bolliger, A. (2007) "Is Zero-till an appropriate agricultural alternative for disadvantaged smallholders of South Africa? A study of surrogate systems and strategies, smallholder sensitivities and soil glycoproteins." PhD Thesis. University of Copenhagen, Copenhagen, p. 67.

Brennan, T. J. (2008) "Discounting the Future: Economics and Ethics." Resources,

Summer 3-6.

Brundtland, G. (1987). Report of the World Commission on Environment and Development: Our common future. United Nations General Assembly Document A/42/427. [New York]: UN.

Cabrera, D., Colosi, L., & Lobdell, C. (2008). Systems thinking. Evaluation and Program Planning, 31, 299-310.

Carter, H. (2018). The impact of agriculture on native species in the Okavango Delta: A thesis study. University of KwaZulu-Natal.

Capper, J. L., R. A. Cady, and D. E. Bauman (2009), The environmental impact of dairy production: 1944 compared with 2007, Journal of Animal Science, 87(6), 2160-2167.

Carson, R. T. and Tran, B. R. (2009) "Discounting Behaviour and Environmental Decisions." Journal of Neuroscience, Psychology and Economics, 2(2), 112-130.

Cederberg, C., U. M. Persson, K. Neovius, S. Molander, and R. Clift (2011), Including Carbon Emissions from Deforestation in the Carbon Footprint of Brazilian Beef, Environmental Science & Technology, 45(5), 1773-1779.

Chitonge, H. and Umar, B. B. (2018). Contemporary Customary-Land Issues in Africa: An Introduction. In: Chitonge, H., and Umar. B. B. (Eds). Contemporary customary land issues in Africa: Navigating the contours of change. Cambridge Scholars Publishing.

Chomba, C., & Kalaba, V. (2020). The pass-on program and its benefits to the people of Northern and Muchinga provinces of Zambia. Mulungushi University.

Dalkir, K. (2005). Knowledge management in theory and practice. Oxford: Elsevier Butterworth-Heinemann.

Donald, S. (2023). Cattle production and methane generation on the Austin ranch in Texas, USA.

EAC. (2022). East African Community livestock and agriculture performance in the midst of economic and global challenges: Annual report.

E-SLIP. (2021). Enhanced Smallholder Livestock Investment Project performance in improving the livestock industry in Zambia: Annual report.

FAO, 2014. Investing in the livestock sector. Why good numbers matter: A Sourcebook for decision makers on how to improve livestock data. 144p.

FAO. (2018). Livestock industry in the sub-Saharan region of Africa: Annual report.

Gibbs, T. (2020). Agricultural development in Chile: A case study of small-scale livestock farmers in Santiago city.

Gowing, J.W. and Palmer, M. (2008) "Sustainable agricultural development in sub-Saharan Africa: the case for a paradigm shift in land husbandry." Soil Use Manage, 24, 92–99.

Herrero M, Thornton PK, Gerber P, Reid RS (2009) Livestock, livelihoods and the environment: understanding the trade-offs. Current Opinion in Environmental Sustainability 1:111–120

Huber, O. (1980). Sustainability and economic development in the world.

IFAD. (2014). International Fund for Agricultural Development funded agricultural projects and their economic outputs in Africa.

Indaba Agriculture Policy Research Institute (2019) "IAPRI Indaba Agriculture Research Policy Institute Centre of Agricultural Policy Excellence." accessed on: 25th February, 2019. http://www.iapri.org.zm/about-us/about-iapri.

Jabulani. (2009). The Massai cattle herders and their influence on the cultural changes and trends in Eastern Africa: A thesis study. University of Nairobi.

Kalinda, J., Kalaba, K., & Chanda, M. (2022). The agricultural performance of small-scale farmers in Zambia.

Ketas, L. (2008). Carrying capacity and livestock development: A case study of commercial farmers in Rosario.

Kothari, C. R. (2004). Research Methodology: Methods and techniques (2nd ed.). New

Delhi: New Age International Publishers Ltd.

Mafongoya, P. L., Bationo, A. J. K. and Waswa B. S. (2006) "Appropriate Technologies to Replenish Soil Fertility in Southern Africa." Nutrient Cycling in Agroecosystems 76, no. 2: 137-51.

MFL. (2019). Ministry of Fisheries and Livestock strategic plan.

MoF. (2021). Ministry of Finance annual performance review of the SLIMP project.

Ministry of Fisheries and Livestock, Zambia. (2022). Livestock Survey Report 2022. zamstats.gov.zm

Mumba, G., & Arthur, F. (2022). The growth of the agricultural industry in Zambia and its implications on land use changes: A case study of Kapiri Mposhi District.

Mutale, O. (2022). Performance of donor-funded projects under the Ministry of Fisheries and Livestock: A thesis dissertation. University of Zambia.

Mwale, P., & Phiri, W. (2021). The growth of the livestock industry in Southern Province of Zambia. University of Zambia.

Nicholson, H. (2012). The impact of the livestock industry on the environment: A case study of the Kalahari livestock farmers. University of Botswana.

Nyambe, O., & Chansa, I. (2019). The impact of exotic pasture varieties on the natural flora and fauna in Zambia. Oxford Publishers.

O'Connor K (2016) The influence of wheel and foot treading on soils under Grasslands. New Zealand Soil Science Society 2:35–37

Pigou, A. (1990). Environmental economic theory: Law and environmental policy.

Regan, T. (2017). The state of the livestock industry in the world: Opportunities and challenges. Oxford University Press.

Reid, L., Ian, K., & Frank, O. (2022). Commercial livestock ranching and challenges in the prairies: University of California.

SADDC. (2020). Annual agriculture progress report in the development community.

SLIMP. (2019). Sustainable Livestock Infrastructure Management Project – appraisal report. Abidjan.

Sichinga, S. (2015) "Priorities for the Management of Soils in Zambia." Ministry of Agriculture and Livestock. Lusaka.

Taylor SA, Gaylen AL (2020) Physical Edaphology: The physics of irrigated and non-irrigated soils. (G. 1. Asheroft, Ed.). WH Freeman and Company, San Francisco.

Tembo, P. (2022). The impact of donor-funded projects on the natural environment in Kasama District: A thesis study. University of Zambia.

Thornton, J., George, A., & Jen, O. (2009). The impact of mechanized agricultural development on the environment in Bulawayo, Zimbabwe.

UNEP. (2019). United Nations Environmental Program annual report. Kenya.

USDA. (2022). United States Department of Agriculture quarterly agriculture performance report.

ZDA. (2021). The national agriculture performance review paper.

ZEMA. (2021). Environmental project brief on the Sustainable Livestock Infrastructure Management Project.

ZEMA. (2022) Annual performance report of the Zambia Environmental Management Agency.

7th National Development Plan Zambia.

Livestock Policy. (2020). The Zambia National Livestock Policy.

APPENDICES

Appendix A: Research Budget

Table 18: Research Budget

SN	ITEM (BUDGET DETAILS)	UNIT COST (ZMK)	TOTA (ZMK)
	Stationary		
1	50 pencils	1.50	50.00
2	4breams A4 paper	70	280.00
3	50 blue pins k2 each	100	100.00
4	**Sub Total**	171.00	430.00
	Communication		
5	Internet services	500	500.00
6	50 envelopes	2.00	100.00
7	**Sub Total**	502.00	600
	Secretarial services		
8	Photocopying	200.00	200.00
9	Printing	800.00	800.00
10	**Sub Total**	1000.00	1000.00
	Field work		
	Transport to research area	1000.00	1000.00
	Food and refreshment	800.00	800.00
	Printing and binding	600.00	600.00
	Sub Total	2200.00	2200.00
	TOTAL	K3,873	k4,230

Appendix B: Questionnaire for the Respondents

Title: Questionnaire on the Environmental Impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on Land Resources in Muchinga, Northern, and Eastern Provinces

QUESTIONAIRE No: ………………………

Dear respondent,

My name is **ZENGANI MBAMBARA**, student number: **MSCEM2312169**, a Postgraduate Masters degree student in the School of Post-Graduate Studies at the University of Lusaka. I am conducting a study on "**The Environmental Impact of the Sustainable Livestock Infrastructure Management Project (SLIMP) on Land Resources in Muchinga, Northern, and Eastern Provinces of Zambia**" in partial fulfillment towards my Master's Degree qualification. I hereby request you to assist me in this data collection process by answering the questions in this questionnaire. Participation is voluntary and your responses will be kept confidential. No personal details will be collected. You can simply tick the answers that you think are appropriate according to the information you have. Your help will be highly appreciated.

Instructions:

1. **Do not indicate your name on any of the pages of this questionnaire.**
2. **You are advised to attempt all the questions, unless the question does not require you to do so.**
3. **The questionnaire is divided into three parts, these are section A, B, C, D and E. All the questions must be attempted.**
4. **Method of Answering. You are advised to tick [ ] in the box which corresponds with your choice.**
5. **Where two or more choices are possibilities, you can tick two or three or all.**

SECTION A: Demographic Characteristics

1. Gender:

☐ Male ☐ Female ☐ Other

2. Age (in years):

☐ Below 20 ☐ 21–30 ☐ 31–40 ☐ 41–50 ☐ 51 and above

3. Province:

☐ Muchinga ☐ Northern ☐ Eastern

4. Occupation:

☐ Farmer ☐ Livestock Keeper ☐ Environmentalist ☐ Other (specify): ___________

5. Level of Education:

☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary ☐ Other: ___________

6. Duration of residence in your area:

☐ Less than 5 years ☐ 6–10 years ☐ 11–20 years ☐ More than 20 years

7. Involvement in SLIMP activities:

☐ Directly involved ☐ Indirectly affected ☐ Not involved

8. Do you own or manage land in your area?

☐ Yes ☐ No

SECTION B: Impact of SLIMP on Soil Health and Fertility

9. How would you rate the impact of SLIMP on soil fertility in your area?

☐ Very positive ☐ Positive ☐ Neutral ☐ Negative ☐ Very negative

10. Have you observed changes in soil structure or texture due to SLIMP activities?

☐ Significant improvement ☐ Slight improvement ☐ No change ☐ Slight degradation ☐ Severe degradation

11. What is the level of soil erosion caused by SLIMP activities in your area?

☐ None ☐ Low ☐ Moderate ☐ High ☐ Very high

12. Has the use of pesticides under SLIMP affected soil health in your area?

☐ Very positive ☐ Positive ☐ Neutral ☐ Negative ☐ Very negative

13. How would you rate the overall impact of SLIMP activities on the sustainability of farming practices in your area?

    ☐ Very positive ☐ Positive ☐ Neutral ☐ Negative ☐ Very negative

14. In what ways have SLIMP activities influenced soil fertility in your area?

____

____

15. What strategies do you recommend for improving soil health affected by SLIMP activities?

____

____

16. Are there specific areas where SLIMP has severely impacted soil health? Please explain.

____

____

SECTION C: Extent of Land Degradation Resulting from SLIMP Infrastructure

17. How much land has been affected by SLIMP infrastructure in your area?

    ☐ None ☐ Less than 10 hectares ☐ 10–50 hectares ☐ 51–100 hectares ☐ More than 100 hectares

18. What is the level of deforestation caused by SLIMP activities in your area?

    ☐ None ☐ Low ☐ Moderate ☐ High ☐ Very high

19. Have SLIMP activities contributed to salination of land in your area?

    ☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

20. How severe is the loss of topsoil due to SLIMP activities?

    ☐ None ☐ Low ☐ Moderate ☐ High ☐ Very high

21. What is the level of land reclamation or restoration by SLIMP in your area?

    ☐ Excellent ☐ Good ☐ Neutral ☐ Poor ☐ Very poor

22. How has SLIMP infrastructure directly or indirectly contributed to land degradation?

____

____

23. What measures can be taken to minimize land degradation caused by SLIMP?

____

____

24. Are there specific examples of land degradation linked to SLIMP activities in your area?

____

____

SECTION D: Effect of SLIMP on Vegetation Cover and Plant Biodiversity

25. How has SLIMP impacted vegetation cover in your area?

    ☐ Very positive ☐ Positive ☐ Neutral ☐ Negative ☐ Very negative

26. Has the introduction of exotic pasture species affected local plant biodiversity?

    ☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

27. How significant is the loss of native plant species due to SLIMP activities?

    ☐ None ☐ Low ☐ Moderate ☐ High ☐ Very high

28. What is the extent of invasive plant species introduced by SLIMP activities?

    ☐ None ☐ Low ☐ Moderate ☐ High ☐ Very high

29. Are you satisfied with the biodiversity conservation measures taken under SLIMP?

    ☐ Very satisfied ☐ Satisfied ☐ Neutral ☐ Dissatisfied ☐ Very dissatisfied

30. What changes in vegetation cover have you observed since the implementation of SLIMP?

____

____

31. How has the introduction of exotic pasture species impacted local ecosystems?

____

____

32. What recommendations do you have for conserving biodiversity affected by SLIMP?

THE END!

THANK YOU FOR YOUR PARTICIPATION