# ENVIRONMENTAL DISCOUNTING AND SUSTAINABLE LAND MANAGEMENT BY SMALLHOLDER FARMERS IN CHIBOMBO DISTRICT, CENTRAL ZAMBIA

By

Fiona Chisanga Mubanga

A dissertation submitted to the University of Zambia in partial fulfillment of the requirements for the degree of Master of Science in Environmental and Natural Resources Management

UNIVERSITY OF ZAMBIA

LUSAKA

2019

# COPYRIGHT

# DECLARATION

I, Fiona Chisanga Mubanga, do declare that this dissertation is my own work except where acknowledgements have been made on other people's work. I further declare that this work has not been submitted previously by me or anyone else for a degree, diploma or other qualification at this or any other University.

Fiona Chisanga Mubanga

Signature:

Date: 18th June, 2019.

## APPROVAL

This dissertation of Fiona Chisanga Mubanga has been approved as fulfilling the partial requirements for the award of Master's of Science in Environmental and Natural Resources Management by the University of Zambia.

| | | |
|---|---|---|
| …………………………… | ……………… | ……………. |
| Examiner 1 | Signature | Date |
| …………………………… | ……………… | …………….. |
| Examiner 2 | Signature | Date |
| …………………………… | ………………. | …………….. |
| Examiner 3 | Signature | Date |
| …………………………. | ………………. | ……………. |
| Chairperson, Board of Examiner | Signature | Date |
| ………………………. | ……………….. | ……………. |
| Supervisor | Signature | Date |

## ABSTRACT

Poor soil fertility management practices coupled with climate variability are among factors negatively impacting crop productivity in Sub-Saharan Africa (SSA). Promotion of Sustainable Land Management (SLM) practices among farmers has been one of the measures taken to improve and maintain crop productivity. Among SLM practices promoted are agroforestry and soil conservation. Despite extensive promotion of SLM practices among smallholder farmers in SSA and benefits that farmers can reap from them, adoption of SLM remains low. Continued low adoption of SLM can potentially result in irreversible soil degradation which can ultimately impact food security among the poor. One of the reasons for low adoption of SLM practices such as agroforestry has been the long time it takes for benefits to accrue. Preference for soon rather than later benefits could indicate discounting behaviour among farmers. The aim of this study was to investigate environmental discounting behaviour among smallholder farmers in Chibombo District. Objectives were to determine SLM practices implemented by farmers; why these practices are preferred; and to what extent farmers demonstrate environmental discounting in their SLM choices. The data were collected from Kalola Agricultural Camp in Chibombo District through semi-structured interviews with 158 randomly sampled farmers, three Focus Group Discussions, key informant interviews, and field observations. The data were analysed using content analysis and Z-proportional test at 95 percent confidence level. Results showed that practices commonly adopted by farmers were crop rotation (84.3 percent), planting of legume to fix nitrogen (57.4 percent), and mixed cropping (56.9 percent). Over 50 percent of farmers would continue using mineral fertiliser, herbicides and pesticides regardless of when soil infertility would occur; and that up to 53.7 percent of farmers would plant fertiliser trees if benefits would accrue to them within twenty years. It was concluded that crop rotation, mixed cropping, and planting of legumes were widely practiced because they are perceived easier to implement, yield fast results and provide food variety. Farmers demonstrated discounting behaviour in their choices to continue using mineral fertiliser and in planting fertiliser trees. Recommendations: investigating discounting behaviour by assessing if farmers would be willing to implement SLM practices given the time taken for benefits to accrue. Other aspect of discounting such as opportunity cost should be investigated to establish how they impact adoption. Materials for SLM implementation such as fertiliser trees should be ready available at district agricultural offices for access to those who want to plant fertiliser trees.

Key words: Sustainable agriculture, Conventional agriculture, Agroforestry, Soil conservation, Environment.

# ACKNOWLEDGEMENTS

I am grateful to the lecturers and other members of staff in the Department of Geography and Environmental Studies at the University of Zambia for providing quality education and creating an enabling environment for higher learning. My deepest gratitude goes to my supervisor and mentor, Dr. Bridget Bwalya Umar, for her patient guidance and invaluable advice. Words are not enough to express how grateful I am to have had the privilege to work with Dr. Umar. I would also like to thank Dr. Kabwe Mubanga for his constructive criticism and the time he took to engage in illuminating discussion with me that contributed to this work.

I would also like to acknowledge the material support of Mr. Daniel Holmes of DH Engineering Consultants, George Sitali and Moses Nkhata of *BCHOD and Partners Consulting Engineers* that enabled my field work. Also, my field work would not have been possible without the help of Chomba Lombe and Meleki of Ministry of Agriculture; Agrey David Mambwe, Victor Kasote, James Mambwe and all the farmers of Kalola Agricultural Camp that participated in my research.

To my dear husband and best friend, Agrey David Mambwe. You have been through it all as research assistant, facilitator, driver, baby sitter, reviewer, and all-weather friend. You endured my late nights and early mornings, mood swings and tantrums that came with this work. Thank you for your un-wavering support.

Special thanks to my elder sisters Chalwe and Ingrid, and my friend and business partner Sharon for keeping me motivated and cheering me on.

To all my family and friends, and anyone who in one way or another made a positive contribution to this dissertation, I thank you all.

## DEDICATION

To my late mother Christine. Everything I am, I owe to her. She was a great woman. To uncle Tom and aunty Mercy for taking care of me; To aunty Mesta for being an awesome role model; To aunty Lilian, even though I didn't become a medical doctor like you, your mentorship did not go to waste. To my young sisters and brothers, nieces and nephews, and to my children Luyando and Bubile-Christine. May this serve as a reminder that anything worth achieving is achievable with focus and determination.

## TABLE OF CONTENTS

COPYRIGHT ..... i
DECLARATION ..... ii
APPROVAL ..... iii
ABSTRACT ..... iv
ACKNOWLEDGEMENTS ..... v
DEDICATION ..... vi
ABBREVIATIONS AND ACRONYMS ..... xiii
CHAPTER 1 ..... 1
INTRODUCTION ..... 1
1.1. Overview ..... 1
1.2. Background ..... 1
1.3. Adoption of Sustainable Land Management Practices ..... 2
1.4. Statement of the Problem ..... 4
1.5. Aim ..... 5
1.6. Objectives ..... 6
1.7. Research Questions ..... 6
1.8. Hypothesis ..... 6
1.9. Significance of the Study ..... 6
1.10 Organisation of the Dissertation ..... 7
CHAPTER 2 ..... 9
LITERATURE REVIEW ..... 9
2.1 Overview ..... 9
2.2 Conceptual Framework ..... 9
2.3 Defining Sustainable Land Management ..... 11
2.4 Agroforestry ..... 11
2.5 Soil Conservation ..... 12
2.6 Factors Influencing Adoption of SLM ..... 13
2.7 Applying Discounting to the Adoption of Sustainable Land Management Practices 16
CHAPTER 3 ..... 18
DESCRIPTION OF STUDY AREA ..... 18
3.1 Overview ..... 18
3.2 Location of study area ..... 18

3.3 Biophysical Characteristics .......... 19
3.4 Social Demographics .......... 20
3.5 Economy of Chibombo .......... 20
CHAPTER 4 .......... 22
METHODOLOGY .......... 22
4.1 Overview .......... 22
4.2 Research Design .......... 22
4.3 Sampling .......... 22
4.4 Data Collection Methods .......... 23
*4.4.1 Semi-structured Interviews* .......... 23
*4.4.2 Focus Group Discussions* .......... 24
*4.4.3 Key Informant Interviews* .......... 25
*4.4.4 Field Observations* .......... 25
4.5 Data Analysis .......... 25
*4.5.1 Quantitative Data Analysis* .......... 25
*4.5.2 Qualitative Data Analysis* .......... 26
*4.5.3 Validity and Reliability* .......... 26
CHAPTER 5 .......... 28
RESULTS AND DISCUSSION .......... 28
5.1 Overview .......... 28
5.2 Demographic Characteristics of the Sample .......... 28
5.3 Farming Practices and Technologies .......... 30
*5.3.1 Mixed cropping* .......... 33
*5.3.2 Legume production* .......... 34
*5.3.3 Agroforestry practices* .......... 35
*5.3.4 Monocropping and the use of hybrid seeds, pesticides and herbicides* .......... 36
*5.3.5 Fallowing* .......... 39
*5.3.6 Crop residue management* .......... 40
*5.3.7 Animal manure* .......... 41
*5.3.8 Ripping versus ploughing* .......... 42
*5.3.9 Crop rotation* .......... 44
5.4 Environmental Discounting by Smallholder Farmers .......... 45
*5.4.1 Farmer Discounting of Environmental Impacts - Mineral Fertiliser use* .......... 45
*5.4.2 Farmer Discounting of Environmental Impacts - Pesticide Use* .......... 48

*5.2.3 Farmer Discounting of Environmental Impacts – Herbicide Use* ...................... 51
*5.4.4 Farmer Discounting of Environmental Impacts – Willingness to Plant Fertiliser Trees* 53
CHAPTER 6 ........................................................................................................ 58
CONCLUSION AND RECOMMENDATIONS...................................................................... 58
6.1 Overview ........................................................................................ 58
6.2 Conclusion....................................................................................... 58
6.3 Recommendations ........................................................................... 60
REFERENCES ...................................................................................................... 62

## LIST OF APPENDICES

**APPENDICES ........................................................................................................ 71**
**APPENDIX A: INTERVIEW GUIDE - SEMI-STRUCTURED INTERVIEWS .. 71**
**APPENDIX B: FOCUS GROUP DISSCUSSION GUIDE ....................................... 83**

## LIST OF TABLES

Table 5.1: Reasons given by respondents for practicing and not practicing mixed cropping 33

Table 5.2: Reasons given by respondents for producing legumes and for not producing legumes 34

Table 5.3: Reasons for practicing and not practicing agroforestry given by respondents 35

Table 5.4: Reasons for fallowing and not fallowing given by the respondents 39

Table 5.5: Reasons for ripping and not ripping given by respondents 43

Table 5.6: Reasons for ploughing and not ploughing given by respondents 43

Table 5.7: Reasons for practicing and not practicing crop rotation given by respondent 44

Table 5.8: Respondents discounting environmental impact of mineral fertiliser use 46

Table 5.9: Respondents discounting environmental impact of pesticide use 49

Table 5.10: Z-statistic results on respondents discounting environmental impacts of herbicide use 51

Table 5.11: Z-statistic results on respondents discounting environmental impacts of planting fertiliser trees 54

## LIST OF FIGURES

Figure 3.1: Location of Kalola Agricultural Camp in Chibombo District 19

Figure 5.1: Age groups of the respondents 28

Figure 5.2: Level of education attained by the respondents 29

Figure 5.3: Land ownership status 30

Figure 5.4: Common sustainable farming practices in Chibombo District 31

Figure 5.5: Conventional farming practices common in Chibombo District 32

Figure 5.6: Percentage of respondents using mineral fertiliser over time 47

Figure 5.7: Percentage of respondents using pesticides over the years 50

Figure 5.8: Percentage of respondents using herbicides over the years 52

Figure 5.9: Percentage of respondents planting fertiliser trees over time 55

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| CA | Conservation Agriculture |
| CSA | Community Support Agriculture |
| EU | European Union |
| FAO | Food and Agriculture Organisation |
| FISP | Farmer Input Support Programme |
| FGD | Focus Group Discussion |
| FRA | Food Reserve Agency |
| IAPRI | Indaba Agriculture Policy Research Institute |
| NGOs | Non-Governmental Organisations |
| NPV | Net Present Value |
| SLM | Sustainable Land Management |
| SSA | Sub-Saharan African |
| WOCAT | World Overview of Conservation Approaches and Technologies |

# CHAPTER 1

# INTRODUCTION

## 1.1. Overview

This chapter introduces the research topic. It begins by giving a background to Sustainable Land Management (SLM) and why it is necessary. It also highlights SLM adoption trends from different parts of the world. The statement of the problem, aim, research objectives, hypothesis, as well as research questions are also highlighted in this chapter. The chapter then states the significance of the study and lastly, the ogranisation of this dissertation.

## 1.2. Background

Land degradation associated with poor soil fertility management practices is one of the major factors underlying low agricultural productivity in sub-Saharan Africa (Zingore et al., 2015; Nkonya et al., 2016). According to Drechsel et al. (2001), it is estimated that soil nutrient depletion accounts for approximately 7 percent of the agricultural share in the average GDP of Sub-Saharan Africa with national values reaching up to 25 percent. This shows that soil degradation can contribute to reducing the agriculture sector's contribution to GDP. Further, an estimated 65 percent of the agricultural land in Sub-Saharan Africa (SSA) is degraded, mainly due to low nutrient application, soil erosion and soil acidification (Zingore et al., 2015). Given that livelihoods of the majority of the rural poor heavily depend on natural resources, countries in the region have designed a number of policies and strategies to address land degradation and to enhance agricultural productivity (Nkonya et al., 2016). One such strategy includes the promotion of Sustainable Land Management (SLM) practices. Sustainable Land Management is the adoption of land use systems that enables land users to maximise the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (Liniger et al., 2011). SLM practices include minimization of soil erosion and leaching using permanent soil cover and mulching, recycling of organic nutrients by retaining all crop residues on the field of origin, enhancement of biological sources of nutrients through practices such as agroforestry, compensate for nutrient loss through the addition of organic or mineral fertilizer, and use of adapted and efficient species of crops to enhance yield (World Bank, 2006). By adopting SLM practices such as agroforestry and soil conservation measures, smallholder resource-constrained farmers can maintain soil fertility better than with mineral fertiliser for which they do not have enough finances to purchase adequate amounts. In comparison to mineral fertiliser that has been reported to result in soil acidity after prolonged use (Bune-mann and McNeill, 2004), agroforestry has been reported as a cost-effective and sustainable way of maintaining soil fertility. The adoption of sustainable agricultural practices is also motivated by fertility increase and concomitant crop yield increase, food security and household incomes (Nkomoki et al., 2018). However, for farmers to sustain these results, they need to continually adopt SLM practices.

## 1.3. Adoption of Sustainable Land Management Practices

Studies from different parts of the world show that the adoption of SLM practices among farmers has been low. A study conducted by Arden-Clarke & Hodges (1987) in different parts of Europe gave two reasons for this. First, the Common Agriculture Policy in the European Union (EU) did not provide incentives for sustainable farming but rather encouraged highly productive farming systems; and second, major producers in the EU such as Germany, France and Great Britain failed to recognise that the challenges they faced in production were as a result of the negative impacts of intensive cultivation on arable land that is a culmination of many years of unsustainable agriculture. In Sub-Saharan Africa, adoption of SLM has also been reportedly low. A study conducted by Bolliger (2007) in South Africa found sporadic pocket of adoption of zero-tillage practices among a small number of farmers and almost no adoption anywhere else throughout the areas he surveyed in South Africa. Reasons for low adoption given were that the practices of minimum tillage encouraged weed growth which increases labour demand for weeding (Bolliger, 2007). An evaluation by Mashingaidze et al (2006) of the outcomes of a two-decade long CA promotion project by NGOs in Zimbabwe also found limited adoption. Among the constraints identified included: high labour demand *vis-à-vis* limited household labour and low mechanisation of the farming systems, lack of appropriate implements, and blanket recommendations that ignored vital extenuating circumstances under which various smallholder farmers operated (Mashingaidze et al., 2006). Although there were claims of widespread adoption of fertiliser tree-planting in western Kenya, Ojiem et al. (2006) found that the fertiliser trees planted and the seed market for the trees had ended together with the campaigns. This trend made Gowing and Palmer (2008) conclude that there has been virtually no adoption of SLM (especially those that were packaged as CA), with only a handful of adopters in Ghana, Zambia and Tanzania.

Kabwe et al. (2009) investigated adoption of agroforestry among smallholder farmers in Zambia. They found an association between adoption of improved fallows and biomass transfer technologies with knowledge of the technologies, skill of implementation and availability of seeds or seedlings. However, the strength of this association was low, showing that there were other factors that influenced the adoption of agroforestry by farmers (Kabwe et al., 2009). During SLM promotion periods, farmers were provided with free inputs to try out a new technology or farming practice so as to experience the advantages and become adopters. To the contrary, some researchers have argued that the provision of these free inputs results in disadoption of practices promoted after the promotion period (Habanyati et al., 2018; Ojiem et al., 2006; Haggblade and Tembo, 2003). Haggblade and Tembo (2003), who studied adoption of CA among farmers in Zambia between 2001 and 2003 reported that the number of farmers who adopted CA in 2001/2002 were 20,000 and this number rose to 75,000 smallholder farmers in 2002/2003. They argued that the 20,000 smallholder farmers were true adopters while adoption by the additional 55,000 farmers was incentivized by starter-pack inputs donated during a drought to promote CA among farmers. Their argument was concurrent with the findings of a study conducted by Habanyati et al. (2018) on disadoption of CA among smallholder farmers in Eastern Zambia. They found that incentives given during the promotion period create a false sense of CA adoption. Thereafter, the farmers could not sustain adoption beyond the promotion period when incentives were no longer provided (Habanyati et al., 2018). In contrast, a study by Styger and Fernandes (2006) conducted in Central America showed how farmers have adopted sustainable agriculture, especially agroforestry. This study narrates how farmers in Central America adopt agroforestry to sustain crop production because they have limited parcels on which to farm and do not have the option of moving from degraded land (Styger and Fernandes, 2006). This shows how a *zero-option* and a perceived threat to soil infertility can motivate farmers to adopt SLM.

Agroforestry is one practice whose adoption has been reported low among farmers in SSA (Mafongoya et al., 2006). One of the reasons given is that farmers in SSA are either not willing to wait for the time it takes to realize benefits from implementing SLM or that they do not perceive soil infertility to be a current problem. For example, Ajayi et al., (2003) reported low adoption of the fertilizer tree systems because leguminous trees take time and resources to get well established in the field before their biomass can be utilized. The trees obtain nitrogen from the air and fix it into their roots, stems, branches and leaves. This biomass is then incorporated into the soil and releases the nitrogen required for crops to benefit after it has decomposed. Although the fertilizer trees system does not have the same instantaneous effect as mineral fertilizer, its benefits entail two to three years of nutrient release to crops without the need for mineral fertilizers (Ajayi et al., 2003). Another example on soil conservation from Southern Ethiopian showed that some farmers who had not applied soil conservation measures were not willing to lose potential productive land to soil conservation structures despite the threat of soil erosion (Tadesse, 2010). Tadesse (2010) concluded that farmers' perception of the soil erosion problem was one of the major factors influencing their decision to implement soil conservation measures in Southern Ethiopia. Although farmers can benefit from SLM, their low adoption remains low because of their perceptions. This suggests that farmers have a tendency to discount future environmental gains or losses (Pearce and Tuner; 1990). Discounting measures how much future costs are worth today (Brennan, 1995). Thus, discounting the environment means lowering the importance of environmental impacts that may potentially manifest in future. Some of the ways that environmental discounting can manifest are through positive time preference - which is the preference of benefit occurring in the near future (Guth, 2009) - and risk aversion - which is the preference of certain but lesser outcomes compared to uncertain but potentially greater outcomes (Boyle et al., 2012). This study focused on SLM practices of agroforestry and soil conservation and makes inference of environmental discounting among farmers in Chibombo District, Central Zambia based on time preference and risk aversion.

### 1.4. Statement of the Problem

Studies that have been conducted to investigate the adoption of SLM practices among smallholder farmers have reported low adoption of the practices, especially those with high initial cost and long term benefits such as agroforestry (Mafongayo et al., 2006; Kabwe et al., 2009; Kuntashula et al, 2005). Farmers opt to use mineral fertiliser and not plant fertiliser trees because soil fertility and plant growth can be experienced almost immediately (Umar, 2012). Research has shown that prolonged use of mineral fertiliser on the same pieces of land can result in soil acidity (Bune-mann and McNeill; 2004). On the other hand, practicing sustainable agriculture can result in increased and sustained crop yields, ultimately leading to food security and household incomes (Nkomoki et al, 2018) from which resource-constrained smallholder farmers in SSA can benefit.

Factors influencing adoption of SLM have been considered from social, economic and environmental perspectives. These factors include weed pressure, lack of appropriate implements, lack of knowledge of implementation of practices and insecure land tenure (Bolliger, 2007; Ajayi et al.; 2003). Promoters have been accused of making blanket recommendations that ignore vital extenuating circumstances under which smallholder farmers operate (Mashingaidze et al.; 2006). This has also been said to contribute to low adoption. Habanyati et al. 2018 noticed that over-incentivisation of SLM practices during promotion that gets farmers accustomed to free inputs, hence leading to disadoption after the promotion period. The perception that soil fertility is not an immediate problem was also pointed out by Tadesse (2010) as one of the factors influencing adoption. The Researcher did not come across any study that has considered the influence of the environmental economic factor discounting, on the adoption of SLM practices. Environmental discounting involves being interested with immediate results and not being concerned with environmental degradation that will be suffered by others in future. If farmers continued to discount future environmental impacts, their unsustainable practices could potentially result in irreversible soil degradation that may consequently reduce crop productivity and jeopardize food security.

## 1.5. Aim

The aim of this study was to investigate the environmental discounting behaviour of smallholder farmers in Chibombo District towards the adoption of SLM practices.

## 1.6. Objectives

The objectives of this study were to:

1. Determine which sustainable farming practices smallholder farmers in Chibombo District are engaged in.
2. Investigate why smallholder farmers' prefer the SLM practices and technologies they use.
3. Determine the extent to which smallholder farmers in Chibombo District demonstrate environmental discounting in their choices in relation to SLM.

## 1.7. Research Questions

1. What SLM practices are used by smallholder farmers in Chibombo District?
2. Why do smallholder farmer in Chibombo District prefer the SLM practices and technologies they use?
3. To what extent do smallholder farmers in Chibombo District demonstrate environmental discounting?

## 1.8. Hypothesis

1. $H_0$: There is no significant difference in the number of smallholder farmers who would continue using mineral fertiliser, herbicides and pesticides if their resultant soil infertility would manifest in 5 years, 10 years, 20 years, 50 years, and in the next generation.
2. $H_0$: There is no significant difference in the number of smallholder farmers who would plant fertiliser trees if their soil improvement benefits would manifest in 5 years, 10 years, 20 years, 50 years, and in the next generation.

## 1.9. Significance of the Study

It is vital to understand how farmers discount the environment so as to know if they would invest their financial and humans resources in continued adoption of SLM practices whose benefits accrue to them in the future. Carson and Tran (2009) pointed out that discounting plays a major role in the life cycle of environmental and natural resources policies. According to Guth (2009), discounting holds the key to striking a compromise between economics and long-term environmental degradation. Therefore, understanding resource users' environmental discounting behaviour is vital to predicting outcomes of environmental and natural resources policy implementation. For SLM adoption project funders, understanding the environmental discounting behaviour of the targeted adoptees can enhance resource-allocation efficiency. Promoters will design and optimize the promotion of practices that are likely to be adopted according to the adoptees' discounting behaviour and other factors that may contribute to their adoption patterns.

Aspects of discounting explored in this study are time preference or risk aversion. By investigating farmer time preference, this study provided insight into how long farmers were willing to wait to benefit from implementing SLM and what risk they can withstand in the short-term for the long-term benefits of SLM. The study brings to light how some of the SLM practices and technologies promoted were not readily adopted due to farmer time preference. The study also highlighted some of the practices and technologies towards which farmers are risk averse. Thus, this study can help SLM programme implementers to design and invest in programmes that best fit farmer discounting behaviour. Additionally, although the literature is replete with studies highlighting factors that affect smallholder farmers' low adoption of SLM practices, there is a dearth of research on their discounting behaviour and how it affects the adoption. This study was an attempt to contribute to narrowing this research gap. The study provided a perspective different from the social and environmental perspectives on adoption of SLM that have been widely written on; thus adding to the body of knowledge on adoption of SLM practices among smallholder farmers.

### 1.10 Organisation of the Dissertation

Chapter one of this dissertation introduces the study topic, outlines the background of the study, problem statement, objectives of the study, hypothesis, research questions, and significance of the study. Chapter two reviews literature and provides the conceptual framework in which the economic concept of discounting is conceptualizes for this study. The chapter also reviews literature on evidence of low adoption of SLM among smallholder farmers in various parts of SSA. Chapter three describes the location of the study area, as well as its bio-physical and socio-economic characteristics. Chapter four lays out the methodology used to achieve the study’s objectives and aim. The chapter outlines the sampling, data collection and analytical techniques that made up the methodology of the study. Chapter five presents the results of the study in line with the objectives and other information gathered during the study using appropriate techniques. It also interprets and discusses the results of the study with inferences from literature and the researchers own understanding of phenomena observed. Chapter six concludes the dissertation by summarising the findings of the study. It also makes recommendations based on the conclusions drawn from the findings of the study and experiences encountered in literature and lessons learnt during field data collection.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Overview

This chapter presents a review of literature on which this study was built and conceptualizes environmental discounting in the context of this research. It defines Sustainable Land Management and highlights the benefits of agroforestry and soil conservation. It also shows what factors have influenced adoption of the practices by farmers.

## 2.2 Conceptual Framework

Environmental Discounting compares the value of future costs and benefits with present cost and benefits (Guth, 2009). Discounting has its roots in economics and has four main aspects: (i) changes in price; (ii) time preference; (iii) productivity of capital and diminishing marginal utility of consumption; and (iv) uncertainties or risk aversion (Stefanie et al., 2003). Guth (2009) defined positive time preference as the preference of now benefits rather than later benefits. Risk aversion was defined by Boyle et al. (2012) as the tendency to choose an option with lesser desirable outcome which is more certain over uncertain, but potentially greater outcome.

In economics, monetary value is usually attached to enable costs and benefits to be quantified in monetary terms. Future costs and benefits are discounted to present value to enable comparison to present costs and benefits (Stefanie et al., 2003). Brennan (1995) explained that this is so because according to rational economic models, the future is less important that the present, which is why it is discounted. Brennan (1995) gave an example of why discounting makes sense. He wrote that getting $250 today was worth more than getting $300 in 10 years even if this $300 was adjusted for inflation. He justified that the $250 today if invested would yield more than $300 with accumulated interest after 10 years. He also added that the delay in time could introduce a host of uncertainties such as death, closure of financial institution before the 10 years, etc; that would further reduce the value of this $300. He also mentioned other psychological factors that constitute time preference such as impatience and lack of self-control, and that they play a role in humans preferring “now payments”. A discount rate is what is arrived at after the application of “rational economics”. A discount rate was defined by Brennan (1995) as the rate at which future outcomes are devalued. A discount factor is usually established to aid the calculation of present value. Stefanie et al (2003) put forth the following equation to calculate a discount factor:

$$d_t = 1/(1+r)^t \ldots\ldots\ldots\ldots\ldots\ldots \text{Equation1}$$

Where: *d = discounting factor*

*t = time*

*r = discount rate*

As economically rational as discounting may seem, it can be detrimental if applied to environmental projects. This is so because the nature of most environmental impacts is such that their negative impacts tend to be felt in future. Therefore, reasoning that the present is more important than the future could cause much harm for future generations. Stefanie et al (2003) gave an example of waste incineration were immediate emissions to the air from incineration had to be weighed against future emissions of slag land-fills. Their study revealed how a positive discount rate of less than 1 percent on future environmental impacts lead to a significant reduction of the impact score; whereas a negative discount rate inflated the results. The common approach to evaluating the environmental cost and benefits associated with a project over its lifetime is to perform a cost-benefit analysis (Boardman et al., 2001; Pearce et al., 2003; Zerbe and Dively, 1994). Projects are estimated in current money values (after factoring in all environmental mitigation measures); and then discounted at an established discount rate to determine the Net Present Value (NPV) of the project (Carson and Tran; 2009). If NPV is positive, then the project is a worthy investment. In relation to SLM implementation programmes, a worthy investment can be predicted by establishing farmers' discount rates using an appropriate aspect of discounting. If a discount rate is low and the resultant NPV is positive, this would signify that farmers place a higher importance on future environmental problems, hence they discount them less. If the discount rate is high and the NPV negative, it would signify that farmers view future environmental problems as less important. Thus, a cost benefit analysis would give a good indicator of a worthy SLM investment. A good SLM investment would be one whose practices are adopted and fully implemented for the sake of agriculture sustainability regardless of when SLM benefits to crop production would manifest.

## 2.3 Defining Sustainable Land Management

Sustainable Land Management SLM integrates land, water and biodiversity and environmental management to meet food and fiber demands required to support livelihoods while sustaining ecosystems (World Bank, 2006). Some practices and technologies include soil conservation, conservation agriculture (CA), integrated crop-livestock management and agroforestry (Liniger et al.; 2011). However, the practices may take on different names or maybe adapted to suit different environments. As Alemu (2016) noted, SLM practices are constantly changing with trends and new opportunities. Thus he broadly defined SLM as practices that use land resources such as soils, water, animals, and plants to produce goods that meet changing human needs while maintaining their long-term productive potential and environmental functions (Alemu, 2016).

Soil conservation combines different soil fertility amendment and water conservation strategies using available resources and is based on three principles: (1) maximizing the use of available organic nutrient resources such as crop residues and nitrogen-fixing crops; (2) minimize loss of nutrients and; (3) the judicious use of inorganic fertilizer according to need and economic availability (World Bank, 2006). Agroforestry, on the other hand, has been defined as the collective name for land - use systems and practices that deliberately integrate agricultural crops with woody perennials for various benefits and services. Agroforestry systems can range from simple and sparse to complex and dense (Liniger et al.; 2011).

## 2.4 Agroforestry

Agroforestry has been promoted among farmers in Zambia since 1997 (Kabwe et al., 2016). According to Kuntashula et al. (2016), agroforestry was necessitated due to the steady decline of maize production that has been attributed to changes in fertiliser subsidies. By adopting agroforestry, farmers would make up for the extra quantities of mineral fertiliser that they could no longer afford (Kuntashula, 2006). Agroforestry involves the transfer of nutrients from fertiliser tree species to the soil using different technologies (Ajayi et al., 2003). Five agroforestry technologies have been promoted among farmers in Zambia, namely: biomass transfer; improved fallows; woodlots; fodder banks; and the planting of indigenous fruit trees (kwesiga et al., 1993). Of these, biomass transfer and improved fallows are used to improve soil fertility. Major tree species used are Faidherbia albida, Sesbania sesban, Tephrosia vogelii, Cajanus cojan and Gliricidia sepium (Kuntashula et al., 2016). In Chibombo, the most common agroforestry tree species used is Faidherbia albida. Tree species used in agroforestry usually grow within a minimum of two years to enable the rapid replenishment of soil fertility into the soil (Kabwe et al., 2016). Improve fallows involve the deliberate planting of leguminous nitrogen-fixing tree species within the crop field. When the trees mature, their leaves and twigs are cut and incorporated into the soil at the time of cultivation to act as a source of nitrogen (Kabwe et al., 2009). Biomass transfer involves the use of nutrients released by tree litter - such as leafy material - into crop fields (Mafongoya et al., 2006). Kwesiga et al. (2003) add that if is mulching or manuring using tree or shrub foliage which is cut and incorporated into the field to improve soil fertility. For biomass transfer, fertiliser trees can be planted among the crop or in a different location.

### 2.5 Soil Conservation

One of the principles of soil conservation is maximizing the use of available organic matter. Manuring and composting is one such method under this principle that is practical for southern Africa where mixed crop-livestock farming is common (Mafongoya et al., 2006). Mixed inter-cropping of cereals with nitrogen-fixing legumes is also another way of maintaining soil productivity. This method also achieves diverse farm production with less effort. Additionally, the judicious use of inorganic fertilizers and organic inputs can increase the efficient uses of inputs while cutting costs for smallholder farmers (Mafongoya et al., 2006).

Several studies that have been conducted in Southern Africa among smallholder farmers have espoused SLM practices and pointed out their advantages. For example, Mubanga (2018) revealed that maize yield in ripped fields was 0.3 tonnes per hectare higher than ploughed fields. Umar (2012) also reported significantly higher levels of nitrogen, organic carbon and potassium under *Faidherbia albida* canopies and a higher maize yield on CA field compared to CV fields. However, she points out there overall, there were no significant soil fertility differences in CA fields after 5years of CA practice. This was attributed to lack of full implementation of CA by farmers (Umar, 2012). Kabwe et al. (2009) highlighted that the adoption of agroforestry practices would provide an alternative to inorganic fertilizers for resource-constrained farmers while addressing soil nutrient requirements. Planting of trees such as *Sesbania sesban* or *Tephrosia* have demonstrated the ability to replenish nitrogen in the soil sufficient to meet most crop requirements (Mafongoya et al., 2006). Apart from soil fertility, Kuntashula and Mafongoya (2005) highlighted other uses of agroforestry trees such as fuel wood production, poles for construction, and fodder for animals. Ajayi et al. (2003) observed that planting indigenous fruit trees in agricultural fields is beneficial for providing nutrition during seasonal hunger and helps to curb deforestation.

## 2.6 Factors Influencing Adoption of SLM

Despite the benefits that result from the adoption of agroforestry and soil conservation practices, studies conducted among smallholder farmers in Zambia and other parts of Africa at large have reported low adoption of SLM practices (Kuntashula et al., 2002; Phiri et al, 2004*;* Gladwin et al., 2002*;* Ajayi et al 2003; Kabwe et al., 2009). Among the reasons advanced for low adoption of agroforestry are labour constraints, lack of seeds and seedlings and the long time taken for the trees to mature (Mafongoya et al., 2006). Crop rotation of maize with legumes such as groundnuts and cowpeas to enhance soil fertility is also not widely practiced because it is said to hinder the production maximization of cereal (Mafongoya et al. 2006). Even though legumes have a higher market value, their supply chain on the market is not as well established as that of maize. Maize is the staple food in Zambia, hence the maize-centric culture of farmers in Zambia. Umar (2011) reported low adoption of crop residue retention among mixed crop-livestock farmers in southern Zambia due to the need for cattle to graze on the residues. Mafongayo et al. (2006) also reported low use of organic fertiliser due to claims of it only being available in insufficient amounts.

Another major factor contributing to low adoption of SLM among farmers in Sub-Saharan Africa identified by several scholars was insecure land tenure (Holder and Ghebru, 2016; Lovo, 2015; Abdulai et al.,2011; 2008; Fenske, 2011; Kassam et al., 2014; Kiyani et al. 2017). Holden and Ghebru (2016) found that insecure land tenure in Ethiopia had a negative impact on farmer propensity to invest in land improvement and that more secure land rights had the opposite effect. In their review of several studies, Holden and Ghebru (2016) found that land transfer rights and secure tenure were associated with higher land investments. They also found a positive association between low-cost land certification and the adoption of soil conservation structures in the Tigray Region of Ethiopia. In Ghana, land rights are weak (Abdulai et al., 2011). Women hold temporary rights to land and do not typically have the right to plant trees (Adedipe et al., 1997). In the past in southwest Ghana, secondary ownership of land typically through borrowing, pledging, leasing were common (Araka et al., 1990). Araka et al. (1990) found that this made land tenure less secure which discouraged soil fertility amendments and reduced the incentive to invest in land as the investor was not guaranteed to receive a greater share of the ultimate returns to the investment. These threats to loss of land do not only apply to the poor and weak. Female cultivators who own land but lack political office or affiliations in the Akwapim region of Ghana fear fallowing their land for fear of losing it (Abdulai et al., 2011).

Lovo (2015) had similar reports from Malawi on how land tenure security influences investment in soil conservation. In her research, she found that the probability of investing in conservation measures was around 6 percent lower for rented plots than for inherited and purchased plots. Still in Malawi, Mafongoya et. al. (2006) reported low adoption of the biomass transfer practice among smallholder farmers despite the practice being inexpensive. They found the reason to be labour intensity as it requires a lot of labour for management and incorporation of biomass into the fields (Mafongoya et al., 2006). Kabwe et. al., (2009) reported low adoption of improved fallows from Zambia because farmers were unwilling to wait for the time it takes for trees to grow and that they did not have the space to fallow. In Rwanda, the lack of skills and technical know-how, as well as the quality of seeds were given as reason farmers declined to adopt agroforestry (Kiyani et al.; 2017).

Further research into farmer adoption behaviour revealed other reasons. Habanyati et. al. (2018) reported disadoption of conservation agriculture (CA) in eastern Zambia after the end of the CA promotion period because the strategies used for encouraging farmers to adopt CA were characterized by input hand-outs. Farmers were unable to sustain acquiring inputs to continue implementing CA after the end promotion period (Habanyati, et. al.; 2018). Phiri et al. (2004) and Keil et al. (2005) also noticed that in Zambia, farmers who are involved with researchers in on-farmer experimentation of agroforestry were more likely to adopt agroforestry technologies compared to those who were not.

The growing popularity of monocropping in the 1960s was followed by the manufacturing of hybrid seeds that would ensure the growth of crops with desired characteristics. However, crops from these seeds have been known to be vulnerable to pest and disease infestation. They are also non-resistant to climatic changes compared to local varieties (Jacques and Jacques; 2012). Such vulnerability has given birth to strong agribusiness in Europe and North America that manufacture complimentary pesticides, herbicides and mineral fertilisers to curb the vulnerabilities of these seeds (Jacques and Jacques; 2012). Hybrid seeds have also been designed in such a way that if replanted, subsequent yields will be unsuccessful, forcing farmers to purchase more of them. Further, the seeds have even been tailored to suit different agro-ecological regions to ensure high productivity in challenging climates, a quality so desirable to risk-averse smallholder farmers. Mechanisation has made monocropping even easier as it usually works well under single crop fields. For example, a large field of wheat can be sprayed with pesticides or herbicides in a short time with a single setting on a machine.

Additionally, Gladwin et al. (2002) and Keil et al (2005) found that farmers who perceive low soil fertility were more likely to adopt improved fallows. Opio (2001) found that lack of security land tenure among female farmers was hampering their establishment of improved fallows in Katete District of Zambia. A synthesis by Ajayi et al. (2003) that reviewed three studies showed that farmers with bigger land potions planted were more likely to plant and even continue with improved fallows compare to farmers with smaller pieces of land. With regards to CA practices such as basins that require preparation of fields way before the rainy season, Umar (2012), discovered that farmers are unwilling to cultivate their fields early because they engage in other off-season activities such as trading in season wild fruits.

## 2.7 Applying Discounting to the Adoption of Sustainable Land Management Practices

Kassam et al. (2014) offered lessons from their review of worldwide spread and adoption of CA. They argued that challenges associated with adoption of SLM practices can be overcome by farmers, rich or poor, large or small scale if they experience the impacts of soil degradation. Reports from North and South America showed that CA is being practiced on some 95,445,100ha of land (Liniger et. al, 2011). In the United States, minimum soil disturbance is said to have been adopted in response to the "dust-bowls" of 1930 in which dust pollution plagued the farming communities in the Southern Great Plains of North America (Kassam et al., 2014). Jeffrey and Thomas (2015), attributed the dust bowls to poor farming techniques and drought conditions in the affected areas. The drought reduced soil cohesion while poor land management practices reduced land cover and increased soil erodability (Jeffery and Thomas, 2015). In Brazil, Argentina and Paraguay, CA practice started in the 1970s and 1980 due to soil degradation from erosion caused by tropical storms (Kassam et al., 2014). Kassam et al. (2014) also noticed that CA was increasing becoming popular in Africa, Asia and Europe due to stagnating productivity that was believed to be as a result of soil erosion, loss of soil organic matter and the impacts of climate change. In their global review, Kassam et al. (2014) observed that adoption among locally-formulated SLM solutions was more wide-spread; most of which were characterized by the involvement of private and public stakeholders working together with local farmers.

Gattig et al, (2007), stated that people's support for measures aimed at environmental sustainability depends on the extent to which they consider environmental problems to be a risk, that is, they tend to discount environmental risks. The difficult relationship between sustainability and discounting was depicted in Hardin's (1968) "Tragedy of the Commons". In this instance, the lands that farmers own are like inter-generational commons from which the farmers reap benefits now using conventional agriculture because the consequences will be borne to others, which leads to the tragedy of land degradation in the long run. Therefore, as suggested by Gattig (2007), it is vital to investigate how environmental impacts that manifest in future are discounted; so as to explore the implication of discounting on the adoption and sustainability of environmental projects.

In summary, this review of literature has revealed studies that discuss the benefits from implementing SLM to agriculture. However, the literature also shows that farmers do not popularly adopt SLM practices. Several challenges to adoption encountered during the review were either social or environmental. Among the social challenges highlighted in the literature were that farmers do not readily adopt practices that are labour intense; that take a long time to manifest benefits, and that pose uncertainty to potential crop yield. It was also brought out that insecure land tenure discouraged farmers from adopting SLM with long-term benefits due to the uncertainty of reaping the benefits. Environmental set-backs such as termites that inhibit the growth of fertiliser trees and the sheer lack of suitability of the SLM practices promoted in an area were also observed to slow adoption. The review also encountered farmers from Central America were adoption of agroforestry was said to be high. It was said that farmers in this region had no choice but to adopt agroforestry because it was their only means to sustain soil fertility. This showed that left with no choice, farmers can plant a tree that takes years to grow. A lot has been said about the reason for low adoption, but little is known on how environmental discounting impacts the adoption of SLM among smallholder farmers in Zambia. Since the researcher found no study on environmental discounting and how it influences the adoption of SLM among farmers in central Zambia, this research was an opportunity to take the first step and peer into the subject by establishing if farmers in Central Zambia exhibit environmental discounting behaviour.

# CHAPTER 3

# DESCRIPTION OF STUDY AREA

## 3.1 Overview

This chapter describes the study area's location as well as its biophysical characteristics. It also highlights the demographics of the study area and gives an overview of the social and economic characteristics of the study area.

## 3.2 Location of study area

This study was carried out in Chibombo District, Central Zambia. The district is divided into 20 agricultural camps. For administrative purposes, the Ministry of Agriculture has divided each district in Zambia into agricultural blocks, which have been further divided into agricultural camps (Mubanga et al.; 2015). An agricultural camp is the lowest level of administration at district level in the Ministry of Agriculture. This decentralization system of dividing a district into camps is in place for easy numeration of farmers to aid, among other things, the sufficient distribution of farmer inputs and the implementation of agriculture policies and programmes. The agricultural camp of interest in this research is Kalolo Agricultural Camp (Figure 3.1).

Chibombo district was randomly selected as the study area for this research because it is one the districts in Zambia were agriculture is practiced as one of the major economic activities. Kalola Agricultural Camp was selected out of the 20 agricultural camps in Chibombo District. This camp selection was done after prior knowledge from key informant interviews with the Ministry of Agriculture revealed that Kalola camp has a good number of smallholder farmers. It was also revealed that the Kalola Agricultural Camp officer kept well organised records of the farmers' names and contact numbers. The camp was also easily accessible by road. With this information, the researcher sited Kalola Agricultural Camp as the study site.

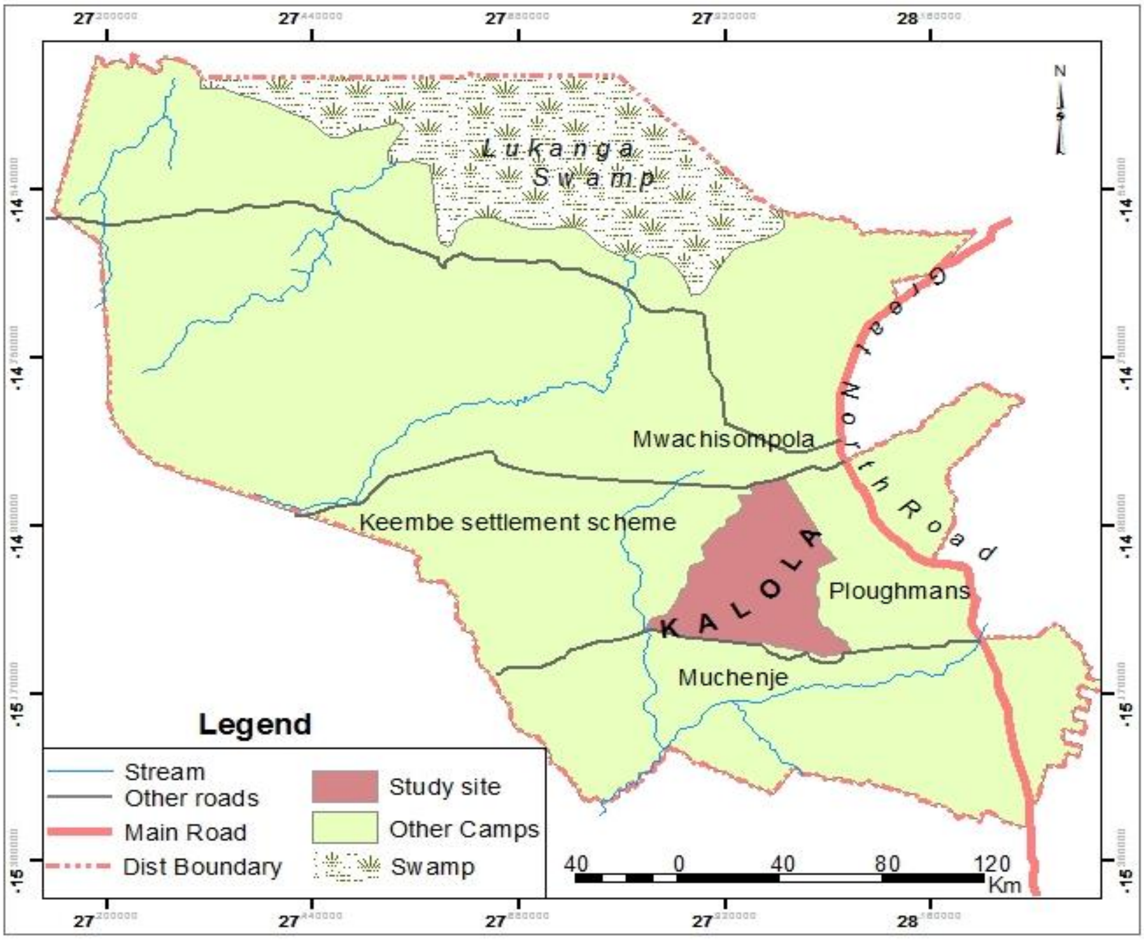


**Figure 3.1: Location of Kalola Agricultural Camp in Chibombo District (Source: Ministry of Agriculture (2017, Author)**

## 3.3 Biophysical Characteristics

Chibombo District receives mean annual rainfall of between 800mm and 1000mm annually, and has a crop growing period of 100 to 140 days. The hottest month in Central Zambia is October and the coldest month is July. Mean maximum and minimum temperatures reached in these months are 26.8$^{o}$C and 14.2$^{o}$C (Saasa, 2003) The study area has an altitude that ranges from 1200m to 1220m above mean sea level. Common soils types in the district include Lixisol, Luvisols, Alisols, Acrisols, Leptosols and Vertisols (Sichinga, 2015).The vegetation in Chibombo district, like most of central Zambia is Miombo woodland. Chidumayo (1987) classified it as the Central Drier Miombo. Common tree species in this woodland are predominant of *Brachystegia*, and to a lesser extent *Combertuem* (Chidumayo, 1987). Trees observed in the study area included *Brachystegia boehmii*, *brachystegia utilis* and *Brachystegia spiciformis*.

### 3.4 Social Demographics

According to the Central Statistical Office (2013), the population of Chibombo District was projected to be 372,487 for 2017, with 185,843 males and 186,624 females by 2018. The population density for Chibombo District was projected at 29.9 persons/km$^2$ while growth rate was projected at 1.8 from 2011 through to 2020 (CSO, 2013). According to the records at the Ministry of Agriculture Chibombo District office, there are an estimated 48,000 smallholder farmers and 120 commercial farmers in the district, spread into the 20 different agricultural camps in the district. The records also show that there are 3,500 active smallholder farmers in Kalola Agricultural Camp.

### 3.5 Economy of Chibombo

The predominant economic activity in Chibombo District is mixed agriculture. Livestock, poultry and crop farming is common Goat, pig and cattle are the major livestock reared. Chickens are the most common fowl reared while crops commonly grown are Soya Beans (*Glycine max L),* Maize *(Zea mays L.),* Sunflower (*Hehanthus annuus L.*), Cotton (*Gossypium gossypieae L.*), Sorgum (*Sorghum bicolor* L.), Groundnuts (*Arachis hypogaea*) and Cowpea (*Vignaun guiculata L).* These are usually intercropped with Pumpkins (*Cucurbita maxima*), Okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*). Other economic activities in the study area include trading imported household goods and transportation (mainly buses and ox-drawn wagons).

Chibombo District is located 80km north of Lusaka District along The Great North Road (Figure 3.1). Because population growth in Lusaka has resulted in the conversion of land that could be used for agriculture to residential and commercial use, Chibombo District is a suitable target for agricultural activities for Lusaka residents. This trend is a likely driver for the establishment and growth of agribusinesses around the district and financial services to cater to their needs (Kajoba, 2018).

There are four (4) chiefdoms in Chibombo District, namely Mungule, Liteta, Chamuka and Chitanda of the *Lenje* people. The study site is in Chief Chitanda's area and *Lenje* is the most commonly spoken language. However, other tribes such as the *Tonga* are also found in the district. The land tenure type in the rural parts of the district were the majority of smallholder farmers are based is predominately customary tenure.

However, recently, it has become common practice for residents of Lusaka District to buy land held under customary tenure in Chibombo District and convert it to leasehold tenure (Chitonge and Umar, 2018). The land is then used for purposes such as semi-commercial agriculture, construction, small scale quarrying and other commercial activities (Kajoba, 2018). Such land is usually fenced off from the locals, in which case access and some rights are lost.

Traditionally, *Lenje* people are matrilineal and like other matrilineal systems, land is passed on from uncle to nephew (Chitonge and Umar, 2018). Therefore, when a couple gets married, they traditionally reside in the matriarchal village (Lovo, 2015). The couple could also choose to establish themselves in a neutral village and buy land allocated to them by village headpersons, and approved by the resident chief. Ownership of such land is assigned to the husband and can be also continue to be inherited according to the matrilineal system (Chitonge and Umar, 2018). Nowadays in Chibombo District, the locals seeking to be allocated new land are given smaller parcels compared to the past years. Renting land for farming from those who have bigger parcels is common.

# CHAPTER 4

# METHODOLOGY

## 4.1 Overview

This methodology chapter discusses the research design that guided this research. It also shows how participants of this research were conducted and how data was collected and analysed.

## 4.2 Research Design

A research design is the arrangement of conditions under which relevant data will be collected and analysed for the research purpose (Kombo and Tromp, 2006). This research used both quantitative and qualitative research strategies in a complimentary manner. A cross-sectional approach to data collection was used, meaning data was collected from randomly sampled smallholder farmers at a single point in time. Quantitative designs were used for the numerical manipulation of observations to explain the phenomena under study (Saunders et al.; 2012). Qualitative designs focused on text and meanings individuals attach to reality and provided an in-depth understanding of reasons for observed phenomena (Spencer et al. 2003). Diversity is inherent in the definition of qualitative research as it encompasses many approaches. Ritchie and Lewis (2003) simplified the definition of qualitative research as methods of research used to address research questions that require explanation or understanding of social phenomena and their context.

## 4.3 Sampling

Sampling is the process of selecting participants for a study (Saunders et. al., 2012). The sampling process is very important as the validity of the entire study can be anchored on how the sampling was done. According to Blumberg et al. (2011), a sampling frame is a complete and correct list of population members from which the sample is to be drawn.

A sample size of 158 Smallholder farmers that were sampled for this study were drawn from Kalola Agricultural Camp in Chibombo District. The Agricultural Camp Officer of this camp kept a well-organised and updated record of all smallholder farming households in the camp. This enabled the researchers to randomly sample the participants of the survey from the camp register. This sample size was arrived at using a two-sample z-proportional test power analysis, with a medium effect size of 0.25 and an alpha level of 0.05.G Power 3.1.9.2 (Faul et al., 2009) was used to determine the sample size.

Purposive sampling was used to select participants for the Focus Group Discussions (FGDs). Purposive sampling is widely used in qualitative research. According to Palinkas and Soydan (2012), it helps a researcher identify and select participants that are especially knowledgeable about or experienced with a phenomenon of interest (Palinkas and Soydan; 2012). A total of 28 discussants participated in the FGDs. These were selected from those that had participated in the semi-structured interviews and had demonstrated a lot of knowledge and experience on the SLM practices of interest to the researcher. The discussants were divided into three focus groups. One FDG consisted of eight elderly persons from 50 years and above. The second FDG had men aged between 18 and 40 years. The third FGD had 15 women discussants aged between 17 and 45 years. Using gender categorization, coupled with the group dynamics that come into play during group discussions, the researcher’s aim was to enable the groups to talk freely about their SLM adoption patterns. From the group that had comprised of the elderly, the researcher aimed at gaining insights into the discounting behaviour of farmers in past decades compared to those in the recent years.

Two officers from the Ministry of Agriculture at the Chibombo District Agriculture Office and three researchers from the Indaba Agriculture Policy Research Institute (IAPRI) were interviewed as key informants for this research. IAPRI is a Zambian limited company whose mandate is to conducts high-quality research in agriculture, food and natural resource. This research is utilised by the private and public sectors to guide policy implementation and investments in the agriculture sector in Zambia (www.iapri.org.zm).

## 4.4 Data Collection Methods

### *4.4.1 Semi-structured Interviews*

Semi-structured interviews were used to collect quantitative data for this research. Fowler (2002) said semi-structured interviews are questionnaires that include open-ended questions which enabled the researcher to probe the respondents and explore the research study further. In this research, questions on the reasons farmers use the farming practices that they use required exploration, hence the need for open-ended ended questions in the interview guide. The researcher and two trained research assistants administrated the interview guides to the 158 randomly sampled smallholder farming households in Kalola Agricultural Camp. The questions were read to the respondents in *Lenje*, the language most commonly used in the study area and in which both the research and the assistants are proficient. The respondents were asked what crop farming practices they used and why they used them. Questions to elicit farmer time preference and risk aversion were also included in the interview guides. This approach to investigating environmental discounting was adopted from Duquette et al. (2011). Duquette et al. (2011) had directly elicited farmer time preference with regard to monetary payments to determine the discounting behaviour of farmers in the United States by asking them to make a single choice of now payments of $400 or later payments that varied in interest with the time each farmer waited. The current study employed a similar single choice method to directly elicit farmer time preference. During the interviews, smallholder farmers were asked if they would stop using mineral fertiliser, herbicides and pesticides if these agricultural inputs would result in their soils becoming infertile after 5 years, 10 years, 20 years, 50 years and in the next generation. Farmers were also asked if they would plant fertiliser trees if they would reap benefits of soil fertility after 5, 10, 20, 50 years; and if they would plant fertiliser trees if soil fertility benefits would only accrue to the next generation.

### *4.4.2 Focus Group Discussions*

Three (3) Focus Group Discussions (FGDs) were conducted with selected smallholder farmers from Kalola Agricultural Camp. Bryman (2016) highlighted that FDGs provide participants with an unstructured group setting where they are free to express their views and perspectives, and they provide "the researcher the opportunity to study the ways in which individuals collectively make sense of a phenomenon and construct meanings around it" (Bryman 2016: 395). The FGDs were conducted in *Lenje* by the researcher and the two trained research assistants. The discussion focused on reasons for low adoption of SLM practices. The proceedings of the FDGs were recorded after informed consent was obtained.

### 4.4.3 *Key Informant Interviews*

Key informants in this research were officers from the Ministry of Agriculture Chibombo District office and researchers from IAPRI. Interviews with the Ministry of Agriculture were conducted first before engagement with other research participants. This enabled the researcher to verify low adoption of SLM practices among smallholder farmers in the region as depicted in literature. The interviews aided the selection and mapping of the study area as well as sampling and locating of participant farming households. The interviews also gave a general picture of the challenges and behaviours that influence farmer adoption of SLM practices. During data analysis, relevant information obtained from all the key informants was cross-tabulated with what farmers said about their adoption of SLM practices.

### 4.4.4 *Field Observations*

Observations by the researcher and research assistants were conducted on fields belonging to smallholder farmers that participated in the research. During the field observations, the researchers looked out for the following practices: agroforestry; crop residue retention, mixed cropping, mulching, and fallowing.

## 4.5 Data Analysis

Data analysis is a process by which data collected is transformed for purposes of making relevant conclusions to the subject under study. According to Shamoo and Resnik (2003) data analysis provides a means to draw inductive inferences from data and segregate the phenomenon of interest from that which is not needed in the data. Quantitative data analysis is mostly centred on statistical procedures and tests aimed at confirming or refuting stated hypotheses. Qualitative data analysis on the other hand is focused on deciphering meaning from experiences narrated by the interviewees.

### 4.5.1 *Quantitative Data Analysis*

Data collected using interview guides was analysed using the two sample Z-proportional test at $p \leq 0.05$ with the aid of the statistical software MINITAB 14 (Minitab Inc., 2004). This test was used to show the differences in farmer time preference and risk aversion in relation to the adoption of SLM practices and the time it takes for the practices to manifest benefits. Practices of mineral fertiliser use, herbicides and pesticides use were portrayed to have soil degradation effects after being used for extended periods of time. For example, mineral fertiliser is known to cause soil acidification after many years of use (Zingore et al., 2015). The time taken for these substances would manifest soil degradation impacts was varied to deduce farmer time preference and risk aversion. Similarly, planting of fertiliser trees and the time it took for the trees to yield soil fertility benefits was used to investigate those discounting aspects. Different times that keep increasing (i.e. from 5 years, 10 years, 20 years, 50 years to the next generation) were presented to the farmers as the time it took for soil fertility to manifest from planting fertiliser trees. The Z-proportional test was then used to establish if there was a difference in the proportions of farmers who would stop using soil degrading inputs today if soil degradation would occur at the different times; and those who would plant fertiliser trees today if the benefits accrued at different times into the future.

### *4.5.2 Qualitative Data Analysis*

Qualitative data collected for this research was from the FGDs and key informant interviews, as well as the open-ended parts of the interview guide. The recordings of the FGDs were transcribed from the *Lenje* to English by the researcher. The transcripts were then analysed using content analysis. This entailed coming up with themes based on the common views, and then determining how frequent those views were expressed. Some representative responses from the FGDs that provided relevant insight into the topic of discussion were extracted as direct quotes from the recordings. However, the identity of the discussants was concealed. Information gathered from the focus groups were used to triangulate the data provided in the semi-structured interviews. Field observations enabled the researcher to corroborate claims from the semi-structured interviews on practices implemented.

### *4.5.3 Validity and Reliability*

Validity is the degree of adequacy with which a test measures phenomenon under study (Langdridge, 2004) and according to Bryman (2008), validity of claims should be judged based on the adequacy of evidence available. On the other hand, reliability of data is based on whether the correct methods and procedures were used to obtain a particular result. To ensure validity of data in this research, data obtained from semi-structured interviews was triangulated with field observations, key informant interviews as well as data obtained from FGDs. For reliability, appropriate sampling, data collection and analysis methods were employed for qualitative and quantitative approaches used in this study.

# CHAPTER 5

## RESULTS AND DISCUSSION

### 5.1 Overview

This chapter presents and discusses the findings of this study. It begins by describing the demographic characteristics of the sample, and then presents the research findings and discusses them in line with the themes derived from the research objectives. Data is presented in the form of text, graphs and tables.

### 5.2 Demographic Characteristics of the Sample

The number of smallholder farmers sampled to participate in this research was 158. There were 72 males and 86 females. Their ages were categorized as shown in Figure 5.1. The majority of the respondents were between the ages of 29 and 50 years. There was only one respondent above the age of 72.

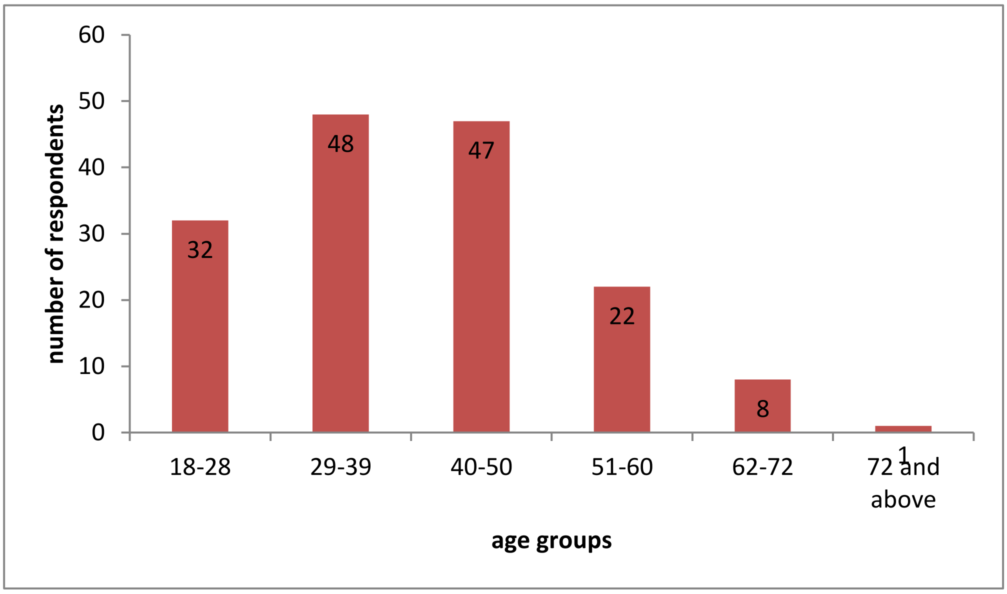


**Figure 5.1: Age groups of the respondents (Source: field data, 2017)**

A good number of respondents had primary and secondary education as can be noted from Figure 5.2.

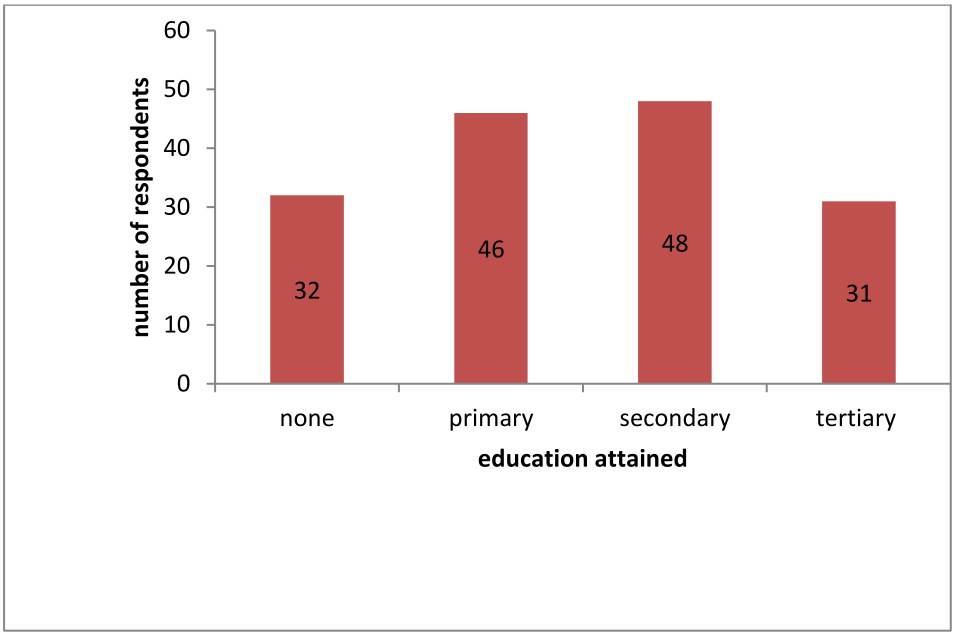


**Figure 5.2: Level of education attained by the respondents (Source: Field data, 2017)**

Regarding marital status, 75 respondents were married and 65 were widowed. Few were single (14), separated from their spouses (2) and divorced (2). Of the 158 respondents, 106 did not engage in any other occupation apart from farming. Some 6 respondents were in formal employment, others were traders of various good and services (36), and 6 were craftsmen.

A total of 90 farmers cultivated on portions of land ranging from 1 to 5 hectares in size. These were the majority, followed by 44 farmers who cultivated portion of land ranging from 6 to 10 hectares. Other farmers cultivated on portions ranging from 11 to 15 hectares (4 farmers) and 16 to 20 hectares (6 farmers). There were 14 farmers who cultivated on portions of land larger than 21 hectares. It was observed from this data that a number of farmers cultivated parcels of land that were less than 10hectares in size. This can be attributed to general population increase experienced in many parts of the world as reported by other researchers that has reduced portions of cultivated land and altered some farming practices (Ajayi et al., 2006; Styger and Fernandes, 2006). It was also observed from the demographic data that less than 8 households had a household size of more than 16 members. This could also contribute to the inability by farmers to cultivate large pieces of land. Ownership of farm land among the sampled respondents is depicted in Figure 5.3. The majority of farmers interviewed owned the land they cultivated under customary law. Few farmers had obtained titled for their farm lands, while some farmed on rented land.

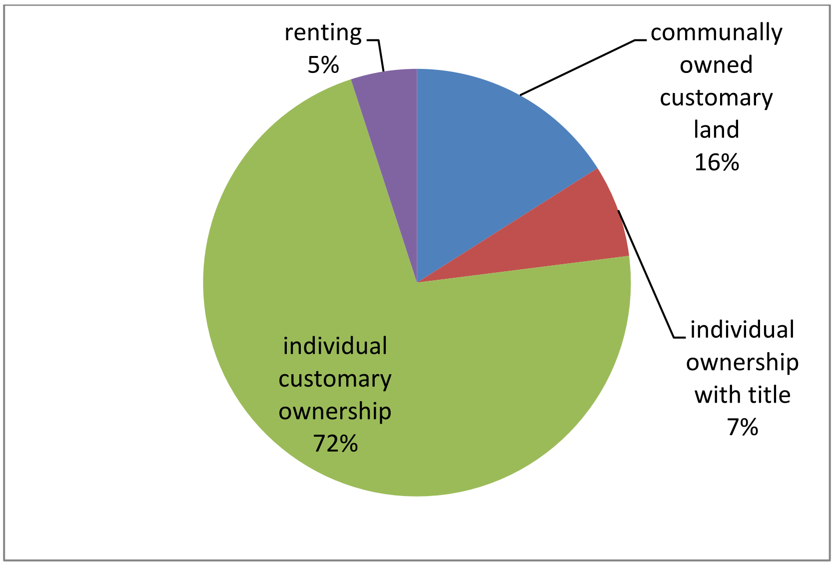


**Figure 5.3: Land ownership status (Source: Field data, 2017)**

## 5.3 Farming Practices and Technologies

The practices and technologies used by smallholder farmers were grouped into SLM practices and conventional farming practices. In the context of this research, SLM practices are those that enhance soil fertility using natural remedies and do not involve the use of chemicals that may be beneficial in the short-term but have some form of negative effect to the environment or living things in the long-term.

The SLM practices that were considered in this study were from two main categories, namely; agroforestry and soil conservation. There were several practices listed under soil conservation as can be observed in Figure 5.3. Respondents were allowed to give a response on each of the practices; therefore each of the practices is number out of 100 percent.

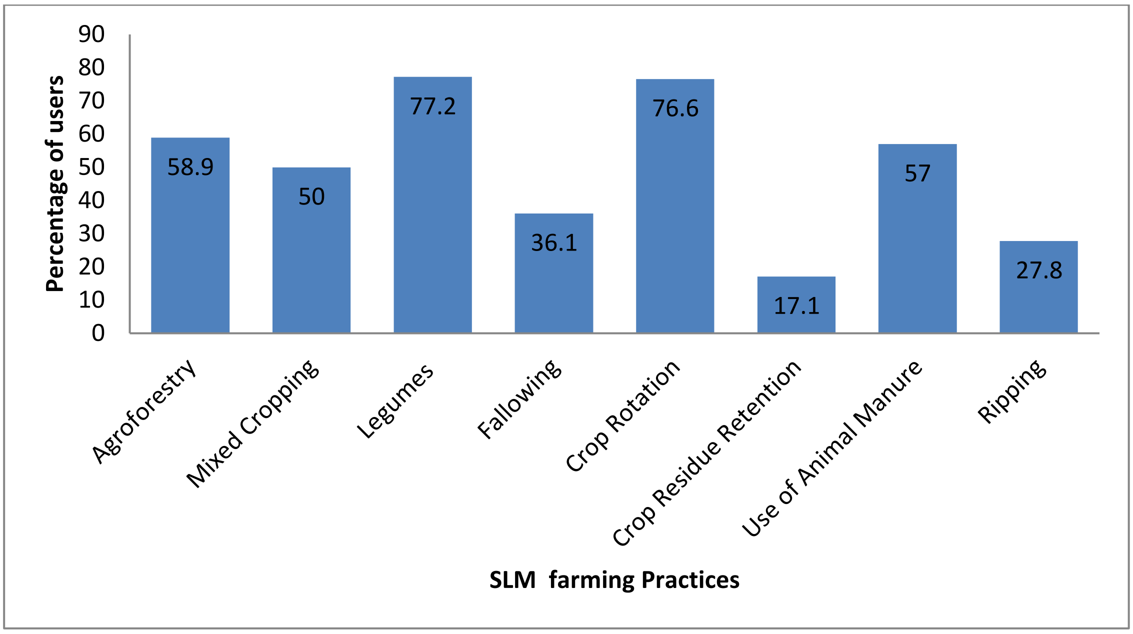


**Figure 5.4: Common sustainable farming practices in Chibombo District (Source: field data, 2017)**

It can be noticed from Figure 5.4 that crop rotation and the production of legumes are practiced by more than 70 percent of the farmers. Legume production and crop rotation deliver results that can benefit the farmer in the short-term. Legumes (e.g. beans, groundnuts and cowpea) are known to fix nitrogen in the soil (Ajayi et. al., 2003) while crop rotation is said to reduce pests, ultimately reducing the amount of pesticides (Slater, 2008). These practices reduce the amount of mineral fertiliser and pesticides required. These benefits were also revealed in the FGDs. The group of elderly discussants also added that they had rotated legumes with cereal for many years to fix nitrogen and reduce pest infestation. Agroforestry, the use of animal manure and mixed cropping were practiced by more than 50 percent but less than 60 percent of the farmers. Agroforestry and animal manure improves soil fertility (Umar, 2011). However, it is likely that legume production and crop rotation were practiced more than agroforestry and animal manure because agroforestry is labour intensive and the trees are not easy to grow (Mafongoya et al, 2006), and animal manure increases weeds (Materechera and Modiakgotta, 2006). Mulching (practiced by 26.6 percent) is not popular among farmers in Kalola Agricultural Camp. Fallowing is not widely practiced probably due to population increase that has resulted in smaller parcels of land per farmer, a common phenomenon according to Styger and Fernandes (2006). Ripping is practiced by less than 30 percent of the participants. It is also said to increase weed pressure (Umar, 2012). Crop residues are retained by less than 20 percent of the farmers. This is likely because farmers use them for fodder and fuel (Umar, 2011).

Conventional farming practices are characterized by intense cultivation of monocropping hybrid seed and their concomitant requirements for the use of herbicides, mineral fertiliser and pesticides (Jacques and Jacques, 2012). According to Jacques and Jacques (2012), these practices became popular during the green revolution and have in recent years been discover to be detrimental to the environment and to humans. Therefore, in the context of this study, inputs such as hybrid seed have been classified as unsustainable because yield results in the short term and are easy to use but can have negative effects on the environment and on living things in the future.

Some of the most common conventional farming practices implemented by smallholder farmers in Chibombo are the use of pesticides, herbicides, mineral fertilisers, hybrid seeds and tillage practices such as ploughing (Figure 5.5).

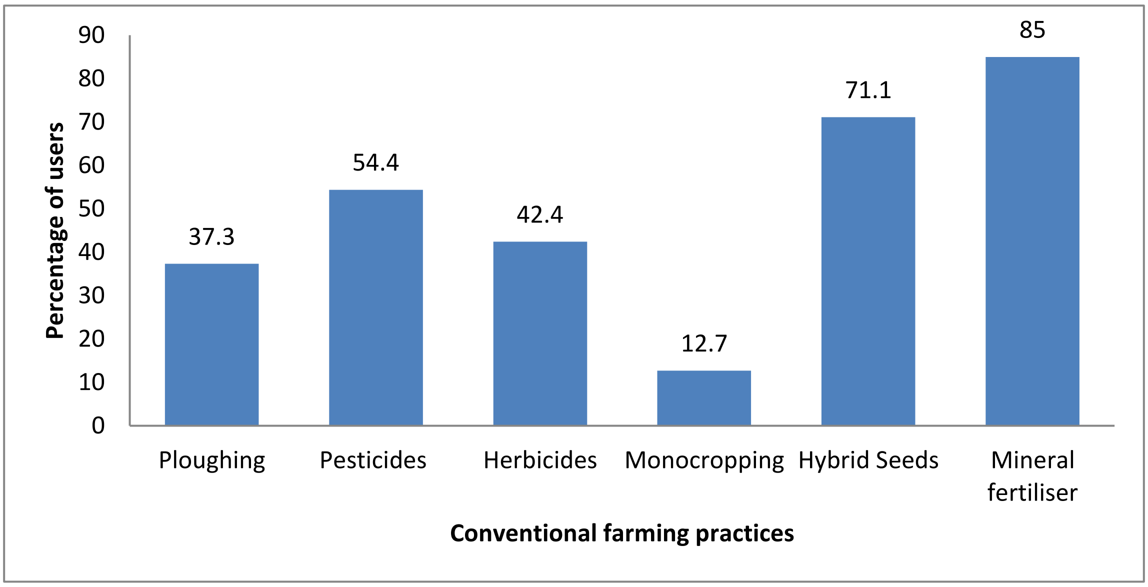


**Figure 5.5: Conventional farming practices common in Chibombo District (Source: field data, 2017)**

Compared to the ripper (27 percent, n=158), the plough was used more (37.3 percent, n=158); while farmers that did not use the plough or the ripper dug by hand with hoes (35.7 percent). Farmers revealed that the ripper was labour intense because it does not over turn the soil to disrupt the growth of weeds. Therefore, the ripper increases weed pressure for some smallholder farmers who weed manually because they do not have money to purchase herbicides. It was also noted during the interviews that some farmers used both the plough and the ripper. When further inquiry was made into this observation, farmers revealed that the plough was good for overturning the soil which resulted in slow weed growth, while the ripper makes straight deep lines for planting crops. Farmers who could afford to do so, wanted to experience the benefits of both.

### *5.3.1 Mixed cropping*

Smallholder farmers that participated in this research gave several reasons for practicing and not practicing mixed cropping as shown in Table 5.1.

*Table 5.1: Reasons given by respondents for practicing and not practicing mixed cropping (n=158)*

| **Reasons for mixed cropping** | **Percentages (n=79)** | **Reasons for not mixed cropping** | **Percentages (n=76)** |
|---|---|---|---|
| For food variety | 56.9 | Crops do not grow well because of cross pollination | 48.7 |
| To maximise land | 56.9 | Difficult to maintain | 5.3 |
| Maintains/restores soil fertility | 39.2 | Labour intense | 5.3 |
| To prevent insects | 5.1 | No reason | 40.8 |
| As contingency in case one crop fails | 2.5 | | |
| Moisture retention | 2.5 | | |

**Note: total percentage is above 100 because respondents were allowed to give more than one answer**

A discussion on mixed cropping during the FGDs revealed further insights into why farmers practice or do not practice mixed cropping. What was mainly highlighted, especially by the women and the elderly, was that mixed cropping of pumpkins and maize is done out of habit, in addition to food variety, land maximization and contingency. It was also noticed that the older generation seemed to have the perception that mixed cropping prevents insects from attacking crops and suppress weeds. Hence reducing or eliminating the need for pesticides and herbicides. Some male discussants argued that competition between mixed plants hinders optimal plant growth. From the differences in reasoning among the groups, it was deduced that women and the elderly are more concern with food variety and men would rather concentrate on one crop. This is likely so because women are said to be the key to food security in the household (Quisumbing et al., 1995).

Mixed cropping was categorized as a sustainable agricultural practice because it is a form of companion planting in which crops are planted in the same field at the same time. A study by Paulsen et al. (2006) showed that mixed cropping can be beneficial for reducing weeds and pests. The prolonged use of mineral fertiliser has been reported to cause soil acidity (Haggblade and Tembo, 2003) while residues of pesticides have been reported to activate pre-cancer cell in humans and animals when ingested (Blaylock, 2018). Mixed cropping has long been practiced in traditional agriculture in Zambia likely for the same reasons mentioned, i.e. to reduce pests, maximise land use and suppress weeds.

### *5.3.2 Legume production*

The smallholder farmers who participated in this research had several reasons for planting and not planting legumes. These reasons are presented in Table 5.2.

*Table 5.1: Reasons given by respondents for producing legumes and for not producing legumes (n=158)*

| **Reasons for producing legumes** | **Percentages (n=122)** | **Reasons for not producing legumes** | **Percentages (n=36)** |
|---|---|---|---|
| Food | 57.4 | No space | 31.6 |
| Income | 18.9 | No seed | 21.1 |
| Good for soil nutrients/nitrogen fixation | 16.4 | No market | 15.8 |
| No reason | 6.6 | Farming on rented land | 5.3 |
| | | No reason | 26.3 |

**Note: total percentage is above 100 percent because respondents were allowed to give more than one answer.**

Of the farmers who produced legumes, 57.4 percent did so for food, 18. 9 percent grew them for income and some 16.4 percent grew them to fix nitrogen in the soil. During the FGDs, a few participants reported not growing any legumes for reasons such as lack of space, preferring to use the little space they had to grow maize. Lack of market was also one of the reasons. Farmers who did not grow beans claimed that markets for legumes were not as readily available as that for maize. One of them narrated:

> For maize, we get seeds from cooperative and when it grows, we sell some of it to Food Reserve Agency (FRA) and to others who come looking to buy maize. Growing maize also means we will have food to eat and money to send our children to schools. The same cannot be said for beans and we can always buy beans to eat.

Most discussants agreed with this point. An inquiry into whether or some farmers plant any beans to fix nitrogen in the soil revealed that farmers with bigger pieces of land (more than 3ha) rotated maize with beans.

Leguminous food crops include velvet beans, groundnuts, soya beans, green beans and cowpeas. These are traditionally intercropped or rotated with a cereal such as maize because they are known to biologically fix nitrogen into the soils (Umar, 2012). It is for this reason that the planting of legumes is encouraged in sustainable agriculture because by fixing nitrogen in the soil, they reduce the amount of mineral fertiliser needed (Mubanga et al., 2015). Apart from fixing nitrogen, legumes also reduce the likelihood of soil acidity as it requires less mineral fertiliser to grow. The GRZ (2014) reported that beans requires 1 bag per hectare of top dressing mineral fertiliser to grow where maize requires 4 bags per hectare of basal fertiliser and 4 bags per hectare of top dressing per hectare; and that beans would not require any fertiliser subsequently. Despite the fact that they have the potential to improve soil fertility, legumes are not cultivated as much as maize. For example, Umar (2012) reported that that in Zambia, maize production was 3026.9kg per household compared to 543.3kg for groundnuts over a period of two complete farming seasons (2008/9 and 2009/10). Market for legumes was reported as a major determining factor for legume production, second to household food security (Mubanga, 2015).

### *5.3.3 Agroforestry practices*

The practice of agroforestry was well known among smallholder farmers in Kalola Agricultural Camp. However, there are a number of factors that influence lack of adoption of agroforestry among smallholder farmers in the camp. The can be seen in Table 5.3

*Table 5.3: Reasons for practicing and not practicing agroforestry given by respondents (n=158)*

| **Reasons for practicing agroforestry** | **Percentages (n=92)** | **Reasons for not practicing agroforestry** | **Percentages (n-55)** |
|---|---|---|---|
| To improve soil fertility/save on fertilizer | 64.1 | Lack of seedlings | 63.6 |
| Soil moisture retention | 2.2 | Benefits take too long to manifest | 5.5 |
| Windbreaks | 25.0 | Does not know about agroforestry | 7.3 |
| No reason | 8.7 | Farming on rented land | 1.8 |
| | | Trees are too thorny | 10.9 |
| | | Trees were eaten by termites | 10.9 |
| | | Trees prevent sunlight from reaching plants | 3.6 |
| | | No reason | 5.5 |

**Note: total percentage is above 100 percent because respondents were allowed to give more than one answer**

From the farmers that practiced agroforestry, 64.1 percent did so to retain nutrients to the soil. However, field observations revealed that very few participant farmers had actually planted any fertiliser trees. It seemed the farmers answered that they planted fertiliser trees to return soil nutrients because that is what they would do if they had tree seedlings. This can be said because 63.6 percent of farmers who did not practice agroforestry responded that they did not plant fertiliser trees because they had no seedling. When asked why they did not purchase the seedlings, some farmers said they could not use their financial resources to purchase seeds. They further stated that promoters of agroforestry give free tree seedlings, therefore they will just wait for them to come around and distribute them. This response was in line with what the Camp Officer had said about low adoption of agroforestry among smallholder farmers in his camp. He said the farmers were accustomed to being given free inputs. Some studies that have reported on low adoption of SLM have also highlighted that smallholder farmers in Zambia are accustomed to handouts (Habanyati et. al.; 2018, Mubanga 2012). Other farmers (1.8 percent) responded that they did not plant fertiliser trees because they farmed on rented land, therefore they could not plant trees for other people to inherit.

Despite its benefits to smallholder farmers and the environment at large, agroforestry has struggled to penetrate mainstream agriculture in SSA. Researchers have given several reasons for low adoption of agroforestry among smallholder farmers in SSA. In southern Africa, some reasons given include lack of seeds and seedlings of the required tree species, labour constraints, and the long time taken for the trees to mature (Mafongoya et al., 2006). In Ghana, women held temporary land rights and did not typically have the right to plant trees (Adedipe *et al*., 1997). Promoters of agroforestry endeavour to provide options of plant species that are fast growing and suited to climatic conditions of an area (Kwesiga and Coe, 1994). Tree species commonly used in agroforestry in miombo woodlands of southern African are Sesbania sesban, *Tephrosia vogelii, Cajanus cajan, Gliricidia sepium and Faidherbia albida* (Kuntashula et al, 2007).

### *5.3.4 Monocropping and the use of hybrid seeds, pesticides and herbicides*

Of the 158 smallholder farmers that participated in this research, 73 percent practiced monocropping of maize using hybrid seed varieties so that they could harvest a lot of maize to sale; others (7 percent) because it was easier to manage a field under monocropping. There were some farmers (20 percent) who monocropped both hybrid and local maize varieties, stating that they wanted to preserve some of their local varieties.

Some farmers did not practice monocropping but used hybrid maize seeds. These planted other crops alongside hybrid maize for reasons such as food security (29 percent), contingency in case of drought (4.8 percent), and to prevent insects (12.9 percent). From the focus groups, most elderly persons expressed that they were not keen on using hybrid seeds because their 'high-maintenance' requirements were detrimental to the environment. They preferred local seed varieties because they were resistant to pests, diseases and drought. The men expressed that they were cognisant of the likelihood that some inputs like mineral fertiliser, herbicides, and pesticides are responsible for soil degradation, but one man stated: "Monocropping is easier because it was easier to focus on growing one crop only." Another man added: "It is easier to put fertiliser, weed killer and pesticides if the field only has one crop."And another one added: "A high yield is almost guaranteed with hybrids seed even when monocropped. There is no need to plant them with legumes, especially if one buys the correct seed for this region." The women also had different views. One woman said: "Practicing monocropping is not safe because it made families vulnerable to hunger if that one crop failed. It is better to have some groundnuts to add to children's porridge and to mix in vegetables." Other women in the group said they used hybrid seeds because they were offered at a subsidized price and that they supplemented the hybrid seeds with indigenous seed varieties. Other women added that they grew these two varieties on two separate portions as a contingency measure in case one of them fails, and as a way to preserve the indigenous seed. From the discussion, it appeared that women were more concern with food variety and contingency while men were more concern about mass production of a single crop. This is likely so because of their different gender roles in the household. Women ensure that there is food variety in the household while men are more concern with generating income to care for such needs as children's school fees.

Farmers who used herbicides (87.7 percent) said they used them to serve on labour. This response shows how farmers can easily adopt a practice that makes farming easier and assures desired results. Of the farmers who did not use herbicides, 53.2 percent could not afford them and 38.3 percent were of the view that herbicides destroy soils. In the discussions, the men and women eulogized herbicides for being easy and fast way to get rid of weeds. One man stated: “A farmer would not use weed killer only if he has no money.” It was also revealed in the discussions that those with large families that provided the labour for manual weeding had no need to buy herbicides.

Discussions on whether herbicides caused soil degradation had some elderly farmers acknowledge that herbicides make their work easier but strongly speak against their use. One elderly man narrated:

> In the past, the use of herbicides was not common. That is why we were able to grow crops without using any fertiliser because the soils were fertile. Nowadays, you cannot obtain a decent yield without using fertiliser because soils have been damage by the excessive use of chemicals such as these.

However, younger men and women could not confirm the harmful effects of herbicides on soils; thus they did not support the view point of the elderly farmers. This is likely because they have not lived long enough to observe plant biodiversity, loss due to the use of herbicides. It could also be that younger people enjoy the benefits of herbicides. For example, they can engage in other activities other than spend time on manual task like weeding. It could also be because young people have smaller families nowadays; hence they do not have enough manpower for manual weeding.

The majority of the farmers who used pesticides (88.5 percent) said they did so because they need to preserve their crop. Cotton farmers (2.1 percent) said herbicides were essential for cotton growing and they could not do away with them. Farmers who did not use pesticides said they were costly (44.4 percent), destroyed soil fertility (33.3 percent) and killed beneficial insects (3.7 percent). During the discussions, elderly farmers were of the view that pesticides cause soil degradation. One elderly man stated:

> I have no doubt that that the chemical substances we have used over the years in agriculture, including pesticides, are responsible for the reduced yields experienced today. In the past, yield were much higher than today. One could plant maize and would grow even without mineral fertiliser, which is not the case today because we have over-use chemical substances on our soils.

Most of the younger farmers expressed that whether pesticides degraded their soils or not, they have to use them if their crop was under attack by pests. Cotton and vegetable farmers emphatically said that they could not do without pesticides and that they might as well not be farming at all if they would lose their crop to pests. Essentially, they have to grown their crops even at the expense of potential long-term environmental degradation. This is evidently discounting in the form of time preference. These young farmers prefer to harvest their crop today, even if they may potentially not be able to have a good harvest, if any, in the future.

### *5.3.5 Fallowing*

Fallowing is a practice in agriculture in which land that was previously cultivated is left uncultivated for a period of time within which it can be treated for replenishment. Fallowing was common practice in the past when population density was low and there was an abundance of land. However, in recent years, fallowing is rarely practiced by farmers due to population increase (Styger and Fernandes, 2006). Table 5.4 highlights factors that influence the choice to fallow given by the smallholder farmers who participated in this research.

*Table 5.4: Reasons for fallowing and not fallowing given by the respondents (n=158)*

| **Reasons for fallowing** | **Percentages (n=57)** | **Reasons for not fallowing** | **Percentages (n=62)** |
|---|---|---|---|
| To rejuvenate the soil | 77.2 | No space | 70.9 |
| We have enough land | 1.7 | Opportunity cost | 8.1 |
| Improves water retention | 14.0 | Makes soils very hard | 1.6 |
| For animal grazing | 1.8 | Do not know benefits | 8.1 |
| Lack of inputs | 5.3 | Farming on rented land | 1.6 |
| | | No reason | 9.7 |

**Note: total percentage is above 100 because respondents were allowed to give more than one answer**

Of the farmers that participated in the survey, 37% practices fallowing. Of those that practiced fallowing, 77.2 reported doing so to replenish nutrients in the soils. From this result, it was evident that farmers are aware of the need to fallow. Yet, it can also be seen from the 8.1 percent who did not fallow due to the opportunity cost of fallowing that discounting influences farmer decisions to fallow. Karpagam (1999) described opportunity cost the sacrifice of something for another thing. Regarding the farmers who did not fallow, they opted to cultivate on the land and harvest crop to sale year after year as opposed to letting the land fallow to regenerate. Of the farmers that did not fallow (40%), a large majority of the respondents who did not fallow (70.9 percent) said they did not due to space limitations; a genuine challenge for many farmers in Kalola Agricultural Camp where some farmers are cultivating small parcels of rented land. Land in the area is becoming ever so prime as it is highly sought by buyers from Lusaka and southern Zambia who find the area desirable for farming. The elderly attested to how they benefited from fallowing in the past. Other discussants highlighted how the practice of fallowing had been fading over the years because of population increase. In a light moment, the elderly farmers agreed to this saying: “Crop fields are getting smaller and smaller over the years because many have been born and are growing up and having many more children. They all want a piece of land to farm. Hence the available land is reducing.” The elderly discussants narrated how they used to fallow the land for 5 years or more while they cultivated different parcels. They summised that this is no longer possible because some farmers do not have enough parcels of land for them to fallow. One young man stated: “It is immoral to let your land lie fallow when your brother has no land on which to farm. That is why those of us with big pieces of land rent them out to those with little or nothing.”

#### *5.3.6 Crop residue management*

The survey revealed that 34 percent of the participants did not practice mulching. Of these, 63.6 percent said they were not familiar with the practice of mulching, some (9.1 percent) said they did not mulch their fields because they gave most of the fodder to their livestock. Others (9.1 percent) said their gardens were too big to be mulched. Over half (52.4 percent) of the respondents mulched their fields for soil moisture retention, while some 47.6 percent said they mulched to reduce weed pressure. Across all the focus groups, farmers who practiced mulching said they did so to improve the amount of water retained in the soils after they watered their gardens or after rain, so that it is available to their crops for longer.

Of the farmers who retained crop residues (17.1 percent), 36.9 percent did so for nutrient retention. Others (50 percent) did it for soil moisture retention. Among those who did not retain crop residues, 30 percent said crop residues make ploughing difficult while 39.1 percent said they burn their fields to remove weeds and eliminate termites (17.4 percent). During the FGDs, some discussants from all the three groups said they did not believe retaining crop residues took back any nutrients to the field. One woman stated: “Crop residues do not rot and integrate into the soil. Instead they just dry up and stay at the top of the soil.” A man added that crop residues are a nuisance because they get stuck in the plough which makes ploughing very difficult. Men pointed this out probably because they are typically the ones in charge of ploughing fields in their households. Some elderly persons narrated how they had retained crop residues in the past. They said practice worked better because it was coupled with fallowing. The residues need to be left in the field for a while to allow for decomposition and integration into the soil. The elderly attributed reduced fallowing to in the study area to population increase. From the discussion, it can be deduced that the decision to retain crop residues by farmers is influenced by their perception of the benefits, and if the practice is convenient for them. In Zambia, most smallholder farmers grow rain-fed crops; therefore they may not see the need to retain crop residues for moisture retention. It is also likely that the intra-seasonal droughts experienced in some parts of Zambia will result in smallholder farmers retaining crop residues. In the discussions, some farmers said they willingly return crop residues because it can be done with ease. However, during the dry season when there is little food left for cattle to graze; cattle graze on the residue. Female farmers also mentioned that they use residues to fuel fires when cooking likely because cooking is their primary responsibility in the home. Competing uses for the residue also influence residue retention.

Mulching and crop residue retention are among the most commonly practiced forms of residue management systems in agriculture. It involved covering the ground around the plants ground with dead organic matter. The aim is to retain moisture to the soil and minimize the growth of weeds. Crop residue retention, on the other hand, involves the retention of crop residues on the field of origin for the purposes of retaining moisture and nutrients (Umar, 2011).

### *5.3.7 Animal manure*

Reasons given for using animal manure by the 56 percent of the participants who used it were that it provided soil fertility (51.1 percent) and that it was a more sustainable way of providing soil fertility (23.3 percent). Others said it was cheaper (4.4 percent) than mineral fertiliser. It was revealed in the women’s group that most farmers who used animal manure used it to supplement mineral fertiliser because animal manure alone could not meet the soil fertility needs of their fields. Of the participant farmers who did not use manure (25.3 percent), 85 percent claimed that it was not available because fewer farmers owned livestock in the villages and if they did, some used it for their own fields. Some 2.5 percent said manure encouraged the growth of weeds. This is very plausible since animals eat several things including seeds that are likely to end up in their dung. Other farmers (5 percent) preferred mineral fertiliser because it was easier to use. Preferences from mineral fertiliser stood out in the men's group were one man expressed himself saying:

> Mineral fertiliser is readily available and easier to transport compared to animal manure. Sometime if we are lucky, it is given to use at a subsidized price. When we use it, we are guaranteed that our crops will grow, especially maize. Animal manure is not as easy to apply and you need large quantities to attain high yields.

Most in the group agreed with their male counterpart. One of the men added that: "We cannot waste money on animal manure which is cumbersome to transport and may not yield results. We would rather buy fertiliser because we are certain it will produce results." Some men even said manure took longer to integrate in to the soil and produce plant-growth benefits, adding that mineral fertiliser produced results faster.

This discussion revealed traits of risk aversion among the men, an aspect of discounting. The farmers would rather buy mineral fertiliser because they are certain of the results, even though using mineral fertiliser over an extended period of time could potentially degrade their soils in future.

### *5.3.8 Ripping versus ploughing*

The ripper has been promoted among farmers in Zambia to achieve minimum tillage under conservation agriculture. Reasons for it use and non-use among farmers in Kalola Agricultural Camp are as shown in Table 5.5.

*Table 5.5: Reasons for ripping and not ripping given by respondents (n=158)*

| **Reasons for ripping** | **Percentages (n=44)** | **Reasons for not ripping** | **Percentage (n=76)** |
|---|---|---|---|
| The ripper is available | 9.1 | Not available | 80.3 |
| It makes good lines for planting maize over a large piece of land | 9.1 | It encourage weed growth | 6.6 |
| Breaks hard pans | 45.5 | Don't know how to use it | 3.9 |
| Minimal soil disturbance | 25.0 | Plant don't grow well, yield is low | 2.6 |
| Holds water | 11.4 | Labour intense and expensive | 3.9 |
| | | No reason | 2.6 |

**Note: total percentage is above 100 percent because respondents were allowed to give more than one answer**

Out of the 158 participants of this research, 48.1 percent did not use the ripper. The majority of those not using the ripper (80.3 percent) said it was not available to them. During the discussions, farmers revealed that ploughs are commonly owned but rippers are owned only by very few farmers, making it difficult for many to access the ripper. When ask why they had not purchase rippers, the discussants answered that they would rather purchase ploughs because they were accustomed to using ploughs. A younger woman discussant said the reason she did not use a ripper was because it does not overturn the soil to disrupt the growth of weeds like the plough does. It thus results in immense weed pressure. Several others in the group had also observed this and said it was also the reason they did not use the ripper. They said the plough was good for overturning soils while the ripper was good for making planting lines. Use and non-use of the plough among farmers was as shown in table 5.6.

*Table 5.6: Reasons for ploughing and not ploughing given by respondents (n=158)*

| **Reasons for using the plough** | **Percentages (n=84)** | **Reasons for not using the plough** | **Percentages (n=16)** |
|---|---|---|---|
| Plough is readily available | 73.8 | Not available | 37.5 |
| Enables easy planting | 17.9 | Forms hard pans | 62.5 |
| Out of habit | 2.4 | | |
| Inhibit the fast-growth of weeds | 5.9 | | |

**Note: total percentage is above 100 percent because respondents were allowed to give more than one answer**

More than half of the respondents used the plough (53.1 percent). The majority used it (73.8 percent) because it was readily available and made planting easier. When asked during the FGDs if they believed that the plough formed hard pans in the soil, most discussants said they believed this to be so. They then revealed that when hard pans form, they use the ripper to break them.

The plough has long been used in agriculture for land preparation. Ploughing involves the complete inversion of soils thus disturbing the growth of weeds and enabling the easy planting of seeds (Umar, 2011). In recent years, loss of soil organic matter from erosion in agriculture has become evident. Some research also revealed that when soils are disturbed from activities such as ploughing, essential elements that could benefit plants escape into the atmosphere (Fowler and Rockstrom, 2001). Therefore, there has been need for farmers to use tools that cause minimum disturbance to the soil. The ripper is one such tool. It achieved minimum soil disturbance by making lines in the soil only were seeds are to be planted, thus reducing the amount of surface area disturbed. Farmers in Zambia today still use the plough and struggle to use the ripper for various reasons, some of which are mentioned in Tables 5.5 and 5.6.

### *5.3.9 Crop rotation*

Respondents of this research had several reasons for rotating crops as shown in Table 5.7.

*Table 5.7: Reasons for practicing and not practicing crop rotation given by respondents (n=158)*

| **Reasons for crop rotating** | **Percentages (n=121)** | **Reasons for not crop rotating** | **Percentages (7)** |
|---|---|---|---|
| To replenish soil nutrients | 84.3 | Farming on rented land thus plant maize only for sale | 57.1 |
| It helps prevent pests and diseases | 3.3 | No reason | 42.9 |
| No reason | 12.4 | | |

**Note: total percentage is above 100 percent because respondents were allowed to give more than one answer**

The majority of the younger discussants said that they rotated crops to prevent their fields from losing fertility. In addition to this reason, the elderly discussants said it was also done to reduce pests. Most farmers practiced crop rotation. Those who did not practice it mainly farmed on rented land. From the responses, inference was made that the elderly may have experienced the benefits of reduced pests from crop rotation in the many years they have practiced agriculture. Those who farmed on rented land mainly grew maize. It was thus inferred that these farmers were more interested in growing high-value crops to get more out of the rent they paid for land. Because the majority of farmers rotated their crops to prevent soil fertility lose, it was conclude that they did this because of their short time preference. Farmers did not have to wait 5years or more to experience the nitrogen-fixing benefits of rotating this cereal crop fields with legumes.

Crop rotation, as defined by Slater (2008), is the alternation of annual crops on a specific field in a planned sequenced so that crops of the same family are not repeated. Crop rotation is considered a sustainable farming practice because it builds soil organic matters, replenishes nutrients and reduces pests and diseases (Slater, 2008) among other things. In SLM, cereals are usually rotated with legumes because cereals are known to take out nutrients from the soils while legumes are known to fix nitrogen. This reduces the amount of mineral fertiliser required to fix nitrogen into the soil, hence mitigating soil degradation. It is for this reason that crop rotation is categorized as an SLM practice in the context of this study.

## 5.4 Environmental Discounting by Smallholder Farmers

The respondents were asked if they would plant fertilizer trees for benefits that would be realised after 5 years, after 10 years, after 20 years, after 50 years, and if the benefits would only accrue to their next generation. For each of these hypothetical years, the respondents were asked to answer ‘yes’ or ‘no’. The respondents were also asked if they would use mineral fertiliser, herbicides and pesticides if these inputs would make their soils infertile after the same periods of time. The results are presented in the sub sections below.

### *5.4.1 Farmer Discounting of Environmental Impacts - Mineral Fertiliser use*

Farmers were presented with the hypothetical scenarios of times when soil degradation would occur. To elicit discounting aspects of time preference and risk aversion, they were asked if they would continue using mineral fertiliser if it resulted in soil degradation at a stipulated time. The results of the Z-proportional test conducted on their responses were as shown in Table 5.8.

*Table 5.8: Respondents discounting environmental impacts of mineral fertiliser*

| **Time of soil degradation occurrence** | **Proportion of respondents using mineral fertilizer** |
|---|---|
| 5 and 10 years | The proportion of respondents who discount environmental impact of mineral fertiliser use that manifests in 5 years (58/144 = 40.3 percent) is not different from the proportion of respondents who discount environmental impacts of mineral fertiliser that manifests in 10 years (62/134 = 46.3 percent). (Z= -1.01; P-value =0.314). |
| 10 and 20 years | There is a difference in the proportion of farmers who discounted environmental impact of mineral fertiliser that manifest in 10 years (62/134 = 46.3 percent) and in 20 years (45/148 = 30.4 percent). (Z= 2.74; P-value of 0.006). |
| 20 and 50 years | The proportion of respondents who discount environmental impacts of mineral fertiliser that manifests in 20 years (45/148=30.4 percent) is different from the proportion of respondents who discount the environmental impacts of mineral fertiliser that manifest in 50 years (71/133 = 53.4 percent). (Z= -3.91; P-value=0.0001). |
| 50 years and Next Generation | The proportion of respondents who discount environmental impact of mineral fertiliser that manifests in 50 (71/133 = 53.4 percent) is not different from the proportion of respondents who discount the same impact if it manifests in the next generation (77/143=53.8 percent). (Z= -0.08; P-value=0.939). |

The results in Table 5.8 show no difference between the proportion of farmers who would continue using mineral fertiliser if soil degradation occurred in 5 years or in 10 years. This was likely because farmers did not perceive the time difference to be too long to change their use of mineral fertiliser. There was also no difference in the proportion of farmers who continued using mineral fertiliser if soil degradation occurred in 50 years or in the next generation, likely for the same reason. On the other hand, there was a difference between the proportions of farmers who would continue using mineral fertiliser if soil degradation occurred in 10 years and in 20 years. There is also a difference between 20 years and 50 years. The percentage of respondents continuing to use mineral fertiliser if soil degradation occurred after 20 years reduced from the percentage of respondents if degradation occurred in 10 years. It is probable that more respondents changed their minds on continuing to use mineral fertiliser if soil degradation would occur in 20years. However, the difference noted between 20 years and 50 years was an increase in respondents continuing to use fertiliser, likely because 50 years was further off into the future compared to 20 years. In Figure 5.6, the percentage changes are shown.

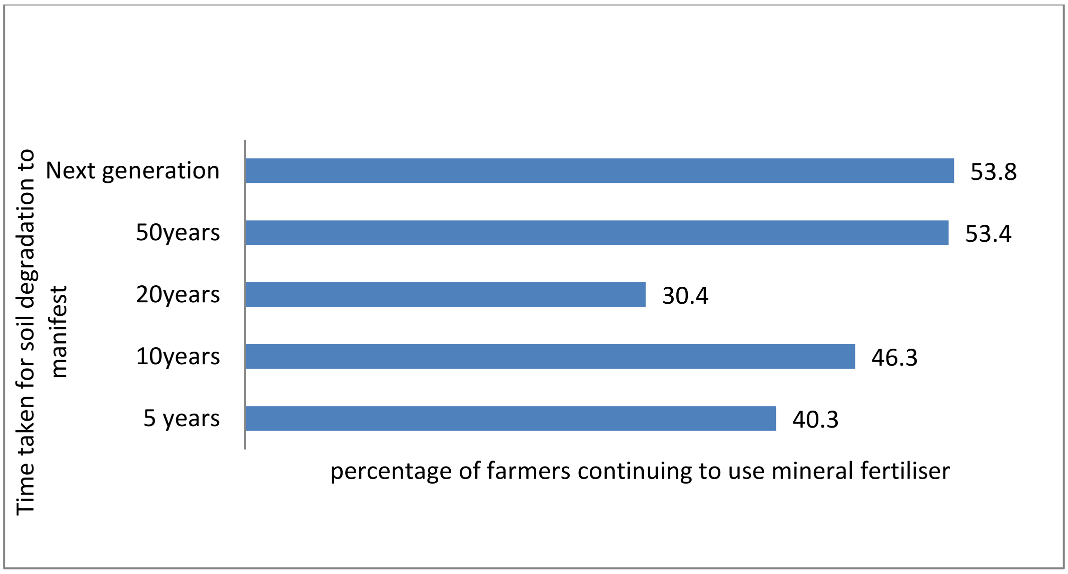


**Figure 5.6: Percentage of respondents using mineral fertiliser over time**

It appeared as though there was a general lack of pattern in the proportion of farmers continued use of mineral fertiliser at the different times of soil degradation. During the FGDs, the respondents revealed that soil degradation due to mineral fertiliser was not perceived to cause irreversible damage to soils. One man in the group expressed a common view: “We can apply lime or move to another piece of rented land if the ones we are currently farming on get damaged by fertiliser.” The attitude displayed in the discussion is similar to what Abdulai et al (2011) reported on about farmers in Ghana. The researchers found that the farmers were unwillingness to invest in land for which they did not have secure tenure. Some women discussants also mentioned that if they planted fertiliser trees, they could reverse the damage caused from the prolonged use of fertiliser. An elderly respondent mentioned that they had started using mineral fertiliser in the 1970s on the land in Chibombo District when they used to be given freely by the central government. Most of the elderly discussants agreed with their contemporary, acknowledging that the prolonged use of mineral fertiliser over many years has culminated into the reduced soil fertility that has been experienced in recent years. In their research on impacts of fertiliser on soil biota, Bune-mann and McNeill (2004) also wrote about how the prolonged use of mineral fertiliser results in soil acidity.

In spite of evident of soil degradation from the use of mineral fertiliser, adoption of SLM practices such as agroforestry, crop rotations and mixed cropping which employ biological means to improve soil fertility has remained low (Mafongaya et al.; 2006). One of the key informants also confirmed that despite being encouraged to employ sustainable soil fertility, smallholder farmers persisted in their almost exclusive use of mineral fertiliser and gave several reasons for not using organic fertilisers (e.g. animal manure and fertiliser trees). One reason smallholder farmers commonly gave was: "Animal manure was not as readily available as mineral fertiliser." The key informants mentioned a general lack of willingness on the part of smallholder farmers to plant fertiliser trees, especially when not give to them for free. From the FGDs, most young men reasoned that if the effects of soil degradation were to manifest after 20 years and beyond, there was no need to stop using mineral fertiliser now. When compared with fertiliser trees, the young men narrated that it was easier to find mineral fertiliser in local agro-shops and though the central government's input subsidy programme - the Farmer Input Support Programme (FISP) - and that mineral fertiliser delivers quicker plant growth than fertiliser trees.

### *5.4.2 Farmer Discounting of Environmental Impacts - Pesticide Use*

Similar hypothetical scenarios of time variations that were used for mineral fertiliser were also used to elicit time preference and risk aversion for soil degradation that would result from pesticide use. The results of the z-proportional test were as shown in Table 5.9.

*Table 5.9: Respondents discounting environmental impact of pesticide use*

| Time of soil degradation occurrence | Proportion of respondents using pesticides |
|---|---|
| 5 and 10 years | The proportion of respondents who discount environmental impact of pesticide use that manifests in 5 years (66/147 = 44.9 percent) is not different from the proportion of respondents who discount environmental impacts of pesticides that manifests in 10 years (67/140 = 47.9 percent). (Z = 0.50; P-value = 0.615). |
| 10 and 20 years | The proportion of respondents who discount environmental impact of pesticide use that manifests in 10 years (67/140 = 47.9 percent) is not different from the proportion of respondents who discount environmental impacts of pesticides that manifests in 20 years (61/127 = 48 percent). (Z =-0.03; P-value = 0.977). |
| 20 and 50 years | The proportion of respondents who discount environmental impact of pesticide use that manifests in 20 years (61/127 = 48 percent) is not different from the proportion of respondents who discount environmental impacts of pesticides that manifests in 50 years (65/132 = 49.2 percent). (Z=0.19; P-value = 0.845). |
| 50 years and Next Generation | The proportion of respondents who discount environmental impact of pesticide use that manifests in 20 years (65/132 = 49.2 percent) is not different from the proportion of respondents who discount environmental impacts of pesticides that manifests in 50 years (63/122 = 51.6 percent). (Z=0.38; P-value = 0.703). |

The results in table 5.9 all show that there is no differences in the proportion of farmers who would continue using pesticides with an increase in time taken for soil degradation to manifest. These results are also depicted in Figure 5.7. The graph shows the percentages of respondents who would continue using pesticides at the different years of soil degradation.

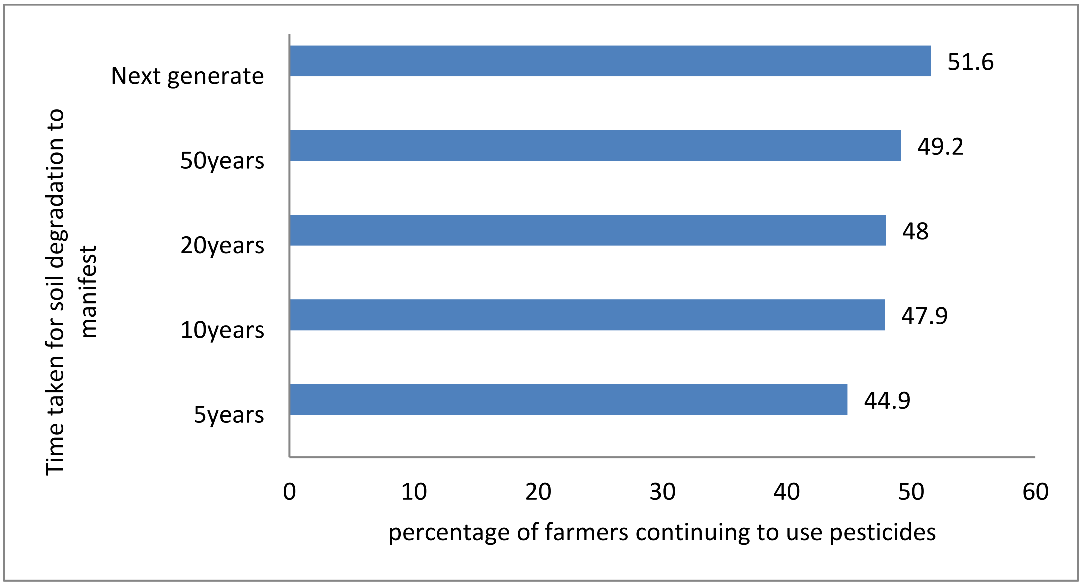


**Figure 5.7: Percentage of respondents using pesticides over the years**

The percentage of farmers who would continue using pesticides in soil degradation manifested in 5 years was lower than the number of farmers who would continue using pesticides if soil degradation manifested in 10 years, 20 years, 50 years or in the next generation. For soil degradation that manifested in the far future, farmers seemed to care less about the effect of pesticides. In the FGDs, a large majority of discussants who used pesticides said they did so because they wanted to protect their crops if they were under attack by pests. One man remarked: "I cannot do without pesticides because some of us grow cotton." Another man said: "Not using pesticides when there are pests is as bad as not having planted any crop at all." Of the respondents that reported not using pesticides, 44 percent said they could not afford to use them. When the researcher made an inquiry into whether the respondents were not concerned with the short-term after-effects of pesticides to their soils, they responded that they were concerned with both long-term and short-term after-effects, because they do not know how to mitigate or reverse the effects of pesticides to the soil like they would with the effects of mineral fertiliser. Overall, this suggests an element of risk aversion among the respondents. Because they would not know how to reverse the effects of pesticides on soil, about half of them asserted they would discontinue pesticide use. Other discussants from all the groups said they did not use pesticides unless they absolutely had to. Most women discussants said crop rotation and mixed cropping keeps pests at bay in vegetable farming. This suggested that women to a degree more conscious and patient with in their farming practices while men prefer to eliminate current risks faster.

### 5.2.3 Farmer Discounting of Environmental Impacts – Herbicide Use

Similar to pesticides and mineral fertiliser, farmers were ask if they would continue using herbicides given specified times at which soil degradation would occur from their use. The results of Z-proportional tests conducted on their responses were as presented in Table 5.10.

*Table 5.10: Respondents discounting environmental impacts of herbicide use*

| Time of soil degradation occurrence | Proportion of respondents using Herbicide |
|---|---|
| **5 and 10 years** | The proportion of respondents who discount environmental impact of herbicide use that manifests in 5 years (39/145=26.9 percent) is a different from the proportion of respondents who discount environmental impacts of herbicides that manifests in 10 years (47/136 = 34.6 percent). (Z = -1.39; P-Value = 0.164). |
| **10 and 20 years** | The proportion of respondents who discount future environmental impact of herbicide use that manifests in 10 years (47/136 = 34.6percent) is a different from the proportion of respondents who discount environmental impacts of herbicides that manifests in 20 years (50/132 = 37.9 percent). (Z-Value=0.57; P-Value= 0.572). |
| **20 and 50years** | The proportion of respondents who discount environmental impact of herbicide use that manifests in 20 years (50/132=37.9 percent) is a different from the proportion of respondents who discount environmental impacts of herbicides that manifests in 50 years (55/138 = 39.9 percent). (Z-Value=-0.33; P-value= 0.739). |
| **50 and Next Generation** | The proportion of respondents who discount environmental impact of herbicide use that manifests in 50 years (55/138 = 39.9 percent) is a different from the proportion of respondents who discount environmental impacts of herbicides that manifests in the next generation (50/124 = 40.3 percent). (Z-Value= -0.08; P-Value=0.939). |

From the P-values in Table 5.10, it was deduced that there were no significant difference in the proportion of farmers who would stop using herbicides in the different years of soil degradation. This means the proportion of farmers who would continue using herbicides was not different regardless of when soil degradation would manifest. A consideration of Figure 5.8 shows slight increases in the percentage of farmers who would continue using herbicides with an increase in time. By comparison, fewer farmers would continue using herbicides if soil degradation manifested in 5 years and more farmers would continue using herbicides if degradation manifested in 10 years up to the next generation. This difference shown in percentages is not reflected in the p-values generated from the z-test because the differences are not significant.

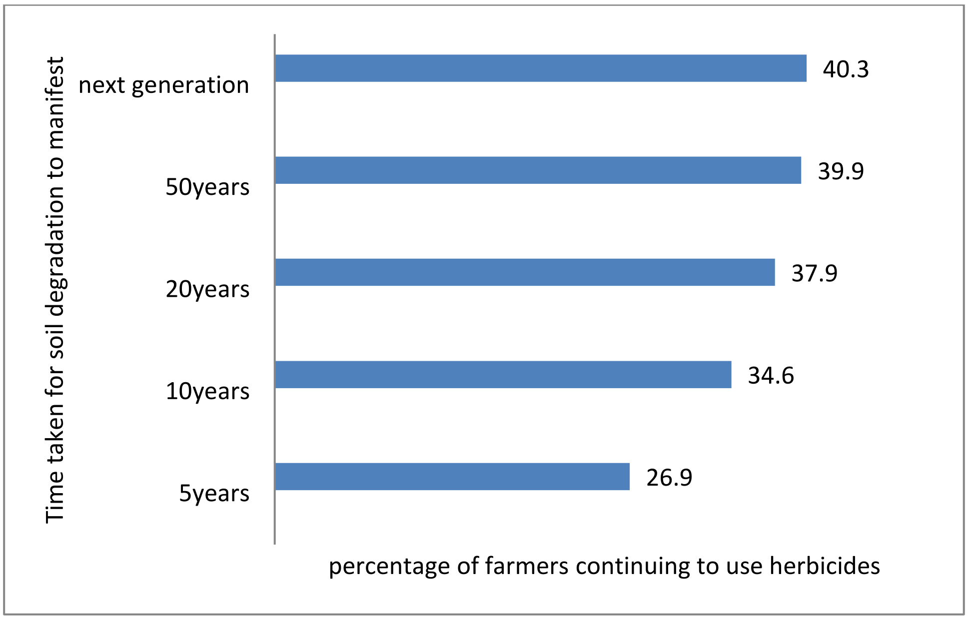


Figure 5.8: Percentage of respondents using herbicides over the years

Opinions of farmers on how they discount environmental impacts were further brought out in the FGDs. A large majority of the respondents that used herbicides used them because weeding manually was labour intensive. One woman from the women's FGD commented: "It is impossible to weed manually for those of us with big pieces of land (10ha and above). Of those who did not use herbicides (n=27), 53 percent said they did not have the financial resources to buy herbicides and thus did the weeding manually. Others (38.3 percent) said they did not use herbicides because they believed that herbicides caused soil degradation.

In the FGDs, discussants in the men's group who appeared to be knowledgeable about SLM - particularly CA - claimed that it was difficult to practice CA without the use of herbicides. This was in line with what Hossain (2015) wrote in his review of recent perspectives of herbicides; that the demand for herbicide use in agriculture worldwide was increasing. One of the reasons he stated for this demand was the spread of sustainable agriculture were the use of herbicides is preferred to maintain minimum soil disturbance as opposed to hand weeding which encourages soil erosion and nutrient run-off (Hossain, 2015). Another man from the men's FGD who allocated a parcel of his land to CA narrated:

> I used the ripper only on a portion of land. It had the most weeds compared to the rest of my farm where I used the plough. The agriculture people [CA promoters] themselves said I could use herbicides. Therefore I do not think they have any soil degradation effects.

Some discussants from the men's FGDs were also convinced that the use of herbicides did not result in soil degradation, while others thought otherwise. The key informants acknowledged the widespread use of herbicides that accompanies the adoption of CA practices and confirmed the higher use of herbicides among CA adoptors. However, the key informants pointed out that herbicide use was especially common among smallholder farmers with financial resources to purchase them. Women farmers also complained of the weed pressure that was characteristic of most CA practices, but they also felt that the prolonged use of chemical inputs such as herbicides contributed to loss of soil fertility in the long term. Most of the discussants from the elderly FGD felt as did the women discussants.

### *5.4.4 Farmer Discounting of Environmental Impacts – Willingness to Plant Fertiliser Trees*

Farmer willingness to plant fertiliser trees was also assessed using the same technique and the results are shown in Table 11. Farmers were asked to choose if they would plant fertiliser trees today for soil fertility benefits that they would reap in 5 years; in 10years; in 20 years; in 50 years; and in the next generation.

*Table 5.11: Respondents discounting environmental impacts of planting fertiliser trees*

| **Time of soil degradation occurrence** | **The proportion of respondents planting fertiliser trees** |
|---|---|
| **5 and 10 years** | There was no difference in the proportion of respondents who discounted environmental impacts of planting fertiliser trees that manifested in 5 years (102/149=68.5 percent) and the proportion of farmers that discounting environmental impact of planting fertiliser trees that manifested in 10 years (79/137=57.7 percent). (Z = 1.89; P-Value = 0.059). |
| **10 and 20 years** | There was no difference in the proportion of respondents who discounting the environmental impacts of planting fertiliser trees if they manifested in 10 years (79/137 = 57.7 percent) or in 20 years (72/134=53.7 percent). (Z-Value = 0.65; P-Value = 0.515). |
| **20 and 50years** | There was no difference in the proportion of respondents who discounted environmental impacts of planting fertiliser trees that manifested in 20 years (72/134=53.7 percent) and the proportion of farmers that discounting environmental impact of planting fertiliser trees that manifested in 50 years (62/133=46.6 percent). (Z-Value = 1.16; P-Value = 0.245). |
| **50years and next generation** | There was no difference in the proportion of respondents who discounted environmental impacts of planting fertiliser trees that manifested in 50 years (62/133=46.6 percent) and the proportion of farmers that discounting environmental impact of planting fertiliser trees that manifested in the next generation proportions (47/124=37.9 percent). Z = 1.41; P-Value = 0.158). |

Statistically, the results show that there are no differences in the proportions of farmers who would plant fertiliser trees whether the benefits would manifest in 5 years, 10 years, 20 years, 50 years or in the next generation. Regarding actual percentages of farmers planting trees, Figure 5.9 depicts decreases in percentages of farmers who would plant fertiliser trees as soil fertility benefits manifested further into the future. It was further noted during field observations that there were very few fertiliser trees (i.e. 2 trees per hectare on average) planted in the respondents' fields.

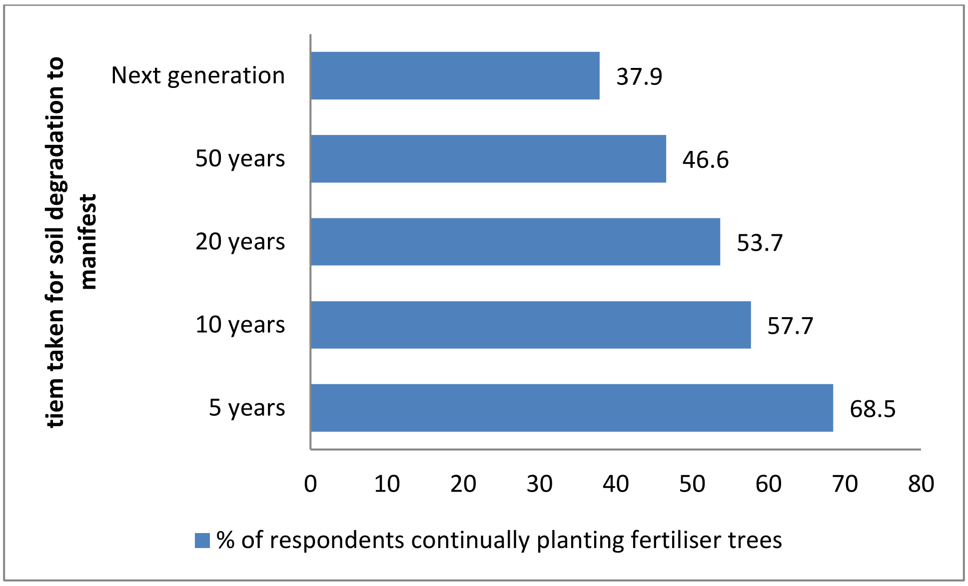


**Figure 5.9: Percentage of respondents planting fertiliser trees over time**

From the men and women discussion groups, discussants revealed that they would plant fertiliser trees if they were given the seedling for free by the promoters of (CA). By implication, they were not willing to buy the seedlings using their own financial resources. A discussant from the women's group attested to the soil fertility benefits of fertiliser trees, stating: "I have observed that maize grown under the trees has bigger cobs and crops grown under the trees generally look healthier." Despite seeing the benefits, smallholder farmers in rural Zambia have long been accustomed to receiving free or subsidized inputs. For example, Programmes such as the FISP which was established in 2002, provides subsidies to smallholder farmers in the form of mineral fertiliser and seeds.

Additionally, agricultural interventions by Non-Governmental Organisations in Zambia have also been characterised by hand-outs of mineral fertiliser, seeds, seedlings and agricultural implements in efforts to incentivize the adoption of CA (Habanyati et. al., 2018). In their study, Habanyati et. al. (2018) reported how these incentives have had a counter-productive outcome to adoption of CA, adding that CA is highly adopted during the CA projects period, but disadopted once such projects ends. The Liniger et al (2011) mentioned that subsidies on mineral fertiliser were aimed at, among other things, growing economies through agriculture and combating poverty among the poor in developing countries. However, it was noted by Kotschi (2009) that the popular use of mineral fertiliser had far-reaching negative effects on the environment and soils, which were the most vital capital for agriculture. Therefore, the goal to combat poverty and grow the economy is not being realised.

Another reason given by the respondents for not buying fertiliser tree seedlings was risk of loss. When asked why they did not buy seedlings like they do for mineral fertilisers if they have seen their benefits, 63.6 percent of the respondents said that mineral fertilisers guaranteed the growth of crops in the short term whereas fertiliser tree growth was not guaranteed and it took much longer for their benefits to manifest. This response implied that farmers are risk averse in their decision-making. Umar (2012) confirmed risk aversion among farmers in southern, eastern and central Zambia, and commented that this behaviour was out of necessity because farmers have to secure their households' need from their current production or face starvation. Therefore, new technologies represent unpredictable outcomes, a risk which most resource-constrained farmers are not willing to take.

Of the farmers who did not practice agroforestry, those farming on rented land (1.8 percent) said they could not risk invest in planting fertiliser trees for the potential benefit of the land owners. This risk aversion behaviour also demonstrated an environmental discounting tendency. By implication, farmers suggested that the benefits may not accrue to them hence they could not plant trees for overall environmental good. From the elderly group, one man narrated how it was the responsibility of every household head to ensure that they plant a tree where ever they are farming or residing. An elderly woman said she has planted many trees in her life and continues to do so for the greater good. This reflected how different the perspectives of the young and older were on tree planting. Still on fertiliser trees, some respondents (10.9 percent) said they did not plant winter thorn (*Faidherbia albida)* trees (which are the most common fertiliser trees known in the study area) because they were too thorny. Another 10.9 percent observed that fertilizer trees were eaten by termites while 3.6 percent said the trees prevent sunlight from reaching crops planted underneath them hence hindering growth. *Faidherbia albida* has been documented to have reverse phenology properties. The tree sheds its leaves during the rainy season when crops are growing under it (Mokgolodi et al., 2011). One man said of this:

> The tree sheds it leaves in the wet season. I do not think it provides the much needed shade to return moisture from the rain. Thus during inter-seasonal drought, I still have

> to water my crop. They are not helpful in this regard. That is why I planted just one and stopped.

Evidence of discounting among smallholder farmers toward the adoption of agroforestry was also reported by Petersen (1999) for eastern Zambia. He indicated the inability of farmers to wait 2 years to see benefits of agroforestry. Kabwe's (2009) study also showed a significant association between experimentation with agroforestry and lack of skill, lack of knowledge, lack of seed and lack of interest. Researcher from Indaba Agriculture Policy Research Institute (IAPRI) also observed the continued low adoption of CA practices among many farmers in Zambia and attributed it to lack of interest and general care for the environment. IAPRI key informants reported short time preference when payments for ecosystem services were introduced to adoption of an ecologically sustainable practice, stating that: "Beneficiaries prefer now payments compared to later payments." It can thus be said about smallholder farmers in Kalola Agricultural Camp that a lack of interest fuelled by high environmental discounting behaviour contributes to low adoption of SLM by them. A historical focus on maize and mineral fertiliser by the government may also have contributed to smallholder farmers' preference for mineral fertiliser and a lack of interest in organic alternatives.

# CHAPTER 6

# CONCLUSION AND RECOMMENDATIONS

## 6.1 Overview

This chapter concludes the study based on the research results and findings. It also makes recommendations for further research and changes to existing practices.

## 6.2 Conclusion

The aim of this study was to investigate if smallholder farmers in Chibombo District, Central Zambia demonstrate environmental discounting behaviour. The research used the adoption of SLM practices, particularly agroforestry and soil conservation, to investigate two aspects of discounting in farmers: i.e. time preference and risk aversion. This study achieved this aim with three research objectives: (i) to determine the SLM practices used by smallholder farmers in the study area; (ii) to investigate the reasons for adoption and non-adoption named practices; and (iii) to determine to what extent farmers engaged in discounting behaviour.

Regarding the SLM practices used by farmers in Kalola Agricultural Camp, research found that crop rotation and legume production were the most widely adopted among the farmers by over 70 percent of the smallholder farmers interviewed. After probes and discussions with the farmers regarding the reasons for adoption of the practices, it was concluded that farmers widely adopt these practice because they are easier to implement, they have more than one benefit to the farmers (e.g. soil fertility, low labour requirements and food variety) and their soil fertility benefits are experienced in the short term. Other SLM practices such as agroforestry, the use of animal manure and mixed cropping were adopted by around half of the farmers. Discussions revealed that farmers were aware of their benefits, i.e. their ability to sustain farming without degrading the soils. It was concluded that farmers did not adopt agroforestry, use of animal manure and intercropping as readily as planting legumes and rotating crops because the practices took long to manifest benefits, increase labour demand and inconvenienced the application of inputs respectively. Hints of discounting began to manifest during the probes for reasons for adoption. Fallowing, crop residue retention and ripping were the least popular; practiced by less than 40 percent of the farmers in

Kalola Agricultural Camp. Probes into this adoption trend lead to the conclusion that limited space due to population increase hampered fallowing, competing uses for crop residues reduced crop residue retention, and increased labour demand discouraged farmers from using the ripper.

On the third objective require the research to determine to extent farmers engage in discounting behaviour. Regarding the use of mineral fertiliser, it was concluded that soil degradation that would result in future from the prolonged use of mineral fertiliser was discounted by the respondents base on time preference and risk aversion. This conclusion was arrived at because the Z-proportional test showed that farmers would continue using mineral fertiliser regardless of when soil infertility would occur. Further discussions with the farmers insinuated short time preference in particular when they expressed preference for the fast benefits realised from using mineral fertiliser compare to other methods of soil fertility such as agroforestry. Risk aversion was deduced from how farmers expressed that how liked using mineral fertiliser guarantees plant growth and reduce the risk of losing their crop.

For discounting environmental impact of pesticides and herbicides, the Z-proportional test also showed no differences in the proportions of farmer would continue using the inputs at the different time of soil degradation occurrence. Investigations revealed that nearly half of the respondents were not convinced that the inputs had any detrimental effects of the soil while the other half feared degradation would be irreversible. Further probes showed that fundamentally, pesticides were used to preserve crop and herbicides were used to reduce labour by those who could afford to do so. In conclusion, regarding the use of herbicides and pesticides, the research did not find any bases to infer discounting based on time preference or risk aversion.

Discounting based on time preference was concluded for willingness to plant fertiliser trees. Farmers were seen to prefer benefits that accrue in the near future compared to those in the far future. It was further concluded that farmers also demonstrate risk aversion in planting fertiliser trees. This was evident in their unwillingness to invest in fertiliser tree seedlings. Farmers alluded to the many challenges associated with agroforestry (e.g. scarcity of seedlings, browsing by livestock, time taken for benefits); and that if they endured these challenges, they are still not guaranteed to benefit from the trees' soil fertility due to insecure land tenure.

### 6.3 Recommendations

Based on the findings of this study, it can be recommended that:

1. The approach used in this study, i.e. to establishing whether targeted adoptees demonstrated discounting behaviour; should be used as the first step in gauging the potential adoption of any SLM programme. Further research into other aspects of discounting such as opportunity cost and uncertainties should be conducted. Policy and programme implementers should conduct research to ascertain discounting behaviour and establish the actual discount rates of potential adoptees, which they can then use to determine the Net Present Value (NPV) of a project. This will enable implementers to ensure that the level of investment into a particular programme marches the anticipated adoption and to ensure sustained adoption by the adoptees.
2. This research highlighted some gendered decisions on the use of soil degrading inputs. However, further research can be conducted to investigate the gendered differences in environmental discounting behaviour, specifically regarding the use of inputs that cause environmental degradation in the long term.
3. Farmers should be educated on the negative externalities of some inputs that they find convenient to use. This will enable them to make an informed choice on whether to use them or not.
4. The Ministry of Agriculture should ensure that tree seedlings are readily available at their district offices and with their camp officers around the districts. This will enable easy distribution of the seedlings to farmers who may be willing to plant trees. Instructions and or training should be provided on successful growth of trees.
5. If a project is important to the long-term preservation of the environment and programme promoters notice environmental discounting traits in potential adoptees, they should consider embarking on a mindset change programme before incentivising adoption of a programme. For example, planting of fertiliser trees can be adopted if farmers were sensitised on the good of their long-term benefits.

This research did not explore other aspects of discounting that may be influencing farmer adoption of SLM. Other aspects of discounting include change in price, productivity of capital, diminishing marginal utility of consumption and opportunity cost. More research can be conducted to fully understand if (and how) the different aspects of discounting influence farmer adoption of SLM.

# 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.

Adedipe, N.O., Olawoye, J.E., Olarinde, E.S. and Okediran, A.Y. (1997) "Rural communal tenure regimes and private landownership in western Nigeria." *Land Reform* 2, 98–110.

Ajayi, O. C., Franzel, S., Kuntashula, E. and Kwesiga, F. (2003) "Adoption of improved fallow technology for soil fertility management in Zambia: Empirical studies and emerging issues." *Agroforestry Systems,* 59(3), 317-326.

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

Araka, J., Giningue, A., Mbalaka, B., de Graft Rosenior, A., Ephson, B., Wainaina, B. and Morna, C. (1990) "Finding enough land for all." *African Farmer:* 14–21.

Arden-Clarke, C. and Hodges, R.D. (1987) "The environmental effects of conventional and organic/biological farming systems." Soil erosion, with special reference to Britain. *Biological Agriculture and Horticulture* 4, 309-357.

Blaylock, L. R., (2018) "Natural Compounds Offer More Benefits for Cancer Treatment." *The Blaylock Wellness Report, 15(8*).

Blumberg, B., Cooper, R. D. and Schindler, P. S. (2011) "Business Research Methods." *International Edition*.

Boardman, A. E., Greenburg, D. H., Vining, A. R., and Weimer, D. L. (2001) "Cost-benefit analysis: Concepts and practice." Englewood Cliffs, NJ: Prentice-Hall.

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.

Boyle, A. P., Lei, Y., Buchman, A. S. and Bennet, A. D. (2012) "Risk aversion is associated with decision making among community-based older persons." *Frontiers in Psychology:* Vol 3 (205) 1-6.

Bune-Mann E. K. and McNeill A. (2004) "Impact of Fertiliser on Soil Biota." *Proceedings of a workshop on current research into soil biology in agriculture Ed. R. Lines-kelly: 62-71.* Tamworth NSW Department of Primary Industries.

Brennan, T. J. (1995) "Discounting the Future: Economics and Ethics." Resources, *Summer* 3-6.

Bryman, A. (2016) "Social Research Methods." International Edition ed. Oxford University Press, New York.

Bryman, A. (2008) "Social Research Methods." 3rd Edition, Oxford University Press, New York.

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

Central Statistical Office (2013) "2010 Census of Population and Housing: Population and Demographics Projections 2011 - 2035." *Central Statistical Office,* Lusaka.

Chidumoya, E. N., (1987) "Species Structure in Zambian Miombo Woodland." *Journal of Tropical Ecology,* 3(2), 109-118. Cambridge University Press.

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.

Drechsel, P., Lucy G., Dagmar K. and Olufunke C. (2001) "Population Density, Soil Nutrient Depletion, and Economic Growth in Sub-Saharan Africa." *Ecological Economics* 38, no. 2: 251-58.

Duquette, E., Higgins N., and Horowitz J. (2011) "Farmer Discount Rates: Experimental Evidence." *American Journal of Agricultural Economics* 94, (2): 451-56.

Faul, F., Erdfelder, E., Buchner, A. and Lang, A.-G. (2009) "Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses." *Behavior Research Methods*, 41, 1149-1160.

Fenske, J. (2011) "Land tenure and investment incentives: Evidence from West Africa."*Journal of Development Economics* 95:137–156.

Fowler, R., and Rockstrom, J. (2001) Conservation tillage for sustainable agriculture: An agrarian revolution gathers momentum in Africa. *Soil and Tillage Research*, 61(1-2), 93-108.

Fowler, F. J. (2002) Survey research methods, Newbury Park, CA, SAGE.

Gattig, A. and Hendrickx, L. (2007) “Judgmental Discounting and Environmental Risk Perception: Dimensional Similarities, Domain Differences and Implications for Sustainability.”*Journal of Social Issues*, 63(1), 21-39.

Gladwin, C. H., Peterson, J. S., Phiri, D. and Uttaro, R. (2002) “Agroforestry Adoption Decisions, Structural Adjustment and Gender in Africa.” In C. B. Barrett, F. Place & A. A. Aboud (Eds.), *Natural Resources Management in African Agriculture: Understanding and improving current practices* (pp. 115-128). Wallingford, UK; New York, USA: CAB International in association with the International Centre for Research in Agroforestry.

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

Guth J. H. (2009) "Resolving the Paradox of Discounting in Environmental Decisions." *Translational Law and Contemporary Problems* 18, no. 1: 95-112.

Habanyati, E. J., Nyanga, P. H. and Umar, B. B. (2018) "Factors Contributing to Disadoption of Conservation Agriculture among Smallholder Farmers in Petauke, Zambia." *Kasetsart Journal of Social Sciences*.

Haggblade, S. and Tembo, G. (2003) “Conservation Farming in Zambia.”EPTD Discussion paper No. 108: International Food Policy Research Institute.

Hardin, G. (1968) “The Tragedy of the Commons.”*Science*, 162, 1243 1248.

Hossain M. M. (2015) "Recent Perspective of Herbicide: Review of demand and adoption in world agriculture." J*ournal of Bangaladesh Agricultural University*, 13(1): 19–30.

Holden S. T. and Ghebru H. (2016) "Land tenure reforms, tenure security and food security in poor agrarian economies: Causal linkages and research gaps." *Global Food Security* 10: 21-28.

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.

Jacques P. J. and Jacques R. J. (2012) "Monocropping Cultures into Ruin: The Loss of Food Varieties and Cultural." *Sustainability* 4: 2970-2997.

Jeffrey, A. L. and Thomas, E. G. (2015) "Multiple caused of Wind Erosion in the Dust Bowl." *Aeolian Research* 19: 15-36.

Kabwe, G., Bigsby, H., and Cullen, R. (2009) "Factors Influencing Adoption of Agroforestry among Smallholder Farmers in Zambia." In *2009 NZARES Conference*. Nelson, New Zealand.: New Zealand Agricultural and Resource Economics Society (Inc.).

Kajoba, G. M. (2018) "Land tenure dynamics in an emerging market: Opportunities and challenges in Chibombo and Choingwe Districts, Zambia." edited by H. Chitonge, Umar, B.B, Contemporary Customary Land Issues in Africa: Navigating the Contours of Change. Newcastle: Cambridge Scholars Publishing.

Karpagam M. (1999) "Environmental Economics." Sterling Publishers Pvt. Ltd., New Delhi.

Kassam, A., Derpsch, R. and Friedrich, T. (2014) "Global achievements in soil and water conservation: The case of Conservation Agriculture." International Soil and Water Conservation Research.

Keil, A., Zeller, M., and Franzel, S. (2005) “Improved Fallows in Smallholder Maize Production in Zambia: do initial testers adopt the technology?”*Agroforestry Systems*, 64, 225-236.

Kiyani P., Andoh J. Lee, Y. and Don, K. L. (2017) "Benefits and Challenges of Agroforestry Adoption: a case of Musebeya sector, Nyamagabe District in southern province of Rwanda." *Forest Science and Technology*, 13:4, 174-180.

Kombo, D.K. and Tromp, D.L.A. (2006) "Proposal and Thesis Writing - An Introduction." Nairobi: Pauline Publications.

Kotschi J. (2009) "A Soil Reputation: Adverse Impacts of Mineral Fertiliser in Tropic Agriculture." *Association of Agriculture and Ecology*. World Wide Fund Study A.

Kuntashula, E. and Mafongoya, P.L. (2005) "Farmer Participatory Evaluation of Agroforestry Trees in Eastern Zambia." *Agricultural Systems*, 84, 39-53.

Langdridge, D. (2004) "Introduction to Research Methods and Data Analysis in Psychology." 2nd Edition.

Liniger, H. P., Studer R. M., Hauert, C. and Gurtner, M. (2011) "Sustainable Land Management in Practice - Guidelines and Best Practices for Sub-Sahara Africa." TerrAfrica, World Overview of Conservation Approaches and Technologies (WOCAT) and Food and Agriculture Organisation of the United Nations (FAO).

Lovo S. (2015) "Tenure Insecurity and Investment in Soil Conservation. Evidence from Malawi." *World Development* Vol. 78, pp. 219–229.

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.

Mashingaidze A. B., Govere I., Rohrbach D., Hove L., Twomlow S. and Mazvimavi K. (2006)"Review of NGO Efforts to promote Conservation Agriculture in Zimbabwe, 2005/2006 season." International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). Zimbabwe.

Materechera S. A. and Modiakgotla L. N. (2006) "Cattle manure increases soil weed population and species diversity in a semi-arid environment." *South African Journal of Plant and Soil,* 23:(1), 21-28.

Ministry of Agriculture and Livestock. (2014) "Agriculture Diary for Extension Officers." *January to December,* 2014 (1).

Minitab, Inc. (2004) "Minitab 14 Statistical Software [Computer Software]." State College, PA.

Mokgolodi, N., M. Setshogo, Shi, L., Liu, Y. and Ma, C. (2011). "Achieving food and nutritionalsecurity through agroforestry: a case of Faidherbia albida in sub-Saharan Africa."*Forestry Studies in China* 13(2): 123-131.

Mubanga, H. K., (2012) "Climate Variability and Adaptation: Implications on Maize Growing in Agro-Ecological Region II of Zambia: A case of Mbabala and Singani in Choma District." *MSc. Thesis.* University of Zambia.

Mubanga, H. K.., Umar, B. B., Muchabi, J. and Mubanga C. (2015) "What Drives Smallholder Farmers' Crop Production Choices in Central Zambia? Lessons from the 2012/2013 Agricultural Season." *Journal for Agricultural Studies,* (2)3.

Mubanga, H. K. (2018). "Drivers of smallholder farmers' crop production, with special focus on maize, in Choma District, Zambia." *PhD. Thesis.* University of Pretoria.

Nkomoki, W., Bavorava M. and Banout J. (2018) "Adoption of Sustainable Agricultural Practices and Food Security Treats: Effects of Land Tenure in Zambia." *Land Use Policy*: 532-538.

Nkonya, E., Johnson T., Ho Y. K. and Kato, E. (2016) "Economics of Land Degradation in Sub-Saharan Africa." In *Economics of Land Degradation and Improvement – a Global Assessment for Sustainable Development*, edited by Ephraim Nkonya, Alisher Mirzabaev and Joachim von Braun. 215-59. Cham: Springer International Publishing.

Ojiem, J., Ridder, N., Vanlauwe, B. and Giller, K.E. (2006) "Socio-ecological niche: a conceptual framework for integration of legumes in smallholder farming systems." *International Journal Agriculture Sustainability* 4:79-93.

Opio, C. (2001). “Biological and Social Feasibility of Sesbania fallow practice in Small Holder Agricultural Farms in Developing Countries: A Zambian Case study.”*Environmental Management, 27*(1), 59-74.

Palinkas, L. A. and Soydan, H. (2012) "Translation and Implementation of Evidence-Based Practice." Oxford University Press; New York: 2012.

Paulsen, H. M., Schochow, M., Ulber, B., Kuhne, S. and Rahmann, G. (2006) "Mixed Cropping Systems for Biological Control of Weeds and Pests in Organic Oilseed Crop." *Aspects of Applied Biology*, 79, 215-219.

Pearce, D., Groom, B., Hepburn, C., and Koundouri, P. (2003). "Valuing the future: Recent advances insocial discounting."*World Economics,* 4, 121–141.

Pearce, R. K. and Turner, R.K. (1990) "Economics of Natural Resources and the Environment." *American Journal of Agricultural Economics* 73(1).

Peterson, J. S. (1999) "Kubweletza Nthaka: Ethnographic Decision Trees and Improved Fallows in the Eastern Province of Zambia." *In Report to the University of Florida's 'Gender and Soil Fertility in Africa' Soils Management Collaboration Research Support Program (CRSP) and the International Centre for Research on Agroforestry*. University of Florida and ICRAF: University of Florida and ICRAF.

Phiri, D., Franzel, S., Mafongoya, P. L., Jere, I., Katanga, R. and Phiri, S. (2004). "Who is using the new technology? The association of wealth status and gender with the planting of improved tree fallows in Eastern Province, Zambia." *Agricultural Systems, 79*(2), 131-144.

Quisumbing, A. R., Lynn, R. B., Hilary, S. F., Lawrence. H., and Christin, P. (1995). "Women: The Key to Food Security." Food Policy Statement 21. Washington, DC: International Food Policy Research Institute.

Ritchie, J. and Lewis, J. ed. (2003) "Qualitative Research Practice: A Guide for Social Science Students & Researchers. Sage Publications, London.

Saasa, O. S. (2003). "Agricultural intensification in Zambia. The role of policies and policy processes. On the project: Africa Food Crisis-The relevance of Asian models, Institute of Economics and Social Research." University of Zambia. Collaborative study between Lund University and The Institute of Economic and Social Research, University of Zambia.

Saunders, M., Lewis, P. and Thornhill, A. (2012) "Research Methods for Business Students." Pearson Education Ltd., Harlow.

Shamoo, A. E., and Resnik, B.R. (2003) "Responsible Conduct of Research." Oxford University Press: Oxford, UK.

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

Slater, A. (2008) "Market Garden Crop Rotations." Ecological Association of Ontario. Atlantic Canadian Organic Regional Network.

Spencer, L., Ritchie, J., Lewis, J. and Dillon, L. (2003) "Quality in Qualitative Evaluation: A framework for assessing research evidence." Government Chief Social Researcher's Office, London: Cabinet Office.

Stefanie, H., Thomas B. H. and Konrad H. (2003) "Discounting and the EnvironmentShould Current Impacts be Weighted Differently than Impacts Harming Future Generations? LCA Methodology with Case Study." Swiss Federal Institute of Technology Zurich, Chemical Engineering Department, Safety and Environmental Technology Group, ETH-Hönggerberg, HCI G129, CH-8093 Zurich.

Styger E., and Fernandes, E. C. M. (2006) "Contributions of managed fallows to soil fertility recovery." In N. Uphoff, A. S. Ball, E. Fernandes, H. Herren, O. Husson, LM, CA Palm, JN Pretty, PA Sanchez, N Sanginga and J. Thies (Eds.), Biological approaches to sustainable soil systems. Boca Raton, London, New York: Taylor and Francis.

Tadesse, M. (2010) "Essays on Contracts, Risk Coping and Technology Adoption in Ethiopia ", Norwegian University of Life Sciences.

Umar, B. B. (2011). “From Maize Mono-Cropping to Conservation Agriculture: A Multi-Perspective Analysis of Smallholder Conservation Agriculture in Southern, Central and Eastern Zambia.”*PhD Thesis*: Norwegian University of Life Sciences.

Umar, B. B. (2012). “Reversing Agro-Based Land Degradation through Conservation Agriculture: Emerging Experiences from Zambia’s Smallholder Farming Sector.” *Sustainable Agriculture Research*, 1(2).

Umar, B. B.  (2012) "A Critical Review and Re-Assessment of Theories of Smallholder Decision-Making: A Case of Conservation Agriculture Households, Zambia." *Renewable Agriculture and Food Systems* 29, no. 3: 277-90.

World Bank. (2006) "Sustainable Land Management: Challenges , Opportunities and Trade-offs." World Bank, Washington DC.

Zerbe, R. O., and Dively, D. D. (1994). "Benefit-cost analysis in theory and practice." New York: Harper-Collins.

Zingore, S., James M., Beverly A., Lulseged T., and Job K. (2015) "Soil Degradation in Sub-Saharan Africa and Crop Production Options for Soil Rehabilitation."  99,2015.

# APPENDICES

## APPENDIX A: INTERVIEW GUIDE - SEMI-STRUCTURED INTERVIEWS

### ENVIRONMENTAL DISCOUNTING AND THE ADOPTION OF SUSTAINABLE AGRICULTURALPRACTICES BY SMALLHOLDER FARMERS IN CHIBOMBO DISTRICT, ZAMBIA.

**INTERVIEW GUIDE NUMBER**

| | | |
|---|---|---|
| | | |

**INTRODUCTION:**

My name is Fiona Chisanga Mubanga. I am a student at the University of Zambia pursuing a Master's of Science degree in Environment and Natural Resources Management. I am conducting research on the sustainable agriculture practices that farmers in this village adopt. I am also interested in knowing the adoption patterns of these practices, i.e., if farmers adopt practices that yield benefits faster more readily than those who's benefits that take longer to manifest.

You have been randomly selected to be interviewed for this research. Your identity will be kept anonymous and the information you will provide will be used for academic purposes only.

**QUESTIONNAIRE IDENTIFICATION**

<table>
<tr><td></td><td colspan="5">PROJECT:<br>Discounting and SLM implementation</td><td colspan="11">Questionnaire<br>September, 2017</td></tr>
<tr><td rowspan="2">STATUS OF RESPONDENT IN THE HOUSEHOLD</td><td colspan="12">Household Head</td><td colspan="4">1 ( )</td></tr>
<tr><td colspan="12">Close family member/Spouse</td><td colspan="4">2 ( )</td></tr>
<tr><td>VILLAGE NAME</td><td colspan="16"></td></tr>
<tr><td>DATE OF INTERVIEW</td><td></td><td></td><td></td><td></td><td>1</td><td>7</td><td>STAR</td><td></td><td></td><td></td><td></td><td>END</td><td></td><td></td><td></td><td></td></tr>
</table>

| | D | D | M | M | Y | Y | T TIME | Hours | TIM E | Hours |
|---|---|---|---|---|---|---|---|---|---|---|
| **INTERVIEWER’S NAME** | | | | | | | | **E-CODE** | _ _/_ _ _ _ _ | |

## SECTION 1: HOUSEHOLD DEMOGRAPHICS

| No | **1. GENDER**<br><br>Man= 1<br>Woman = 2 | | **2. AGE OF household head** | **3. EDUCATION level of household head:**<br>No formal education = 1<br>Primary school = 2<br>Secondary school = 3<br>College = 4<br>University = 5<br>I don't know = 999 | | | | | | **4. MARITAL STATUS:**<br><br>Single = 1<br>Married = 2<br>Widowed = 3<br>Separated = 4<br>Divorced = 5 | | | | | **5. OTHER OCCUPATION**<br>Businessperson = 1<br>Government employee = 2<br>Craftsman = 3<br>Private sector worker = 4<br>Housewife = 5<br>Caregiver = 6<br>Retired = 7<br>Other =<br>None. Farming only = 9 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **M** | **F** | **YEARS** | **EDUCATION LEVEL** | | | | | | **MARITAL STATUS** | | | | | **OCCUPATION** | | | | | | | | |
| 01 | 1 | 2 | | 1 | 2 | 3 | 4 | 5 | 999 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

**6. Total number of household members ………………………**

## SECTION 2: ON FARMING

**7.** What is the total land size owned by your household? Record actual size in hectares...........

**8.** What is your ownership status of your farm plot(s)?
1 ( ) owner (with title)
2 ( ) owner (customary ownership)
3 ( ) rented
4 ( ) family-owned land
5 ( ) clan member
6 ( ) using land for free as common property
7 ( ) Other (please specify)……………………………………

**9.** Do you rent out any land?
1 ( ) Yes …………..size ……………………..

2 ( ) No

**10.** Do you rent in land?
Yes…………Record actual size in hectares........

No................

**11.** How long have you been farming on your farm plots? Record actual years........

Plot 1: size........................years..............................

Plot 2: size........................years..............................

plot 3: size........................years..............................

**12.** Do you have trees within your field?
1 ( ) Yes
2 ( ) No

**13.** If yes, did you find them there or did you plant them?
1 ( ) Found them

2 ( ) Planted them

3 ( ) Planted some and found some

**14.** What kind of trees are they?
1 ( ) Indigenous

2 ( ) Exotic

**15.** What are your reasons for planting trees?
1 ( ) shade
2 ( ) soil fertility
3 ( ) to encourage rainfall
4 ( ) to maintain cool ambient temperatures
5 ( ) other, specify...........................................................

**16.** What crops do you grow in you grow in you field?
1 ( ) Maize
2 ( ) Groundnuts
3 ( ) Cassava
4 ( ) Beans
5 ( ) Sweet potatoes
6 ( ) Pumpkins
7 ( ) Sorgum
8 ( ) Millet
9 ( ) Cowpeas
10 ( ) Cotton
11 ( ) Other, specify.......................

**17.** What method of soil fertility do you implement in your fields?
1 ( ) Animal manure,
2 ( ) Plant biomass)
2 ( ) MineralFertiliser
3 ( ) Other, (specify).....................................

**18.** Which is your most preferred fertiliser type?
1 ( ) Organic Fertiliser
2 ( ) Chemical Fertiliser
3 ( ) Both
4 ( ) Other, (specify).....................................

**19.** Give reasons for your answer:…………………………………………………………........

## SECTION 3: USE OF VARIOUS AGRICULTURAL PRACTICES AND TECHNOLOGIES

**20.** What agriculturalpractices and technologies do you use in your field? *Other practices missed can be added.*

| Tick | Practice | Reasons |
|---|---|---|
| | Mixed cropping | |
| | Legume production | |
| | Agroforestry (specify type of trees planted) | |
| | Mono cropping | |
| | Use of hybrid seed | |
| | Use of herbicides | |
| | Use of pesticides | |
| | Fallowing | |
| | Crop rotation | |
| | Mulching | |
| | Crop residues | |
| | Animal manure | |
| | Ripping | |

**21.** What agricultural practices and technologies do you **not** use in your field? *Other practices missed can be added.*

| Tick | Practice | Reasons |
|---|---|---|
| | Mixed cropping | |
| | Legume production | |
| | Agroforestry (specify type of trees planted) | |
| | Mono cropping | |

| Tick | Practice | Reasons |
|---|---|---|
| | | |
| | Use of hybrid seed | |
| | Use of herbicides | |
| | Use of pesticides | |
| | Fallowing | |
| | Crop rotation | |
| | Mulching | |
| | Crop residues | |
| | Animal manure | |
| | Ripping | |

**22.** How long have you been farming on your plot(s)? Record number of years.................

**23.** What do you think has happened to soil fertility over the years you have been here?

a. Plot 1
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

b. Plot 2
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

c. Plot 3
1 ( ) reduced
2 ( ) increased

3 ( ) not changed

**24.** Give reasons for you answer to question 23...........................................................................................................................
.............................................................................................................................
.............................................................................................................................
.............................................................................................................................
...............

**25.** Do you think soil organic matter content in your field has........................over the years you have been here?
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

**26.** Give reasons for you answer to question 23...........................................................................................................................
.............................................................................................................................
.............................................................................................................................
.............................................................................................................................
...............

**27.** Do you think has happened to soil water retention properties over the years you have been here?
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

**28.** Give reasons for you answer to question 23...........................................................................................................................
.............................................................................................................................
.............................................................................................................................
.............................................................................................................................
...............

**29.** Do you think ploughing results in the formation of hard pans in the ground?
1 ( ) yes
2 ( ) no
3 ( ) not sure

**30.** Give reasons for you answer to question 23...........................................................................................................................
.............................................................................................................................
.............................................................................................................................
.............................................................................................................................
...............

**31.** Do you think ambient atmospheric temperatures have..........
1 ( ) increased
2 ( ) reduced
3 ( ) not changed

**32.** Give reasons for you answer to question 25.........................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
...............

**33.** Do you think ambient air quality has ...................
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

**34.** Give reasons for you answer to question 23.........................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
...............

**35.** What do you think has happened to ground water quantity over the years you have been here?
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

**36.** Give reasons for you answer to question 23.........................................................................................................................
..............................................................................................................................
..............................................................................................................................
..............................................................................................................................
...............

**37.** Do you think ground water quality has....................over the years you have been here?
1 ( ) reduced
2 ( ) increased
3 ( ) not changed

**38.** Give reasons for you answer to question 23.........................................................................................................................
..............................................................................................................................

..........................................................................................................................
.........................................................................................

**39.** Has the amount of vegetation ............ over the years
1 ( ) increased
2 ( ) reduced
3 ( ) not changed

**40.** What do you think are the positive impacts of having trees in your environment?
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
...........

**41.** What do you think are the negative impacts of having trees in your environment?
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
...........

## SECTION 4: ENVIRONMENTAL DISCOUNTING

**42.** If you were told that using fertiliserwould render your soils infertile in.....
a) 5 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
b) 10 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
c) 20 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
d) 50 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
e) Your next generation. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe

**43.** If you were told that using herbicides would render your soils infertile in.....
a) 5 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
b) 10 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
c) 20 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
d) 50 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
e) Your next generation. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe

**44.** If you were told that using pesticides would render your soils infertile in.....
a) 5 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
b) 10 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
c) 20 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe
d) 50 years. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe

e) Your next generation. Would you use them? 1 ( ) Yes 2 ( ) No 3. ( ) Maybe

**45.** Would you plant soil improving trees if it took.....
a) 5years to get soil improvement benefits. 1 ( ) Yes 2 ( ) No 3( ) Maybe
b) 10 years to get soil improvement benefits. 1 ( ) Yes 2 ( ) No 3 ( ) Maybe
c) 20 years to get soil improvement benefits. 1 ( ) Yes 2 ( ) No 3 ( ) Maybe
d) 50 years to get soil improvement benefits. 1 ( ) Yes 2 ( ) No 3 ( ) Maybe
e) Your next generation. 1( ) Yes 2( ) No 3 ( ) Maybe

Consider the following table 3:

| | **YEAR AND COST OF CHEMICAL FERTILISER PER Ha.** | | | | |
|---|---|---|---|---|---|
| **PRACTICE** | *Year 0* | *Year 5* | *Year 10* | *Year 15* | *Year 20* |
| *Cost of Chemical fertiliser without SLM* | K1,600 | K3,200 | K6,400 | K12,800 | K25,600 |
| *Cost of fertiliser with Agroforestry* | K1,600 | K800 | K0 | K0 | K0 |
| *Cost of fertiliser with Mulching, crop residue, animal manure.* | K800 | K600 | K400 | K200 | K0 |

**46.** Up to what point would you use mineral fertiliser?
1. ( ) year 0
2. ( ) year 5
3. ( ) year 10
4. ( ) year 15
5. ( ) year 20

**47.** Would you implement agroforestry if it would reduce your cost of fertiliser from K3,200 to K1,600 in 5 years?
1. ( ) Yes
2. ( ) No

**48.** Would you use mulch, crop residue and/or animal if it would reduce your cost of fertiliser from K800 to K600 in 5 years?
1. ( ) Yes
2. ( ) No

**49.** Has the amount of fertiliser you use per ha in your field increased or increased over the past 5years?
1. ( ) increased
2. ( ) reduced
3. ( ) no change

*End of Survey*
*Thank the respondent for their time in participating in the survey*

### *2.1.1.1. INTERVIEWER'S DECLARATION*

*I certify that this interview has been personally carried out by me with the respondent. I further declare that all the information is truthful and correct as told to me by the respondent. I understand that any discrepancies discovered during back-checking of this questionnaire will result in the cancellation of this interview.*

**SIGNATURE OF THE INTERVIEWER:**

__________________________________________

## APPENDIX B: FOCUS GROUP DISSCUSSION GUIDE

Thank the discussants for coming to the discussion and assure them that the discussion will be over in 40mins (unless it goes over time due to their own wanting).

Start the discussion by mentioning that you have been in their area interviewing some people and outline some of the SLM practices that you have come across in their village. Also outline some practices that can be used that you have not come across or that were not frequently encountered during your interviews with the locals. Then ask,

1. Why is it that most of you implement (e.g. crop residue retention) and not (planting agroforestry trees)?

Allow for answers and opinions.

2. Ask politely for someone to mention the advantages of practicing SLM over conventional methods of farming.
3. Ask an older participant if SLM practices were widely used in the past and what forms SLM took and how things have changed today.
4. Ask the participants if they would be willing to adopt SLM practices for the sake of agricultural sustainability for their future generations. Ask if they would implement even if the beneficiaries are not their descendants.
5. Then ask; if there was a PES system created around SLM practices such that adopters of SLM are paid, would you implement?

   For example, if you were told that for planting *Ferdherbia albida*, you can either be given K1,000 now, or K 1,100 after 1 year, or K5,000 after five years, would you prefer to be paid now, after 1 year of after 5 years?