UNIVERSITY OF COPENHAGEN

Factors Influencing Soil Conservation Practices

A study of Gikirima Village, Embu County, Kenya

Interdisciplinary Land Use and Natural Resource Management
SLUSE February-April 2017

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Abstract

This project seeks to understand what influence a farmer in Gikirima Village, in the Central Highlands of Kenya to implement soil conservation practices, through field observations, qualitative and quantitative studies, as well as the use of the sustainable livelihood framework.

Generally, we found that the farmers in Gikirima are aware of the risks posed by soil erosion on their shambas. Every plot of land has a steep slope and is prone to erosion during the rainy season. Terracing and fanya juu, combined with grass lines and cover crops, are considered the better suited techniques for the area, both in the past - encouraged by a more present extension service - and in the present. Those techniques require a capital investment: labor, which implies either time availability, or financial investment in hiring external labor which are significant limiting factors.

Macro-scale economic trends and national policies have shaped the context of Gikirima and have influenced the choice of livelihood strategies. Orientation towards cash crops and reduced government input into extension has led to a privatization of extension services that limit the effectiveness of soil erosion control.

We recommend policies that close the gap between public government extension and farmers that cannot access those services, and strengthen coordination between private and public extension services, so that knowledge is provided in the context of the farm as a holistic system. Soil conservation should be coordinated at a village level through involvement of all stakeholders to overcome limitations in labor and finance.

Acknowledgements

The field based part of the SLUSE course was a collaboration between the Wangari Maathai Institute for Peace and Environmental Studies at University of Nairobi, Roskilde University and University of Copenhagen. The inputs and efforts of lecturers from the Wangari Maathai Institute, University of Copenhagen and Roskilde University are highly appreciated and we would like to thank our supervisors Dr. Christian Pilegaard Hansen and Dr. Ebbe Prag for their guidance during the course and their assistance in the field. Also, we would like to thank Dr. T. Thenya and Professor Dr Cecilia Onyango from University of Nairobi for commenting on our work and providing us with useful information during our time in Kenya.

The field work and design of the project was collaboratively done by students from University of Nairobi and University of Copenhagen. We would like to thank our Kenyan counterparts Lucy Njola, Lucky Cinny and Christine Nyanjweso, with whom we had a great time with in Gikirima, for their collaboration and assistance.

Our deepest gratitude belongs to our hosts in Gikirima: Wanyaga Kariuki, Gilbert Mbugua, and Githinji Mbogori who welcomed us to their homes and provided us with a lot of care. They have contributed to the information in this report through informal communication. Their contribution is acknowledged and much appreciated.

We are grateful to the chief and the community leaders in Kibugu location for logistical support in the implementation of training.

Further, we owe a special thanks to the farmers and key informants, who allowed us to take their valuable time and have provided us with essential information for this report. We specially thank Agricultural Extension Officer Mary Wambugu from the Ministry of Agriculture, Senior Forester Elizabeth Kariuki from Kenyan Forest Service, Extension Officer Eudesia Ndwiga from the Plant Clinic in Kibugu, and Coffee Manager John Mbogo from Gikirima Coffee for providing us with key information about the institutions in Kibugu Location.

Finally, we would like to thank Daniel Rudd for assisting us with GIS.

Abbreviations

DEM	Digital Elevation Model
KFS	Kenya Forest Service
KTDA	Kenya Tea Development Agency
MOA	Ministry of Agriculture
NALEP	National Agriculture and Livestock Extension Program
NAEP	National Agriculture Extension Policy
NASEP	National Agriculture Sector Extension Policy
PRA	Participatory Rural Appraisal
SAP	Structural Adjustment Program
SC	Soil Conservation
SSI	Semi Structured Interview
WB	World Bank

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1. Introduction

The current food crisis and famine unfolding in the Horn of Africa affects 17 million people. In Kenya alone, an estimated 2.7 million people are facing famine (Awite, 2017). Drought warnings had been issued as early as 2014 for the region, but national and international institutions have been unable to avert the crisis. This situation highlights once again the vulnerability of the continent to food insecurity and drought, and the need to increase yields.

In Kenya, 80% of the population depends on agriculture for food and income, and it constitutes 65% of foreign exchange earnings through exportation of products such as macadamia, tea, and coffee (ASCU, 2012). Fertile soils are located in the central highlands, coastal plains and lake region, while the rest of the country is semi-arid to arid. Agricultural land is mostly privately owned. Increasing population, and cultural norms dictating even distribution of land to children, are dividing the land into smaller units. In addition, more population may in fact lead to more erosion as land holdings and communities become more fractured and atomized without institutional support that the government can provide (Ovuka, 1999). In Eastern Africa, farming systems of the shambas are intensified and there is no fallow period, which pressures the soil and can accelerate land degradation (Cohen, 2002). Former studies in Kenya have shown that crop intensification is a main livelihood strategy, in rural areas with increasing population and reduced land holdings (Smucker and Wisner, 2008). The access to secure tenure is a key factor influencing land conservation investments (Kimaru and Jama, 2006; Alufah et al. 2012.)

Soil erosion is a worsening problem in sub-Saharan Africa and contributes to significant losses in the agricultural sector that hampers economic development and heightens the risk of food insecurity (Lal, 1990; Pimentel et al. 1995; Pimentel, 2006). As early as the 1930's, the colonial government identified soil erosion as a problem that could collapse agricultural production in Kenya. During the later stages of the colonial government (1945-1960), the government instituted aggressive and compulsory erosion controls. Following independence in 1963, farmers were left to their own farm, and a resentment of colonial legacies meant that erosion control was rarely practiced, and limited to the household rather than the whole contour techniques applied by the government (Shanguhyia. 2015).

Changes in the institutional framework have influenced agriculture in Kenya. Structural adjustment programs (SAP) started in 1980 with a 55 million loan from the World Bank. The part of the budget allocated to agriculture decreased from 10% in the 1980s to 5% in the 1990s (Nyangito, 2003). The Training and Visit approach to extension services was introduced in 1982 by the World Bank, and by 1990 extension services were deemed to be staffed and funded to effective levels (Tiffen et al. 1994). Nevertheless, the outcome was that farmers were aware of simple agronomic recommendations, but that more complex and context-specific messages were not diffused, and the impact on farm productivity was limited (World Bank, 1999). In 2001, the Ministry of Agriculture (MOA) designed the National Agricultural Extension Policy (NAEP) to try to diversify, decentralize and strengthen extension services. But in 2011 Kenyan public extension services comprised of only 5470 staff members for a rural population of around 31,5 million (Index Mundi, n.d.). Due to the insufficiencies in the public extension system since the 2013 decentralization, Kenya extension services are now provided by a wide range of private and public actors (G-fras, n.d.). SAP's effects on liberalization and privatization, the devolution, and market orientation towards exports appear to shape the context of participation in soil erosion control. Furthermore, SAPs have been found to have a long term negative effects on per capita agriculture GDP (Mbithe, 2009). This leads to decreased farmers' income which limits the efficient implementation of SC technologies.

Successful integration of women in soil conservation (SC) practices is also important because women depend on water and soil resources for their livelihoods. They have also been found to be better adopters than their male counterparts (Alufah et al. 2012). Gabrielsson et al. (2013) states the need of government action in order to provide equal access to training for vulnerable groups. Many NGO's have been established in order to empower women in rural communities (JoyWo, n.d). Social differentiation influence access to

assets and household coping capacity, issues that are exacerbated in female headed households (Eriksen et al. 2005).

International markets and national policies that orient national markets towards export have a large impact on the adoption of SC as well. For example, the encouragement of coffee and tea production for export necessitates the use of SC techniques in terraces and fanya juu to meet the quality necessary for export. These policies also connect the resources of buyers abroad to the farmer in the form of fertilizers and extension (Boyd and Slaymaker, 2000). In many cases engagement in these markets necessitates the use of group marketing, the type of social organizing that can aid in implementation of SC (Boyd and Slaymaker, 2000).

High erosion levels have been found in the Central Highlands of Kenya, where the slopes are heavily cultivated (Okoba and Strek, 2006). Previous researchers in the area found that 98% of the farmers experienced soil erosion, despite SC and land management efforts (Okoba and De Graaff, 2004). Table 1 shows the commonly used techniques used in Kenya to control erosion.

Fanya Juu	This terracing technique is based on digging trenches along the contour lines and the use of the remaining soil to form bunds upslope (40 - 50 cm height).
Bench Terracing	Terracing where the slope is altered into "benches" where the surface is level with vertical or near-vertical steps between level benches
Napier Grasslines	Grass planted across the contour line of a farm to slow down surface drainage of water. These lines can be combined with terracing, stabilizing the slope and providing a double output, used also as fodder.
Cover Crops	Crops planted with the purpose of covering soil from rain impact and stabilizing soil through root structure and nutrient input.
Mulching	Residue left after the harvest of a crop to cover the soil from impact from rain and to slow down surface flow of water and transport of sediment
Agroforestry	Tree planting across a contour line which serves multiple purposes in controlling erosion. The root structure stabilizes the soil column. The canopy and the litter aid in covering soil from raindrop impact, the litter also slows surface runoff and adds soil organic matter than can also stabilize a soil column.

Table 1: Soil Conservation Techniques (WOCAT, 2007; Liniger et al., 2011; Tiffen et al., 1994; Young, 1989; Kang et al., 1990)

The most frequently identified erosion problems in the Central Highlands are rills, root exposure and sheet wash (Okoba and De Graaf, 2004). In their study, farmers were aware of the relation between slope, level of erosion and crop yields. They found that farmers' perceptions is that erosion is associated with high rainfall, runoff, and steep slopes; factors they cannot control fully. Few farmers saw a link between tall trees, lack of soil cover and up to down tillage practices. Further, Assefa and Hans-Rudolf (2016) find that farmer's perception of the issue is a determinant of the acceptance and adoption of a certain land management strategy.

Increasing yields and reducing labor inputs are critical incentives in the cost benefit analysis to implement SC technology (Tiffen et al. 1994). Furthermore, access to institutional credit is limited in rural areas, often due to a lack of collateral and farmers' primary reliance on savings. Farmers with access to credit were found to be likely to implement SC techniques (Alufah et al. 2012). Some of the main constraints in the Central Highlands were identified to be lack of financial capital and insufficient labor force (Okoba and De Graaf, 2004).

Long-term efficient erosion control can fail due to a number of factors. Failures in conservation projects can happen for several reasons: 1) lack of extension offices and trained officers, replaced by private providers, 2)

lack of financial resources for tools or farm inputs, 3) strategies did not include other stakeholders such as education or local governments, or did not take into account the farmers' diverse income strategies or 4) projects did not link environmental issues, social equity and economic development in a sufficient way (Mutisya et al, 2010). The issue is difficult to address in a rural context dominated by smallholder agriculture because social pressures against colonial practices and extreme aversion to risky investment dominate the decisions of the farmers (Byiringiro and Reardon, 1996; Foster and Rosenzweig, 2010). The returns from investment may not be realized over short timescales, and the benefits may be discounted heavily by those in poverty (Holden et al., 1998).

1.2 Research Problem and Question

After several decades of erosion control efforts in Kenya and the evolution of the institutional framework influencing land tenure, market access and extension services, our research aims to identify the factors influencing farmers' decisions to implement SC technologies, from local to global. This project aims to take into account intensifying and changing macro-scale processes such climate change, urbanization, economic and market developments that have affected smallholders in the last decade. Change occurs quickly as we have seen in the history of soil erosion and governance in Kenya. Previous studies conducted in other parts of Embu county have provided us with background, however there is sparse literature on the area and subject in the past ten years.

Consequently, our research questions are the following:

What influence farmers' decision to use soil conservation techniques?

- How do livelihood assets influence farmers use of soil conservation practices?
- How do institutions influence farmers use of soil conservation practices?
- How does context influence farmers use of soil conservation practices?

2. Area of study

The fieldwork was carried out in Gikirima Village, located in Kibugu Location in Embu county. Embu county is situated on the slopes of Mount Kenya, around 120 km North East from Nairobi and its capital is Embu Town. 70% of the population in Kibugu is employed in the agricultural sector, and the majority of farms are small-holdings (SLUSE, 2017).

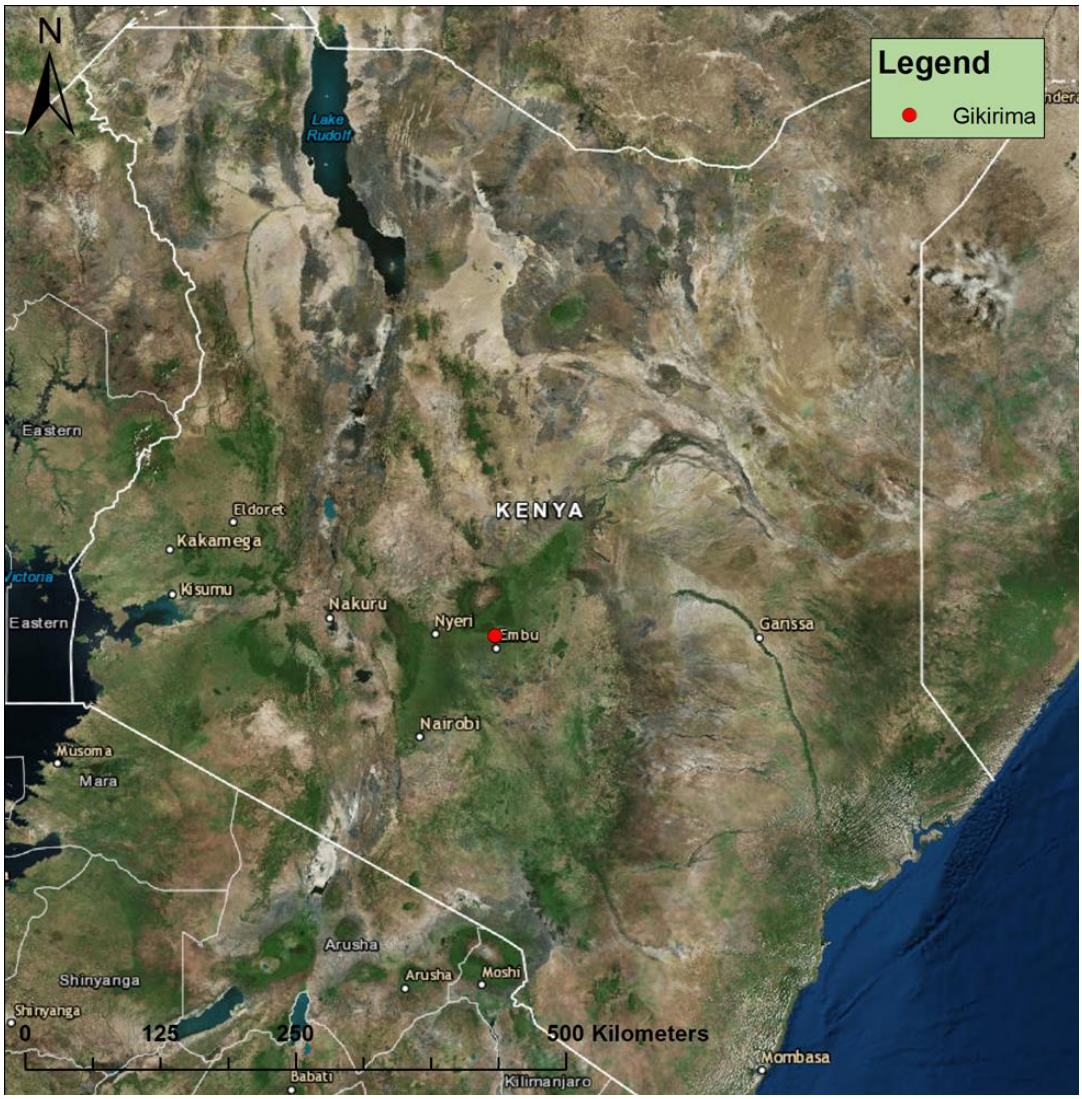

Figure 1: Field location, Embu county, Kenya

Gikirima village has one main road that follows a ridgeline and extends to the valley floor below with steep slopes (13-28 degrees) on both sides, see figure 2 (Transect Walk; Slope Assessment). The village is situated at around 1,600 masl. and covers an area of 140,2 acres. The area has a bimodal rain pattern with long rains between March and June and short rains between October and December, with rainfall level around 1,500 mm per annum (SLUSE, 2017; PRA).

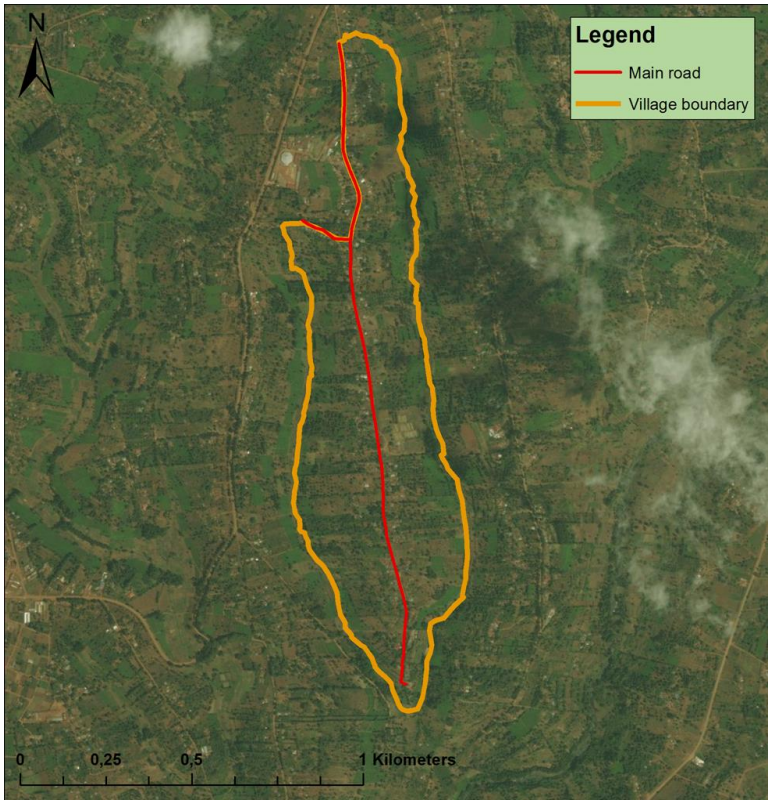

Figure 2: Gikirima Village.

Gikirima village has approximately 90 households (estimated to approximately 300 to 400 people). The main income source is cash crop production, followed by livestock and off-farm employment (Questionnaire). The cash crop production is dominated by tea, coffee and macadamia. Milk is an important livestock production and milkmen come twice a day. Food crops are mostly composed of maize, kale, cabbage, arrowroots and some legumes. Land is divided in shambas, smallholdings with high crop diversification and intensity. Spatially, cash crops are situated close to the house and on the steepest slope, and food crops in the lower part of the shamba, near the stream, see figure 3. Fruit trees, eucalyptus and agroforestry species such as *Grevillea robusta* and *Calliandra calothyrsus* are grown on the farms (Transect Walk).


Figure 3: Shamba in Gikirima (photo: Maite Jurado)

The area has been populated since independence and is now almost 100% cultivated with farmland and trees. Prior to settling, the area was a highland savannah grassland, but after independence land was divided and people started clearing bushes, planting trees, and cultivating the land (Elder Ruth). The area is mostly composed of deep Ultisols and Oxisols, that have a high clay content and a red color due to the oxidation of Fe and Al. Those soils can be subjected to low Phosphorus, zinc, and organic carbon levels and have a low pH. Inadequate soil organic matter means there is low water infiltration and holding, which can result in soil erosion (NAAIAP, 2014).

3. The Sustainable Livelihoods Framework

In order for us to understand what influence farmers' decision to adopt certain SC technologies, we have chosen to apply elements from the Sustainable Livelihoods Framework (SLF) presented by DFID (2000), and taken into consideration the review made by Scoones (2009), see figure 4. We draw on this framework to analyze the factors that influence the decision to invest in SC practices as a livelihood strategy. This report focuses on specific elements of the SLF, which we find important in relation to SC.

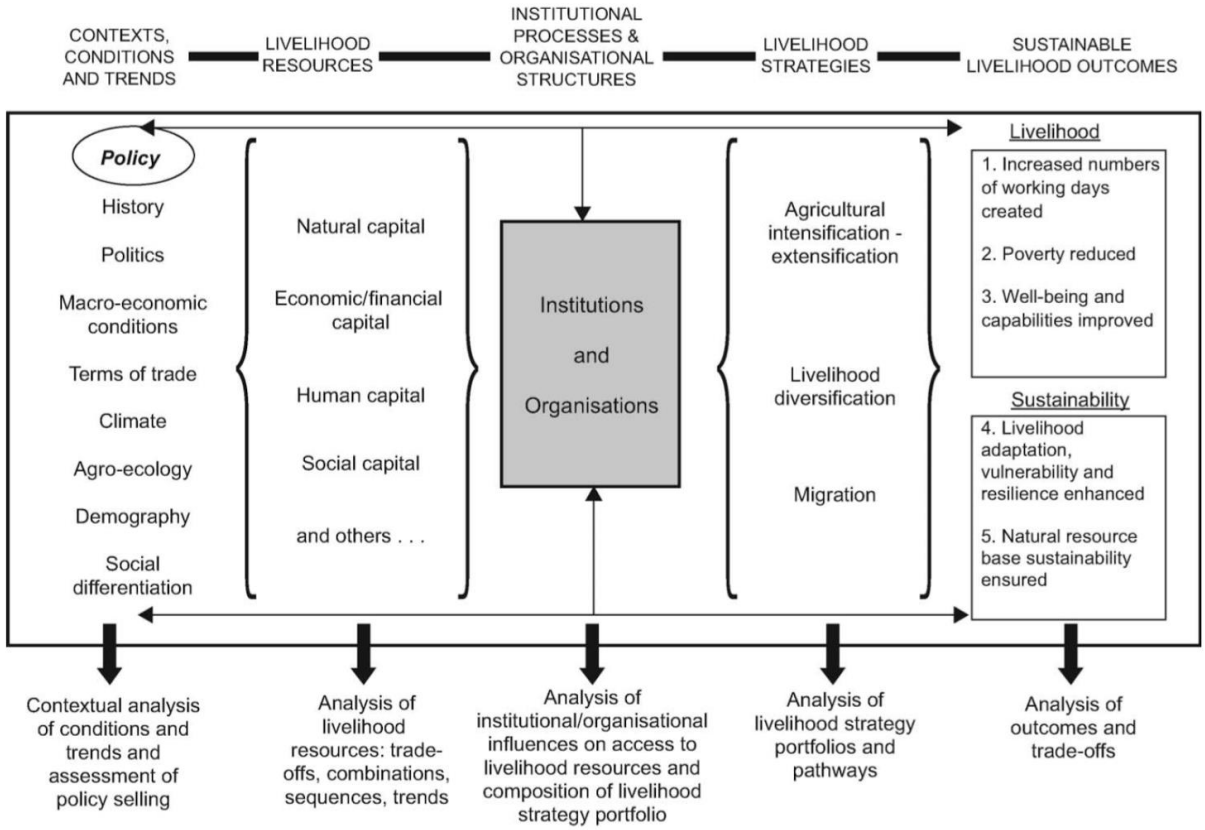

Figure 4: Sustainable Livelihood Framework (Scoones, 1998)

Livelihoods is understood as the different means a person or household use for a living which are influenced by the different capitals present in the household, see table 2 (Ellis, 2000). Even though the SLF uses the household as the unit of analysis, our aim is to have a general focus on the village and the difference between assets that influence the adoption or maintenance of SC practices.

Livelihood Assets	Description
Natural capital	Natural resources stocks: Land, forest, water, and soil fertility
Physical capital	Basic infrastructure and producer goods: Implements, shelter, buildings, and energy
Social capital	Social resources: Networks (horizontal and vertical), kinship, and group memberships
Financial capital	Available stocks and regular inflows of money: Credit, savings, pensions, remittances
Human capital	Skills, knowledge, labor, health, and formal education

Table 2: Description of livelihood assets (DFID, 2000)

Institutions refers to "*transforming structures and processes*" e.g. governmental institutions, organisations and private companies. In this study, they are divided as formal and informal institutions which mediate livelihoods through their cultural and regulatory roles, delimiting people's behavior and aspirations (Jakimow, 2013). We want to focus on the influence of the importance of these institutions in SC implementation and the actual access that farmers have to them. The term access indicates the ability to benefit from things by different means (Ribot and Peluso, 2003).

The term context captures long term changes such as climate change and globalization, as well as macro policies or international markets that unavoidably influences rural livelihoods (Scoones, 2009). We focus on trends such as migration patterns, colonization, and global development schemes, as their effect may be visible in study.

4. Methodology

The following chapter presents the methods applied in studying farmers' decision to implement SC techniques in Gikirima. Several methods were applied during our fieldwork, in order to gain as nuanced and representative data as possible, and to understand the problem through various sources. We used a variety of social and natural methods which have given us both quantitative and qualitative data, see table 3 and appendix 1. The results have been triangulated to cross check the gathered data and thereby improve the validity of the results.

Method	Quantity
Semi-structured interviews	14
Transect walk	2
Life story exercise	1
Social mapping	1
Ranking exercise	1
Seasonal calendar	1
Respondents for questionnaire	31
Slope assessment	8

Table 3: Methods used during the fieldwork (Appendix 1).

4.1 Field observations

Participatory observation constitutes a method in which "*the researcher aims to participate in the process under study so as to gain intimate knowledge of subjects and their habits*" (Gregory et al., 2009). With this method in mind, researchers can use practices such as conversation, observing, eating, smelling, listening etc. as representations of reality. In our project, integrating and interacting with our host families and the local community was crucial in order to provide us with informations on the agronomic and economic issues and dynamics present in the community, and hints on potential research points related to crop technologies. Talking with our host families and guides we gained a nuanced understanding of how the shambas were run and how income was earned.

During one of the first days we went to an agricultural fair to gauge the general state and priorities of the stakeholders' present. We conducted informal interviews at different stands (Appendix 1).

4.2 Questionnaire

Questionnaires are used as an instrument for collecting data for survey analysis, in order to learn about the respondent's behavior and life (Gregory et al., 2009). The aim for the questionnaire carried out in Gikirima was to gain quantitative data and a broad overview of the local setting, perception of erosion and household information, which help us for our interview preparation.

Beforehand we had decided to conduct a common questionnaire together with the other groups, but as our Kenyan counterparts had objectives broader in scope than our own, and had already drafted a questionnaire, we decided to do our own questionnaire targeting crop farming technologies and erosion control in our village. We tried our common draft questionnaire on Mr. Githinji, and this mock questionnaire proved invaluable in making the questionnaire more concise and understandable. Before starting, we discussed how to translate certain questions, and how to ask them so that the results would be consistent. After completing half the interviews, we reviewed again the problems we had encountered in the interpretation of some questions, for example n°16 or n°22.

We divided into three teams of students and guides, and sampled every third household along three routes we identified from the transect walk. If nobody was home, we would go back to the second household. Our objective was to talk to farmers across the village, and as figure 5 illustrates, our respondents have been distributed evenly throughout the village.

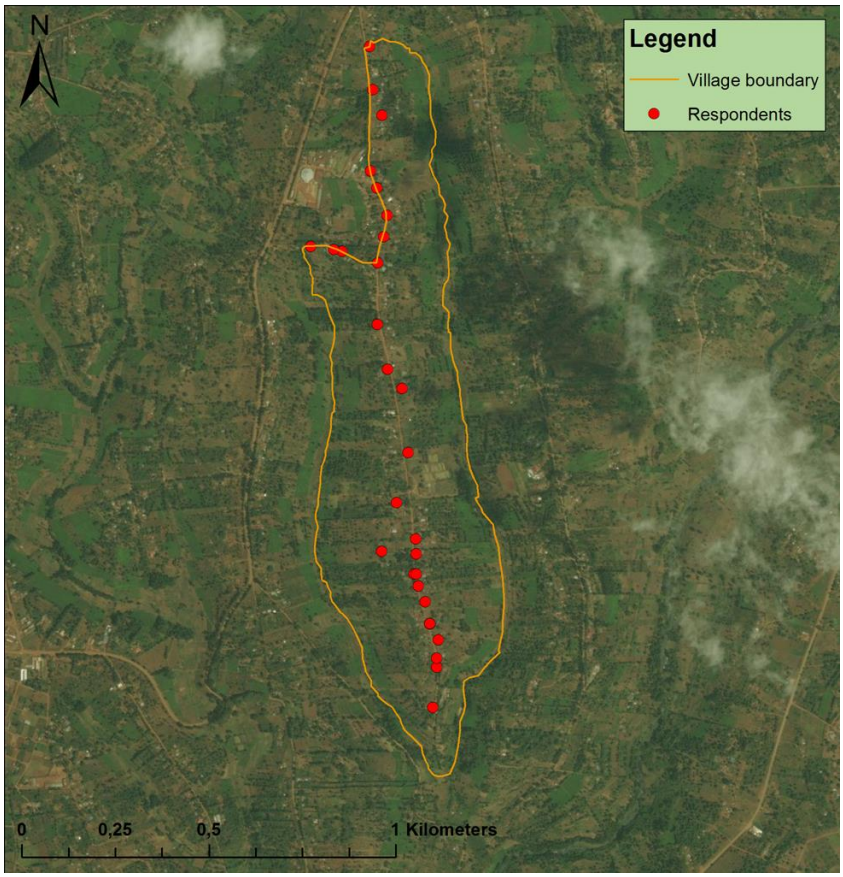

Figure 5: Household location of respondents

4.3 Semi-structured interviews

We carried out semi-structured interviews (SSI) with key informants from public and private institutions and farmers from Gikirima as one of our main tools, which allowed us to gather information about people's perceptions of the issues we wanted to explore. This type of interview consists of open-ended questions, prepared beforehand, and the informants are expected to express themselves and focus on the parts that they considered more relevant (Casley and Kumar, 1998).

4.3.1 SSI with farmers

In general, we tried to distribute our interviews across the following categories: geographic location, experiencing soil erosion, level of knowledge, age and income, see figure 6 for the spatial distribution of SSI.

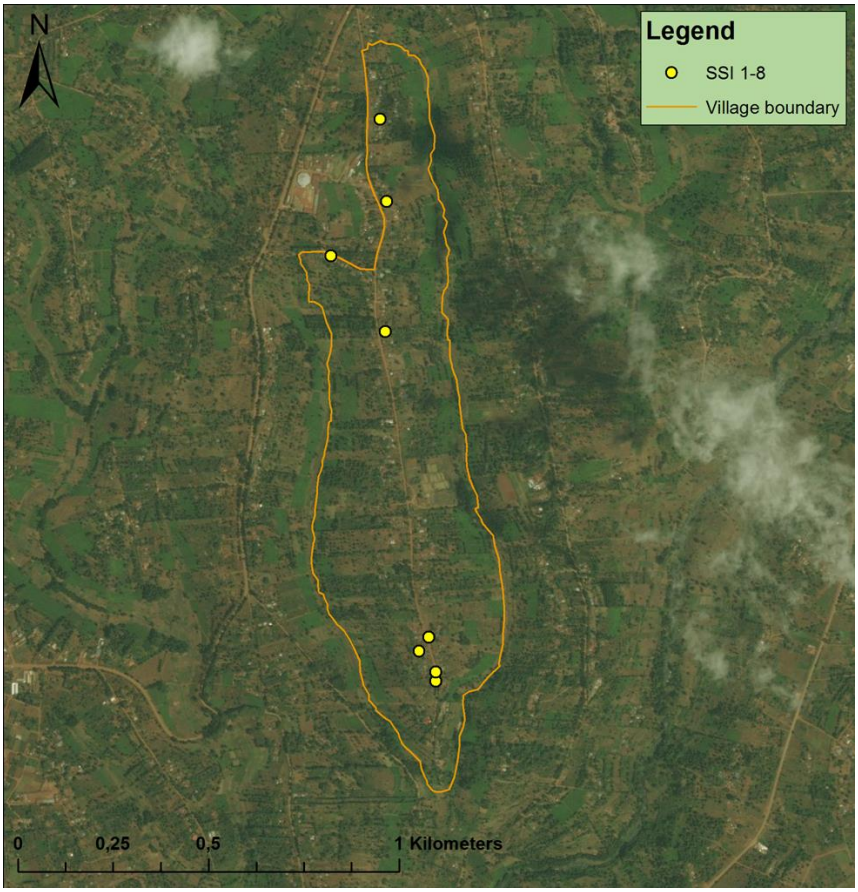

Figure 6: Household location of SSI.

The questionnaire gave us an idea of the different farmers we could find in Gikirima. We used this method as a sampling strategy for choosing our interviewees. Our aim was to gain information about the individual farmers understanding of soil erosion, management strategies and influential institutions. We conducted the interviews at the respondent's home, allowing them to have a safe environment. After the interview, we also visited the shambas in order to observe their main characteristics (crops, technologies used, steepness or levels of soil erosion) and triangulate their answers. The interviews were carried out in Kiembu and/or Kiswahili; therefore, a translator was needed.

As the Kenyan group and our group did not have the same objectives, we decided to separate and conduct individual interviews. Nevertheless, we shared relevant information with each other. As both groups' strategy was to talk to the informants from the questionnaire, we discovered some difficulties. Two respondents of our interest lived in the central part of Gikirima, but as the Kenyan group interviewed them, we decided to choose other informants.

4.3.2 SSI with key informants

Four extension officers from different institutions were interviewed: The Forestry Extension Officer Elizabeth Kariuki, the Agricultural Extension Officer Mary Wambugu, the extension officer from the Plant Clinic in Kibugu Eudesia Ndwiga, and the manager of the Coffee Factory John Mbogo. The aim of these interviews was to investigate the role of institutions in the area and the impact they have on farmers in Gikirima. These interviews were carried out in English.

Two elders from Gikirima were interviewed: Mrs. Ruth (109 years old) and Mr. Githinji (78 years old). The main objective was to understand the development in village throughout time. We wanted to focus on the main changes experienced in landscape, agricultural production and institutions. For the SSI with Mr. Githinji we carried out a life history interview, in order to get as much information as possible.

4.4 Participatory Rural Appraisal (PRA)

4.4.1 Transect walk

Our initial action in Gikirima was a transect walk to familiarize ourselves with the geography and farming practices of the village. Our guides provided us with a general information about the village, and GPS points were taken at each turn along with the landscape position, elevation, and general land use. Because of the topography of the village, which rests on a single ridge line, we could see the majority of the shambas. We also walked the road that runs through the center of the village on top of the ridgeline where we primarily observed village landmarks such as shops, schools, the homes of village elders etc.

We wanted to be able to characterize the natural and physical conditions of the village, and looked into technologies used, planting methods, soil quality and topography challenges inherent to the village. The transect walk gave us an understanding of the challenges faced by farmers and it necessitated us to adjust the content of the questionnaire in order to make it suited the respondents in Gikirima.

4.4.2 PRA session with women's group

Following the completion of our questionnaire and the majority of our semi-structured interviews, we ran a Participatory Rural Appraisal session with 10 women from a Gikirima women's group. The meeting was arranged with the help of our host families. The women were distributed in age from 35 to 80, see appendix 1. A similar exercise for men was not able to be carried out representing a possible bias in our characterization of the village.

Four exercises were facilitated: 1) social mapping, 2) participatory mapping of a typical shamba, 3) ranking exercise of SC technologies, and 4) seasonal calendar.

These methods allow an active analysis of the community context and a problem identification based on the discussion of its own members (Selener et al., 1999). The main objective was to investigate the ways in which farmers view their land, which technologies are used and their vision of the role of extension services. Data was gathered through the completed exercises and discussion.

The goal of the **social mapping** was to gain a spatial understanding of the problem of erosion in Gikirima. The participants were asked to draw their own shamba and discuss where soil erosion was prominent, both on their shamba and in the village. Another aim was to investigate where the villagers perceived the good and bad plots of land to be in the village. Beforehand we had drawn a map of Gikirima with the village boundary, the main road, coffee factory, church and school.

For the **ranking exercise**, we wanted to know which SC techniques the participants found most common and most effective. We wished to understand how the women reflected upon the different techniques, and if they related all of them with erosion control. The results are presented in table 7.

The aim of the **seasonal calendar** was to gain an understanding of the participants schedule and the main village's activities throughout the year. We wanted to know what months were the busiest of the year, when was money most limiting, and what activities the participants prioritize. We divided the sheet in 12 months and let the participants choose how to design it. One woman wrote letters corresponding to the activities her and the others wanted to include.

4.5 Mapping

We used the GPS continuously during our stay in Gikirima. We brought it with us at our transect walk, and this enabled us to construct a map of the village boundary and main road by plotting the GPS data into GIS. During the questionnaire, we plotted each location of household questioned, and the same was done during the SSI. This has provided us with information to construct maps to illustrate the spatial distribution we were seeking.

4.6 Slope assessment

The aim of the slope assessment was to triangulate the respondents own perception of their slope and erosion problem with the actual slope. We used a clinometer to calculate the slope on the 8 farms where we did SSI. The assessment was carried out by whoever was carrying out the semi-structured interview and not the same person every time, a possible source of error.

5. Results

Soil conservation in Gikirima is an important issue, nevertheless, it seemed that not everyone is maintaining their soils as finance and knowledge limit optimal maintenance. Our results are analysed and presented through the SLF with explicit focus on SC practices, this chapter presents four sections: SC practices in Gikirima, institutions influence on SC practices, livelihood assets influence on the use of SC practices and finally a section about livelihood outcome which is a result of the interaction of the previous stages.

5.1. Soil Conservation strategies in Gikirima

Gikirima is characterised by a steep slope, and we observed that everyone is using SC techniques to some degree (Transect Walk). The main technologies identified in Gikirima are shown in figure 7.

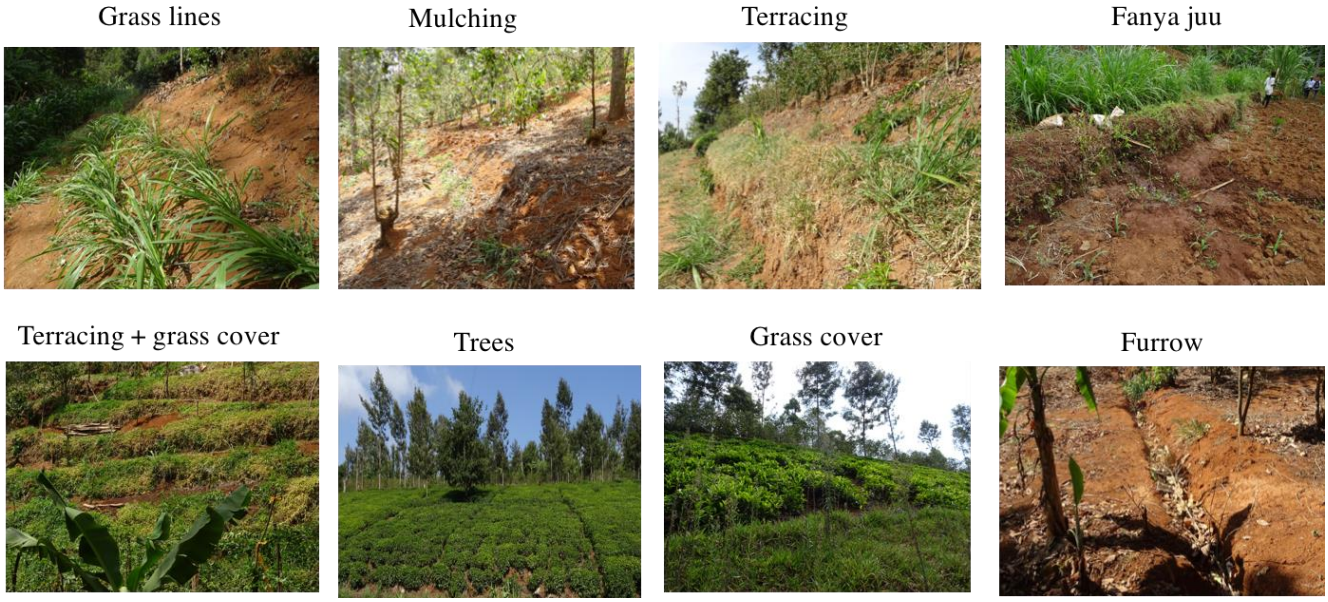

Figure 7: Main SC practices in Gikirima (Photos: Maite Jurado)

We observed that terracing is implemented on almost every farm, additionally cover crops, mulching and grass lines were commonly used (Transect Walk). We saw that some of the practices are combined to improve the SC efficiency. According to the participants at the PRA session, fanya juu should be combined with grass lines and terracing combined with cover crops, see table 3. Reduced tillage was not a technique the farmers knew about, and was not considered for erosion control (PRA).

SC Technique	Common	Effective
Terracing	3	2
Fanya juu	1	1
Cover crops	4	2
Planting trees	6	3
Grass lines	2	1
Mulching	5	4
Reduced tillage	7	5

Table 3: Ranking exercise PRA. (1= most used; 7= less used)

Fanya juu was not initially part of our SC technique list in the questionnaire, since we included it in the terracing; that is why it is not in table 4. However, in the field we realized that it is a frequently used technique and that farmers differentiated it from terracing: *"they* [fanya juu] *are higher, when the water*

comes it will not jump" (PRA). Generally, fanya juu are taller terraces with furrows, but even between the farmers we could see some discussion on the definition of the two techniques (PRA). As the two practices resemble each other we did not put too much into this distinction, but the locals express higher effectiveness and advantage for fanya juu.

When asked about the use of SC technique during the questionnaire, most respondents are implementing terracing see table 4 (Questionnaire), which match our impression from the transect walk.

SC Technique	Number of users
Terracing	24
Cover crops	7
Grass lines	15
Planting trees	11
Mulching	8
Other	6

Table 4: SC techniques used by farmers in Gikirima (Questionnaire)

As table 4 shows, 11 respondents are planting trees, but they mentioned that the purpose was not for soil erosion control. Rather the purpose is "*wind protection*" (R7), "*to attract the rain*" (R10), "*provision of firewood and timber*" (PRA) and lastly used "*along the boundary of the farm*" (PRA). From this we assess that knowledge about the potential role of trees in SC is absent, neither are trees prioritized as the size of the shambas is relatively small.
We observed a tendency to plant coffee and tea on the steepest part of the shamba; coffee on terraces or fanya juu, and tea directly on the slope, as its cover, its roots and the debris left on the soil is viewed as erosion control (PRA, SSI-5).

Given the apparent similarity in the use of practices (Transect Walk), the difference between farms comes with the quality of maintenance, since it is a practice that requires capital and labor investment. Before the rainy season starts, furrows and terraces must be redone in order to make them resistant against rain and runoff. The availability of different household capitals, described in the following chapters, influence the extent to which this maintenance is carried out (SSI-1, SSI-3, SSI-5, SSI-8). Figure 8 shows a well-maintained SC practice where terracing is combined with grass lines (SSI-6).

Figure 8: Well-maintained SC practices in Gikirima (photo: Maite Jurado)

Others did not seem to maintain their SC practices in the same manner, and thus their shambas looked like figure 9, where SC techniques could be observed, but the implementation was not optimal (SSI-8).

Figure 9: Not well maintained SC practices in Gikirima (photo: Maite Jurado)

We made few observations of farmers not implementing any type of SC technique, figure 10, which makes it difficult to cultivate. An example of this is, who SSI-2 mentioned that she could not control the flow of water and that erosion was too strong for her to cultivate half of her shambas. She had given up on food crops and just did tea.

Figure 10: Shamba with no implementation of SC practices (photo: Maite Jurado)

This leaves us with different degrees of effectiveness to which the population implement SC techniques. What we are interested in, is to understand what determines the implementation of SC practices which the following chapters will present.

5.2 Institutional influence in Soil Conservation

5.2.1 Formal institutions

There are a variety of public and private institutions available to farmers in Gikirima from which they can receive extension services and resources concerning soil erosion. Those identified by farmers in questionnaire and SSI include the Kenyan Ministry of Agriculture extension office, the Plant Clinic, the Kenya Forest Service (KFS), the Gikirima Coffee Factory, a facility of The Kibugu Coffee Farmers' Cooperative (Table 5)

Institution	Description	Services Provided to Farmers
Ministry of Agriculture - Extension Office	Provides one extension officer per sub-county, in charge of extension services on all farm practices.	Farmer Field Schools. Information through Media. Crop Technology Assistance. Private Partnership.
Ministry of Agriculture - Plant Clinic	Provides a plant clinic twice a week in Kibugu where farmers come with their infected samples.	Identification of Pest a disease sources. Mitigation plans for pest and disease.
Kenya Forest Service	National Agency that encourages agroforestry, and restoration of degraded forest as well as protection of intact forest. Their stated goal is to restore Kenya's forest cover to 10 % of land cover.	Free Seedlings. Agroforestry Extension. Restoration of degraded forests. Planting of trees (10 % cover objectives).
Kibugu Coffee Farmers' Cooperative	Local marketing institution, owned by 700 members throughout Kibugu Location with a processing factory in Gikirima.	On-farm visits. Fertilizer and Pesticide. Terrace Design. Coffee Specific planting knowledge.

Table 5: Institutions more or less present in Gikirima (Mary Wambugu, Elizabeth Kariuki, John Mbogo, Eudesia Ndwiga).

The private services, particularly the extension officers organized by the coffee cooperative, are the primary formal institutions that provide knowledge on soil erosion control techniques (Questionnaire, John Mbogo, PRA). They are the only services that visit farms on a regular basis, they measure the terraces and advises the planting of grass on the terraces (John Mbogo). The adoption of erosion control appears to be near universal where there is coffee planted in the village (PRA).

Farmers reported being advised on soil erosion control and terrace design (SSI-1, SSI-2), fertilizer use and pest and disease management by the coffee factory (Questionnaire). The tea factory advises the farmers to do mulching with the tea branches waste for fertility and erosion control, but the tea is not grown on terraces. Farmers reported they also advised them on waste management (SSI-2) and fertilizers use (SSI-1).

These formal institutions are limited in their effectiveness on soil erosion control because their role in organization is limited to specific crops, farm scale extension, and group marketing (SSI-4). The society does not coordinate farmers for soil conservation, in that control methods are not linked across property lines (PRA, Transect Walk). Non-aligned terraces, fanya juu, and grass lines limit the effectiveness and provide a weak point that can further erode a slope. The scope of this extension is limited in scale to one shamba. Furthermore, it does not seem that the farmers view the coffee and tea factory as forums for discussing

agriculture in any other way (Questionnaire). 5 out of 31 respondents mentioned that they were part of a cooperative as a social network, even though most of them seemed to have a connection to a cooperative in forms of sales of coffee (Questionnaire). We believe that they do not perceive it as a social network but as an institution to be accessed.

Mary Wambugu said that most farmers she visited were aware of soil erosion. The agricultural officer recommends them several technologies such as terraces, tree planting, cover crops, contouring of terraces or stone lines, and riverbank protection. Some field days are dedicated to soil and water conservation. Elizabeth Kariuki said KFS provides information on agroforestry for soil conservation and riverbank protection to the farmers. Through plant clinics, there are extension officers present in Kibugu twice a week, but they do not provide any informations on SC (Eudesia Ndwiga).

The government institutions, the agriculture extension office and the Kenya Forest Service, are available to the farmer, but the level of access is a matter of degree. The government uses a demand driven strategy and resources are low, which limits the access to those services (Mary Wambugu, Elizabeth Kariuki). In the vast majority of cases there has been no recent contact with a government extension officer (Questionnaire, SSI-3). Two respondents mentioned that the agricultural extension officer used to come but no longer have any contact (Questionnaire). There is even less awareness concerning the services offered by the KFS. There was no mention made of any service offered by the KFS by anyone in the village (PRA, SSI, Questionnaire). As such these government institutions appear to influence farmers in Gikirima very little in soil conservation. The coffee factory was the most cited to help with the laying of the terraces (Questionnaire, SSI).

5.2.2 Informal institutions

We have identified gender and family as underlying structures influencing the use of SC technologies.

Gender norms

During the PRA session, it appeared clearly that gender influences the extent to which women can implement SC techniques in regard to labor and time requirement, and access to knowledge and finance. Women are responsible for the farm, the household management and the children. Men are considered the head of household and are responsible for decision-making, especially in finance. They are the one with off-farm labor (Questionnaire),

SC techniques such as terracing or fanya juu are labor and time intensive and require physical strength. Generally, women need to rely on themselves or hire labor. SSI-6 mentioned that they could not implement the SC techniques they wanted because they could not hire labour and physically she was not able to do it. SSI-I and SSI-3 did not hire labor because it was too expensive. In SSI-1, the informant mentioned that without additional labor, it takes her 2 to 3 weeks to repair the terraces and that alone she cannot dig deep enough for perfect control of the water flow.

Women have heavy work days, which restrict the time they can allocate to SC techniques. When asked about the gender division in the household chores during the PRA, women described their day:

"In the morning we milk the cows, prepare breakfast, prepare our kids for school and feed the cows. If there is time, we go to the farm to cultivate and then we prepare lunch. We take coffee or tea to the factory. Later in the afternoon, we feed the cows, milk them and prepare dinner for the family. By the time we go to bed, we are exhausted. Sometimes we also wash the clothes".

Furthermore, those heavy work days restrict their access to knowledge and institutions where they could learn about SC techniques and general farming technologies. The extension that is available to farmers is offered in ways mostly amenable to men due to the division of labor and money in the household. Respondent 13 mentioned that she was aware of field days but could not attend because it was too far

(Questionnaire). SSI-2 said she had no information about SC techniques and wished she had more. Her husband could not help her. Eudesia Ndwiga said that most of the farmers coming to the plant clinics are men and that she is reaching women as an extension officer on the field and in women's groups, but not as a plant clinic officer. Furthermore, the women in the PRA confirmed they did not know about the plant clinic in Kibugu. They can be reached in their farm during the day, but the resources for farm visits have decreased and are limited. Women cannot afford the time or money to access services that are demand driven.

Mary Wambugu and Elizabeth Kariuki said that networks such as barrazas or churches were important in disseminating informations, but not specifically on soil erosion control. Nevertheless, the women at the PRA said, *"The village elder never invites for meetings, except when someone has committed suicide"* and if they are invited or aware of such events, they do not always have the time to go. If they go to church or barrazas, they often have to leave early to go do their chores. They are not part of the coffee cooperative, that has an important role in teaching farming about terracing, but only part of the women's groups (PRA). This was also seen in our questionnaire, where only half of the women asked stated that they were part of the cooperative because men are the head of the household. These results could explain the discrepancies between the knowledge that is present and the actual access those women said they have, which is limited or inexistent.

Finally, women have limited access to finance. Even though women are the primary farmers, the finance decisions and the cash generated ultimately goes to the head of the household. *"One challenge is lack of money to purchase fertilizer and seeds. The men do not help out in the farm, the women must make an effort to get the necessary inputs […] In general we lack fertilizer, labor, money and seeds"* (PRA). This limits the extent to which they can decide to invest in SC techniques, or hire labour to help them with it.

Family
Family is another important informal institution on which farmers rely for knowledge and labor which improve the implementation of SC techniques. For example, SSI-8 answered that he did not discuss farming with anybody and that it was something you learnt from your family. Family members also provide with labor to work on the farm. Two of the SSI informants pointed out that the fact that children are not at home influenced their ability to work on these technologies (SSI-4, SSI-6). Finally, the access to land is determined through family. 25 out 31 respondents said they inherited the land from their parents (Questionnaire). 7 respondents said that their land was owned by relatives but that they used it.

5.2 Household capital's influence on SC practices

5.2.1 Finance and Labor
We find that labor and finance are connected assets with regard to soil conservation. According to the interviews, farmers are limited by the lack of financial means to hire labor and the decrease of workers supply in the area. 22 respondents said finance was a challenge (Questionnaire). 8 respondents out of 31 identified labor as a challenge, however, this could be due to the type of question asked, that referred also to other kind of technologies besides SC. In the SSI, finance was identified as a challenge in implementation, but in relation to the ability to hire labor, a possible explanation for the low total in the questionnaire (SSI-1, SSI-2,SSI-6, SSI-8). Six out of eight households interviewed did not hire labor. SSI-8 connected labor and finance as limiting factor for his use of SC, and he seemed required to do all the hard work by himself (SSI-8). As SC techniques are labor intensive compared to fertilizer use, we discovered that hiring labor to redo e.g. terraces were given a lower priority economically.

In relation to specific technologies, labor is an important limiting factor for the implementation and maintenance of terracing and fanya juu. Often the implementation of terracing is a matter of access to human capital instead of lack of training (SSI-6, SSI-1, PRA). For example, SSI-1 is aware of the SC techniques

and interested in collecting water during the rainy season, but cannot implement it due to lack of labor and finance. The lack of labor influences the outcome especially if the main worker is aged as it happens in the case in SSI-6.

SC technologies are not the priority when it comes to invest in farming practices. Furthermore, there are other services that are seen as crucial nowadays such as children education. Farmers are struggling economically when sending their children to school, and as it was seen in many SSI, it is an important long-term investment strategy (SSI-1, SSI-6, Informal Conversations). The money earned from cash crops has to cover school fees, purchase of food, casual labor, fertilizers, seeds, pesticides etc. (PRA).

According to the interviews, farmers are limited by the lack of financial means to hire labor and the decrease of workers supply in the area. Furthermore, the family size has decreased due to family planning, leading to less available household labor. "*Those who cannot afford to hire* [labor], *they do it themselves. If we do not have money or labor we do terraces* [instead of fanya juu] *as it is simpler*" (PRA).

5.2.2 Social Network and Knowledge

In terms of knowledge about soil erosion, all the respondents and informants were able to identify soil erosion signs in their farms, mainly categorizing it as a seasonal phenomenon that results from the rains (SSI, Questionnaire, PRA).

From the questionnaire and the SSI, we received an overview of the different knowledge sources of SC techniques which are the coffee and tea factory, media, social networks (neighbours, church**),** government extension, family and education. Currently, the most influential and active institution can be considered the coffee and tea factories. 14 respondents mentioned them during the questionnaire, and in the all the SSI they were mentioned as the only assisting visitors in their shambas.

As discussed, the access to government extension services is severely limited by the demand driven outreach strategy. None of the SSI interviewees have been visited by the government extension officers lately. However, it was pointed out that they used to visit in the past and train farmers in fanya juu terracing (PRA, Questionnaire, Mr. Githinji).

It appears that general communication among neighbors and the village does influence farming practices. Soil erosion control is present in some form or another on almost every plot in the village which may indicate a village wide norm, also many respondents and interviewees identify that practices were discussed with their neighbors (SSI-3, Questionnaire). Nevertheless, the effect of these village relationships is limited to observation and some knowledge sharing. There is no coordination between neighbors on erosion control techniques despite its potential benefits e.g. terracing, where the path between plots undermines the effectiveness of terraces on both sides (PRA).

Some prominent networks are not used to discuss SC technologies. Church is generally not used as a forum for discussion agriculture, but rather they family issues (PRA, SSI-3). There is some mention of church being used to advertise extension services and agricultural products but this is rare (Mary Wambugu, Elizabeth Kariuki, SSI-2). Finally, the women's groups also seem to be generally oriented towards other topics.

5.2.3 Land Characteristics

As a consequence of land division between descendents, the farm size per household is relatively small (1.11 acres on average, ranging from ⅛ acres to 5 acres). Land fragmentation is mentioned as a challenge in the questionnaire and in the PRA session, as it demands intensive cultivation. This influences the soil fertility and the investments that a farmer is willing to take for a small plot. This is also a limiting factor in terracing,

as we observed in some of the shambas where only furrows and bananas trees were used to hold the soil (SSI-3).

During the transect walk of the village boundary we noticed that all shambas are located on slope and the steepest slope was located in the North-East, North-West and Southern corner. Our observations fit the Digital Elevation Model (DEM) presented in figure 11. When asked to discuss where in the village the land was best, or where erosion was the worst, it appeared they considered it was equal throughout the village, and that the difference laid in individual management decisions (PRA). However, the social map showed that there is more prominent erosion in the Northern part of Gikirima. The slope assessment, showed in table 6, shows that there is a prominent difference between the slopes in the village.

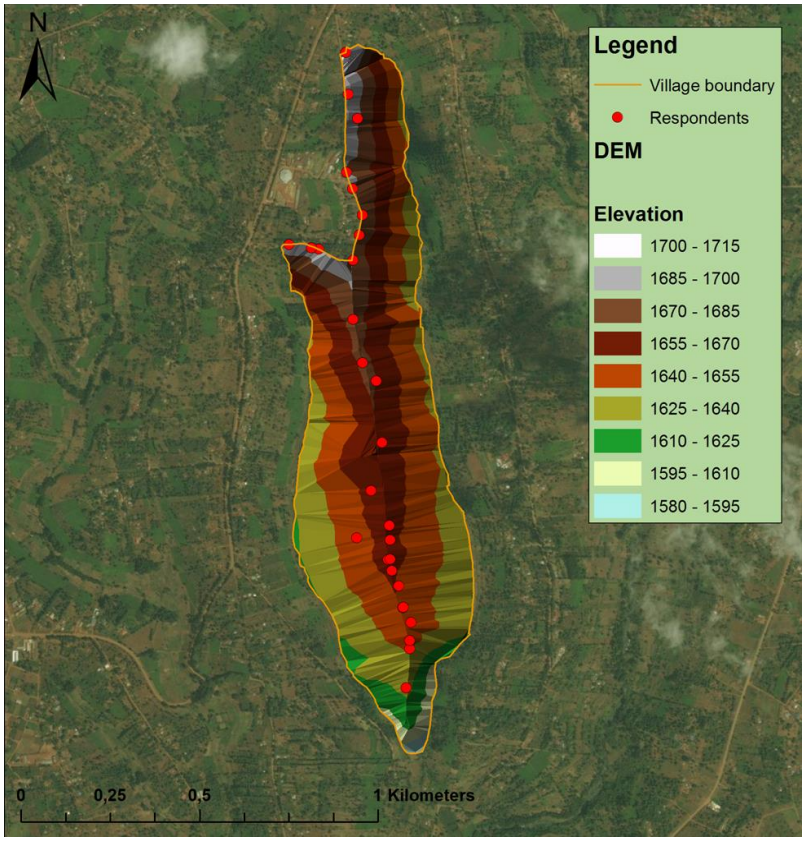

Figure 11: Digital elevation model of Gikirima with household location of respondents.

Informant	Slope
SSI-1	18
SSI-2	12
SSI-3	18
SSI-4	13
SSI-5	23
SSI-6	25
SSI-7	11
SSI-8	11

Table 6: slope assessment of SSI informants' farms

SSI-2 commented that her farm is poorly located because of runoff from two sides, that no SC techniques was efficient enough. This was the reason why she couldn't grow enough food crops and the reason why she

has decided to buy food instead of growing it. Her farm is located in the Northern part of Gikirima, and thus confirm the above assumption.

5.3 Context

5.3.1 National policy

Governmental extension officers used to be more present in the 1980's and 1990's, when they visited the farms (SSI-2, SSI-7, Questionnaire). SC techniques such as fanya juu used to be mandatory for growing coffee and enforced by the colonial government through extension officers. Mr Githinji told us that he learnt terraces when scouts visited his farm in the 1970's. The government, chiefs and extension officers used to be influential in disseminating agricultural knowledge (Elder Ruth and Mr. Githinji).

Mr Githinji commented "*Now the agricultural officers do not visit. The extension officers try to sell products to the farm*". Nobody answered that governmental extension officers currently come to their farm (Questionnaire). There is a disconnect, for example the extensions officers said they teach farmers about trees and erosion control, but there is very low perception of tree planting as erosion control among the farmers (Mary Wambugu, Questionnaire).

Furthermore, Mary Wambugu and Elizabeth Kariuki both said that since the devolution, some resources, such as transportation, are not available anymore: *"For example we had projects like NALEP which was helping the extension services to reach the farmers. There was facilitation for moving but not after devolution. And this has an impact on our work"* (Mary Wambugu).

There has been a shift to a demand driven extension by government services. This restricts on-farm visits and the contacts with farmers, especially women. *"Officers are few and the ratio between the extension officers and farmer is large. The ministry decided, that if you have a need, it is always good to demand the services; that is why it is demand driven. The gap has been created by freezing of recruitment of new staff while some have retired and others are deceased*" (Mary Wambugu). The official government guidelines on the National Agriculture Sector Extension Policy (NASEP) from 2012 confirms the shift away from top-down approaches and focuses on "*the importance of clientele participation and demand driven extension system; recognizing the role of the private sector in pluralistic extension; and setting out modalities for commercialization and privatization of extensions services*", a policy approach that matches our findings in the field.

This transition has resulted in private organizations replacing governmental institutions to provide extension services. During the questionnaire, it quickly became clear SC training came from the coffee factory (10 respondents), tea factory (10 services) and macadamia brokers (5 respondents). This may affect the way farmers comprehend their farm system; not from a holistic perspective with connected elements and flows, but focusing on specific crops, commercialization, and yield improvement.

5.3.2 Population distribution and demographic patterns

Changes in demographic and population distribution patterns have influenced the availability of labor necessary for SC techniques. According to the interview with Mr. Githinjii and the questionnaire, the number of family members have decreased, which can have been influenced by factors such as the size of the land and the cost of education. In addition to this, young people tend to move to bigger towns with off-farm jobs opportunities. During the interview with a young college student, his perspective was to move and find an off-farm job, but keep the land (SSI- 4). These trends influence the gender aspect of SC, as men are often the members of the household that leave to find formal labour, drawing labor away from the household.

5.3.3 Weather patterns and natural resource depletion

It was said that the rain pattern has been inconsistent during the last years compared to what it used to be, which impacts the amount of water flowing down the stream (Mr Githinji, Elder Ruth) The village elder Ruth also commented on this issue "*Mt. Kenya has broken and fallen down*" is a metaphor of the melted glacier at Mt. Kenya. She mentioned further that there used to be heavy rainfall which would fill the streams.

Furthermore, there is a general view of soil as a degrading resource in the area. This is mainly caused by the intensity of rains that wash the topsoil and the reducing size of the land that leads to intensification of crop production, not leaving time between harvest and sowing in many cases (PRA, Informal Observation). This increases the need for SC technologies to maintain soil fertility.

5.4. Livelihood strategies and outcomes

We have identified different livelihood strategies in Gikirima and we found that cash crops are the main source of income. As people strive to improve their income, they wish to increase their yields, which result in land intensification and increased use of farm inputs. During the PRA session, the participants mentioned that they both harvested and sowed seed at the same time, which influence the productivity of the soils, as nutrients do not have time to regenerate (PRA). Intensification stresses the importance of the adoption of SC strategies.

Most livelihoods strategies related to specific farming activities have a short-term prospect, influencing the extent to which farmers include SC techniques in their farming strategies. The lack of capital invested in these practices along with the constant cultivation can lead in the future to a higher soil depletion that can impact the crop yields and the sustainability of the natural resources within the shamba. Nevertheless, farmers could see the link between the implementation of SC techniques and the increased in soil fertility (SSI-1 and SSI-5).

Another important aspect is the investment in education. The shift towards formal education and formal employment and the absence of free public services after primary school, have made investment in children's education another household strategy with a long-term view. Migration from rural areas to urban centers leaves the elder generations in the rural areas. With less physical capacity than the younger, we observed that some farms are being left unfarmed and terraces not maintained, as the farmers did not have the strength nor the money for labor.

The adoption and maintenance of SC practices plays a key role in the sustainability of livelihoods in Gikirima. Households are vulnerable to external factors such as fluctuations in market prices in Kenya and internationally, climate change. The changing weather pattern requires resilient cultivation systems, in order to reduce vulnerability to shocks such as uncertainty and intensity of rains. The reliance on markets requires diversified production. Implementing successful SC techniques helps maintaining the farm fertility levels and yields, and thus farmers' income.

6. Discussion

This chapter presents two different discussions, first a discussion of our findings compared to other studies, where it is explained how our study fits into the existing information about soil erosion in Kenya. Secondly, a discussion of data use and methodology will illustrate possible errors influencing the results. In addition, we discuss how group dynamics and our separate studies are reflected in this study.

6.1 How our research fits into other studies

This paper adds to a large body of work investigating the drivers of both soil erosion. There are consistent themes that characterize the influences on soil erosion control concerning available capital, gender roles and institution influence, and how critical broader political economic trends manifest in differing household outcomes.

6.1.1 Magnitude of Population Effect

Tiffen (1994) put for the argument in a book entitled *More People, Less Erosion*, that a rise in population provided the needed human capital to reverse environmental degradation and soil erosion in an area similar in character to Gikirima. Our work largely corroborates this thesis however in the negative. While population is increasing nationally, urbanization and formalization of the workforce siphons labor away from smallholder agriculture in rural areas and this has had a negative impact on the adoption of soil erosion techniques. As our study shows labor is becoming scarce both within the family and in the community, this limits the ability of farmers to implement SC and the farm produces less as a result. Essentially smaller households and less productive farms limit the human and financial capital that are necessary for effective management of soil erosion. However, there are a number of other large scale processes that may have as much of an impact as demographic changes. Our results also show particularly that economic forces that favor the production of coffee and tea have had a very large effect on soil erosion control.

Population growing can drive agricultural intensification and contribute to food security, as stated in the Boserupian theory. However, this should be accompanied by an increase in institutional support for SC practices that maintain soil fertility (Okuva, 1999). The devolution of 2013 has been a complex process that has separated functions in agricultural sectors between the national and county governments and a decrease in resources. As we found in our study, the public institutions did not provide sufficient support for SC practices. Land fragmentation poses an additional challenge to rural livelihoods in Kenya. Gikirima is experiencing both issues with land size and crop intensification that is not accompanied by public assistance in training. Therefore, the argument of Tiffen (1994) has not worked in our area of study, at least with the absence of public training that currently characterised Kenya. As it is stated in Kabubo-Mariara (2015), institutional isolation directly impacts the adoption of SC techniques, along with land tenure security and market access.

6.1.2 Gender Norms and Outcomes

Gender roles were not the main aspect to be explored during our field work, however its influence in livelihood outcomes became apparent. Women face several constraints such as lack of access to productive resources such as extension services, improved inputs and marketing facilitation (Alila et al., 2006). Gendered division of labour hinders women's access to training and diversification of livelihoods strategies (Eriksen et al., 2005). Indeed, the fact that most women alone take care of the farm limits the adoption and the effective execution of SC.

More broadly, exclusion from formal and informal institutions, as well as public life, limits the knowledge that transforms outcomes on the farm. Cornwall (2008) highlights that even though women in rural areas wish to engage in organisations or meetings, they are often excluded due to their daily chores. This is seen in our study as a limiting factor for SC practices, but also for participation in social groups which may empower the women. However, the work of NGOs on empowering women through financial access is seen in Gikirima, where the women have strengthened their economy and thus been empowered (SSI-7, PRA).

6.1.3 Perception of Erosion Control

Identification of erosion is critical, but knowledge of erosion controls, and their effectiveness, are just as important in controlling erosion. With regard to the individual farmer's perception of erosion, our results corroborate what has been concluded by Okoba and De Graaf (2004). They showed that farmers in the central Kenyan highlands did not view forestry or cover crops as an erosion control. Our findings in Gikirima corroborate these results, where agroforestry is not widely practiced as a means of soil erosion control, nor is it even perceived to aid in erosion control. Given the perceived value of timber, this is a valuable target for multipurpose practices. There was however some knowledge that certain crops that are considered cover crops (legumes, sweet potato) are capable of controlling erosion, but adoption of these practices remains limited as well. Following the finding from Assefa and Hans-Rudolf (2016), we saw that as soil erosion is not seen as the biggest challenge in cultivating the land, and that SC practices are not implemented to a necessary extent.

6.1.4 Vulnerability and Resilience

An investigation into soil erosion, a process that is continuous and occurs on many timescales, offers insight in many ways into the processes that govern a response to climate change, and the general trends discussed here do not appear promising with regard to adaptation. Agricultural intensification and crop based extension may not contribute to building up the resilience of the farm system necessary for adapting to climate change.

Furthermore, less frequent and more intense rainfall will require a coordinated approach to soil erosion control around Mt. Kenya. Several farmers in Gikirima note that, in intense rainfall, their erosion control measures do not hold, consistent with findings in other parts of the country (Bryan et al. 2013). Long-term adaptive capacity can be undermined by short-term coping strategies in rural livelihoods if government action is not implemented (Gabrielsson et al. 2012). Bryan et al. (2013) notes that the effective utilization of social capital for community wide adaptation is necessary for successful climate adaptation. Demand based extension as well as privatized cash crop extension does not allow for proactive and coordinated usage of the social capital that already exists in the area and limits the adaptive capacity of a community.

6.2 Methodology Reflection

This chapter discusses our choice of methods in the field which may have influenced our results. We have been extremely time limited due to the structure of the SLUSE course. However, we have worked hard in the field and in Copenhagen and believe that we have attained the pursued goal of this interdisciplinary course, using different methods and theoretical approaches to define what influences farmers' decisions to implement SC practices. However, time and resource limitations made it difficult to assess the magnitude of different influences.

We sought to find unbiased and objective data in the field, but as cultural differences and subjectivity cannot be eliminated, biases become possible source of error. The respondents and informants interviewed may have had personal biases for talking to us. It is difficult to say if they wanted to be interviewed due to our presence, potential gifts or benefits. We started our questionnaire Monday morning, which in Gikirima is one of the two days where farmers collect tea for the tea factory which must be brought by midday.

During our fieldwork, we did not quantify the degree of maintenance systematically, which could have been useful as it may have provided us with a baseline for comparing maintenance at the farms. We relied on our pictures and notes, which made it difficult to assess maintenance in a uniform way.

Additionally, if we were to do this research again, we would look further into the role of gender in soil erosion control outcomes, as we believe this power relations in the household affect access to information.

Reflecting upon our use of framework, we have had trouble finding a framework that fitted our approach and research questions. At first, we designed our own framework where a farmer's final decision was influenced by several factors (physical, financial, social), mediated by his capital endowment. In the end, we changed our research questions to fit into the SLF. We had some issues because the SLF is more general than our focus on SC practices but we adapted it in a useful way to frame our report.

6.2.1 The use of guides

As we did not speak Kiswahili nor Kiembu the use of guides as translators has been fundamental. We made sure to inform our guides, James and Sylvia, about the objectives of the research as they had to introduce and explain the purpose of our presence before conducting interviews. As the guides were not experienced in translating, at times they went beyond the scope of our research with their questions e.g. about rainbows in the past. Nonetheless, they mostly provided us with a deeper understanding of the situation as the guides wanted to make sure that we received our pursued answer.

It is our impression that translating from Kiembu to Kiswahili did not feed difficulties, whereas the translation to English was of a quite difficult matter, even at times for our Kenyan Counterparts. The language barrier has affected our results as we multiple times experienced long conversations on Kiembu or Kiswahili which were only translated to short responses e.g. "medium slope".

6.2.2 Group dynamic

We were placed in an interdisciplinary team as we are from different countries, studying different fields and have different methodological and theoretical approaches. Our group consisted of a geography student, an agris mundus student, an agricultural development student and a climate change student. We have used each one's capacities to the best during the data collection and the writing of the report, dividing the work depending on people's strengths and interests. We chose to focus on social sciences, which has influenced our choice of methodology and data collection in this project. We did not struggle to cooperate.

Cooperating with Kenyan students has been very useful as they provided us with cultural and country specific knowledge, which we otherwise would have overlooked. We decided to cooperate in the questionnaire and the key informant interviews, but separated during the SSI. We did not experience any problems in this division, and we shared new insights with each other.

In the end, we have relied on our findings as being strong, we have made sure to triangulate between methods and to create good relations with our respondents and informants with the purpose of establishing trust.

7. Conclusion

The aim of this report has been to examine what influence farmers' decisions to adopt SC techniques in a context where soil fertility is declining, in a location that is considered among the highest quality, most productive land in Kenya. The research project sought to explore to which extent farmers are influenced by endogenous factors such as household capitals and exogenous conditions represented by institutions and macro level processes.

We found that farmers are influenced by various factors when choosing to implement SC techniques. Livelihood capitals influence land management decisions in Gikirima. Access to finance, labor, knowledge, and social networks play an essential role for farmers in implementing SC practices and maintaining their efficiency. However, access to finance and labor are the main limitations.

The current role of formal institutions can be summarized as a decline of access to public extension services, thus the influence of cash-crop related (coffee, tea, macadamia) private companies has become critical in order to sustain the SC techniques. Decreased funding for agriculture since the 1980s, and the devolution have made public extension services demand driven, which has led to a sort of institutional marginalization when it comes to advising in SC practices. However, information provided by extension officers regardless of source, plays a major role in supplying farmers with knowledge about SC techniques, and improving yields on their farms. Additionally, the influence of crop-specific recommendations in regard to soil management may prevent farmers from considering the shamba as a system.

Prevailing informal institutions, represented by gender and family norms, results in an unequal access to institutions and influence the usage of capital. Gender norms appear to siphon knowledge, labor and capital away from the shamba, limiting women's ability to achieve effective SC.

Finally, we found that context and macro-scale trends influence farmers as they must adapt to rapid changes both in terms of climate change but also in terms of access to the market. Gikirima has evolved into a highly cultivated village where societal changes are felt as urbanization trends and off-farm employment is attracting youth and leaving behind an elder generation that is required to adapt a long-term livelihood strategy in order to achieve security.

7.1. Implications

We believe that our project has contributed to the field with new insights about the source of information provided to farmers. From our results above, there are several implications that can be considered.

Firstly, government action is needed in order to fill the gap present between farmers and the public extension officers, taking into account the particular challenges women farmers face in accessing those services. Information provided is compartmentalized and crop dependent. Thus, public and private institutions should consider the farm as an holistic ecosystem. Furthermore, land intensification needs to be accompanied by training in different strategies that avoid soil from be depleted.

Privatization and focus on market have centralized cash crops and yield improvements, but improving soil fertility should remain a priority. Nutrient depletion is a current risk that may increase household vulnerability in the next years. Actions on soil conservation and climate change resilience need to be coordinated at the village level, which implies a mobilization of social networks and institutions present. Migration has affected the labor supply and its costs, which heightens the need to rely on social network to fill the gap.

Finally, there is room for further research that relates gender issues with SC adoption and access to knowledge in the area as well as future and present climate vulnerability.

References

Alila, P.O., & Atieno, R. (2006). Agricultural Policy in Kenya: Issues and Processes. Nairobi: Institute for Development Studies, University of Nairobi.

Agricultural Sector Coordination Unit (ASCU). (2012). NATIONAL AGRICULTURAL SECTOR EXTENSION POLICY (NASEP). Government of Kenya. Nairobi.

Alufah, S., & Shisanya, C.A., & Obando, J.A. (2010). Analysis of Factors Influencing Adoption of Soil and Water Conservation Technologies in Ngaciuma Sub-Catchment, Kenya. *African Journal of Basic & Applied Sciences 4* (5): 172-185, 2012

Awiti, A. (2017, March 14th). Africa's Famine is mostly man-made. *The Star*.

Assefa, E., & Hans-Rudolf, B. (2016). *Farmers' perception of land degradation and traditional knowledge in Southern Ethiopia—resilience and stability.* Land Degradation & Development, 27(6), 1552-1561.

Byiringiro, F., & Reardon, T. (1996). Farm productivity in Rwanda: effects of farm size, erosion, and soil conservation investments. *Agricultural economics*, *15*(2), 127-136.

Cohen, E. (2002). *Land tenure and land degradation in eastern Africa*. Working Paper No.15. Regional Land Management Unit (RELMA). Swedish International Development Cooperation Agency

Cornwall, A. (2008). Unpacking 'Participation': models, meanings and practices. Oxford University Press and Community Development Journal. 269-283.

DFID (2000). Sustainable livelihoods guidance sheets. *Department for International Development*

Ellis, F. (2000). A Framework to Livelihoods Analysis, Chapter 2 in *Rural Livelihoods and Diversity in Developing Countries*. Oxford University Press.

Eriksen, S. H., Brown, K., & Kelly, P. M. (2005). The dynamics of vulnerability: locating coping strategies in Kenya and Tanzania. The geographical journal, 171(4), 287-305.

Foster, A. D., & Rosenzweig, M. R. (2010). *Microeconomics of technology adoption*. New Haven, Conn: Yale Univ., Economic Growth Center.

Gabrielsson, S., Brogaard, S., & Jerneck, A. (2013). Living without buffers—illustrating climate vulnerability in the Lake Victoria basin. *Sustainability Science*, 8(2), 143-157.

G-fras (n.d.). Worldwide Extension Study: Africa: Eastern Africa: Kenya. Global Forum for rural advisory services. Available at http://www.g-fras.org/en/world-wide-extension-study/africa/eastern-africa/kenya.html

Gregory, D., Johnston, R., Pratt, G., Watts, M., & Whatmore, S. (2009). The Dictionary of Human Geography. Wiley-Blackwell, West-Sussex.

Holden, S. T., Shiferaw, B., & Wik, M. (1998). Poverty, market imperfections and time preferences: of relevance for environmental policy? *Environment and Development Economics*, *3*(01), 105-130.

Index Mundi. (n.d.) Rural Population in Kenya. Available at: https://www.indexmundi.com/facts/kenya/rural-population

Jakimow, T. (2013). Unlocking the black box of institutions in livelihoods analysis: Case study from Andhra Pradesh, India. *Oxford Development Studies*, 41(4), 493-516.

JoyWo (n.d.). Joyful Women Organization http://joywo.org visited 27/03/17.

Kabubo-Mariara, J. (2015). Does Institutional Isolation Matter for Soil Conservation Decisions? Evidence from Kenya. *Sage Open*, 5(1), 1-9

Kang, B. T., Reynolds, L. and Atta-Krah, A.N. (1990) Alley farming. *Advances in Agronomy* 43, 315-359.

Kimaru, G., & Jama, B., (2006). Improving land management in eastern and southern Africa: A review of practices and policies. ICRAF Working Paper no. 18. Nairobi, Kenya. World Agroforestry Centre.

Lal, R. (1990). Soil erosion and land degradation: the global risks. *Advances in soil science* (pp. 129-172). Springer New York.

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

Mutisya, T.W, & Luo, Z., & Nenkari, J. (2010). Soil and Water Conservation in Kenya-Operations, Achievements and Challenges of the National Agriculture and Livestock Extension Programme (NALEP). *Journal of American Science, 6*(3), 7-15.

National Accelerated Agricultural Inputs Access Program (NAAIAP)., Kenya Agricultural Research Institute (KARI). (2014). Soil Suitability Evaluation for Maize Production in Kenya. Nairobi: Department of Kenya Soil Survey.

Nyangito, H. (2003). *Agricultural trade reforms in Kenya under the World Trade Organization framework*. Nairobi, Kenya: Kenya Institute for Public Policy Research and Analysis.

Okoba, B. O., & De Graaff, J. (2004). Farmers' knowledge and perceptions of soil erosion and conservation measures in the Central Highlands, Kenya. *Land Degradation & Development*, 16(5), 475-487.

Okoba, B. O., & Strek, G. (2006). Quantification of visual soil erosion indicators in Gikuuri catchment in the central highlands of Kenya. *Geoderma, 134*, 1, 34.

Ovuka, M. (1999). More people more erosion? Land use, soil erosion and soil productivity in Murang'a District, Kenya. *Land Degradation and Development, 11:* 111±124 (2000)

Pimentel, D., Harvey, C., Resosudarmo, P., & Sinclair, K. (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science*, *267*(5201), 1117.

Pimentel, D. (2006). Soil erosion: a food and environmental threat. *Environment, development and sustainability*, *8*(1), 119-137.

Ribot, J. & Peluso, N.L. (2003) A Theory of Access. *Rural Sociology*, *68*(2), pp.153-181

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies*, *36* (1), pp.171-196

Selener, D., N. Endara, and J. Carvajal (1999). Participatory rural appraisal and planning workbook. The International Institute of Rural Reconstruction, Quito, Ecuador, pp. 3 – 7

Shanguhyia, M. S. (2015). *Population, "tradition", and environmental control in colonial Kenya.* NY: Boydell & Brewer, University of Rochester Press.

SLUSE (2017): SLUSE 2017 Study Thematic Areas. Country: Kenya.

Smucker, T. A. & Wisner, B. (2008). Changing household responses to drought in Tharaka, Kenya: vulnerability, persistence and challenge. *Disasters*, 32(2), 190-215.

Tiffen, M., Mortimore, M., & Gichuki, F. (1994). More people less erosion: environmental recovery in Kenya. Chichester [u.a]: Wiley.

WOCAT (2007). SWC Technology: Improved trash lines, Uganda, 121-124.

World Bank. (1999). *Précis: Agricultural Extension, the Kenya Experience*. World Bank Operations Evaluation Department.

Young, A. (1989). *Agroforestry for soil conservation* (Vol. 4). Wallingford, UK: CAB International.

Appendix I: Applied Methods

Mapping

38 Waypoints and 2 tracks taken during the 2 transect walks on 4th of March.
31 Waypoints taken at each household during the questionnaire 6th of March.
8 Waypoints taken at each SSI household from 7th of March to 10th of March.

Questionnaire

1 pilot test conducted with Mr. Githinji the 5th of March.
31 Questionnaires conducted in Gikirima the 6th of March.
Questionnaire conducted in three groups with one speaking Kiembu in each group:

1. Christine, Amalie and Sylvia
2. Lucy, Maite and Alice
3. Lucky, Tim and James

Semi Structured Interview

8 Semi structured interviews were conducted with farmers in Gikirima Village from 7th to 10th of March.

1. SSI-1

Observations: Has implemented terracing on her shamba, but they are not well maintained.
Semi-structured interview 7th of March
Interviewer: Maite
Translator: James
Supplementary questions and note taker: Alice
Present: Dr. Thenya and Dr. Onyango

2. SSI-2

Observations: Has implemented minor SC techniques, half of the land is left bare and the rest is not well maintained.
Semi-structured interview 7th of March
Interviewer: Alice
Translator: James
Supplementary questions and note taker: Maite
Present: Dr. Thenya and Dr. Onyango

3. SSI-3

Observations: House located on a relatively small size of land with steep gradient, did not seem aware of different soil erosion techniques, not well maintaining soil erosion.
Semi-structured interview 8th of March
Interviewer: Amalie
Translator: James
Supplementary questions and note taker: Maite

4. SSI-4

Observations: Has implemented SC practices, and they are well maintained, household labor available. Well informed about farming practices.
Semi-structured interview 8th of March
Interviewer: Maite
Translator: James

Supplementary questions and note taker: Amalie, Tim

5. SSI-5
Observations: Has implemented SC practices and they are well maintained, household labor available.
Semi-structured interview 10th of March
Interviewer: Maite
Translator: James
Supplementary questions and note taker: Tim

6. SSI-6
Observations: Has implemented SC practices, but her terraces are very damaged and lack maintenance.
Semi-structured interview 10th of March
Interviewer: Maite
Translator: James
Supplementary questions and note taker: Tim

7. SSI-7
Observations: Has implemented SC techniques and they are well maintained. She hires labor day-to-day for assistance in her shamba.
Semi-structured interview 10th of March
Interviewer: Amalie
Translator: Sylvia
Supplementary questions and note taker: Tim

8. SSI-8
Observations: Has implemented SC techniques, his terraces and furrows were decently held, but the grass lines were weak.
Semi-structured interview 10th of March
Interviewer: Maite
Translator: James
Supplementary questions and note taker: Alice, Tim

6 semi structured interviews were conducted with key informants from the 7th to the 10th of March.

1. Mary Wambugu
Title: Agricultural Extension Officer
Semi-structured Interview 8th of March
Interviewer: Tim
Supplementary questions and note takers: Alice, Amalie, Christine, Lucky, Lucy, Maite
Present: Dr. Thenya and Dr. Onyango

2. Elizabeth Kariuki
Title: Senior Forester, Forest Extension Officer
Semi-structured Interview 8th of March
Interviewer: Lucy
Supplementary questions and note takers: Alice, Christine, Lucky, Lucy, Tim

3. John Mbogo
Title: Coffee Factory Manager
Semi-structured Interview 7th of March
Interviewer: Christine

Supplementary questions and note takers: Alice, Lucy, Tim

4. Eudesia Ndwiga
Title: Extension officer at the Plant Clinic in Kibugu
Semi-Structured Interview 10th of March
Interviewer: Emilie
Supplementary questions and note takers: Alice, Camilla, Emilie, Frederik, Jeannette, Lucky, Natasha, Peter.

5. Mr. Githinji
Title: Village elder
Semi-structured Interview 10th of March
Interviewer: Amalie
Translator: James
Supplementary questions and note takers: Alice, James, Lucky, Maite, Tim

6. Ruth
Title: Village elder
Semi-structured Interview 7th of March
Interviewer: Amalie
Translator: Sylvia
Supplementary questions and note takers: Lucky, Tim
Present: Ebbe

PRA

2 Transect walks were conducted 4th of March: One of the village boundary, and a second of the main road.
Participants: Alice, Amalie, Christine, Lucky, Lucy, Maite, Tim
Guides: James and Sylvia

A seasonal map, a ranking exercise and a social map was conducted during a PRA session with 10 participants from Gikirima Village the 9th of March.
Facilitator: Christine
Participants: Purity Mukami Muriithi (age 35), Lucy Wawira (age 45), Regina Kithinji (age 73), Regina Gichovi (age 64), Jemimah Wangiri (age 80), Damaris Wambeti John (age 75), Jacintah Wawira Nyaga (age 43), Millient Karimi (age 35), Wanyaga Kariuki (age 60), and Flora Muthoni.
Present: Alice, Amalie, James, Lucky, Lucy, Maite, Sylvia, Tim

Seasonal Map:

HC = Harvest coffee, L = Labor need peak, TF = Terraces and Fanya Juu digging, Fer = Fertilizer

Ranking Exercise:

SC Technique	Common	Effective
Terracing	3	2
Fanya juu	1	1
Cover crops	4	2
Planting trees	6	3
Grass lines	2	1
Mulching	5	4
Reduced tillage	7	5

Field observation

Field observations were done throughout our time in Gikirima (2nd of March to 13th of March). We were housed by three different families: Githinji Mbogori hosted Christine, Alice and Tim; Gilbert Mbugua hosted Lucky and Maite; Wanyaga Kariuki hosted Lucy and Amalie.

Informal conversations with informants at the Agricultural Fair 3rd of March. During the fair, we spoke with a private company promoting horticultural crops; a representative from Kenya Plant Health; representatives from Kenyan Tea Development Agency; a representative from Embu County; and Ward Agricultural Officer for Embu County Mbia Samuel. We also walked around on a demo plot where the county promoted ways of cultivating different crops.

Slope Assessment

Slope assessment was carried out during our SSI with farmers in Gikirima.

Appendix II: Questionnaire

We are students from University of Nairobi and University of Copenhagen. We are here to learn about your Crop Farming Technologies and would like to ask you a few questions .All answers from this study will be confidential and for research only. Please, answer as briefly as possibly.

GPS Point	Interviewer
Household Name	Note Taker
Picture	Date and time

1. What is your gender?
    - Male
    - Female
2. How old are you?
    - 18-35 yrs
    - 36--55yrs
    - 56 years and above
3. Marital Status
    - Single
    - Married
    - Divorced
    - Widowed
4. What is level of education?
    - None
    - Primary
    - Secondary
    - College
5. Are you part of any the following networks?
    - Church
    - NGO
    - Cooperative (specify)
    - Social Club
    - Others
6. What are the 3 main income sources for your household? Mark 1 for the highest source of income, 2 for medium, 3 for lesser source.
    - Cash crops
    - Livestock
    - Handicrafts
    - Off farm employment
    - Services
    - Remittances
    - Only subsistence
    - Other income source, please specify……..
7. How many people are you in this household?
8. How do you consider your household income?
    - Low Income
    - Middle Income
    - High Income
9. How many acres is your farm?
10. How would you rate the slope at your farm compared to your Village?
    - Low

- Medium
- High

11. How did you acquire this land?
    - Inherited
    - Rented
    - Purchased
12. What type of land tenure situation is your land?
    - Own with title deed
    - Own without title deed
    - Owned by parents or relatives but we use
    - Community ownership
13. What are the main types of crops you grow in your farm?
    - Tea
    - Coffee
    - Banana
    - Macadamia
    - Maize
    - Legumes: Beans, Cow peas, Pigeon Peas,
    - Root Crops: Arrow roots, Irish potatoes, Sweet Potatoes, yams
    - Fruits: Avocados, Passion Fruits, Pineapples, Tree tomatoes
    - Napier Grass
    - Agroforestry plants: Grevillea Robusta (Mukima), Calliandra
    - Others
14. How fertile do you think your soil is currently?
    - Low
    - Medium
    - High
15. Are you experiencing soil erosion?
    - Yes
    - No
16. If yes, what type of erosion are you experiencing?
    - Sheet erosion
    - Rill erosion
    - Gully erosion
    - Splash erosion
    - Do not Know
17. Do you use soil and water conservation methods?
    - Yes
    - No
18. If yes, which methods?
    - Terracing
    - Cover crop
    - Grass lines
    - Planting trees
    - Mulching
    - Other
19. Which type of crop farming technology have you adopted?
    - Irrigation
    - Soil and water conservation
    - Using of hybrid seeds
    - Mixed farming and Intercropping
    - Use of organic fertilizer
    - Use of inorganic fertilizer

20. Do you have any credit facility that support crop farming technologies?
    - Yes
    - No
21. If yes from which institution?
22. What motivates you to use the above chosen crop farming technologies?
    - High productivity
    - Regulatory policy on exports
    - Awareness from Extension officers
    - Media
    - Financial Access
    - Availability of resources (e.g. organic manure)
23. What challenges are you facing in adoption of the crop farming technology?
    - Financial
    - Awareness
    - Labor
24. Do you have a field extension officer visiting you farm?
    - Yes
    - No
25. If yes, from which organization / institution?
    - Government
    - NGO
    - CBO
    - Cooperative
    - Research Institution
26. What is their role?

Thank you for your time.
If we have some further questions can we contact you in the coming days? _____
Altitude, Observation, Credibility, Impression, Motives, Notes

Appendix III: Interview Guides

Interview Guide with farmers

- How do you know that your soil is eroded?
- What do you do to prevent soil erosion?
- When did you start to use these methods?
- Where did you learn to do that?
- How much does it cost (time, labor, money) you to make this (terraces/grass lines/agroforestry)?
- Can you get any loans for soil conservation techniques?
- To what extent do your neighbors/the church/social groups influence your decisions?
- To what extent do financial factors influence your decision?
- Are there any additional factors which influence your decision to implement technologies?

Interview Guide Agricultural Extension Officer Mary Wambugu

General introduction:

- What area do you cover?
- How do you deliver information?
- What is your relation to politics (the government)? e.g. guidelines, policies etc.
- Which resources do you posses?

Historic overview:

- How long have you been working as an extension officer?
- Has your role evolved?
- Are there more or less extension officers now?

What are the main issues you advise farmers on currently?

Soil conservation:

- How do you advise farmers to control soil erosion?
    - What factors do they take into considerations? e.g. topography, type of farms.
    - What is the efficiency of the methods?
    - Do you do any follow-up?
- To what extent has the issue been controlled? (Better/worse)
- Are there field days dedicated to soil erosion?

Hybrid seeds and fertilizers:

- What do you advise farmers to do?
    - Methods: what type of seeds/fertilizers?
    - What is the efficiency of the methods?
    - Do you do any follow-up?
- How do they determine what type of fertilizers for seedings?

Efficiency of extension services: influence of farmers?

Do you collaborate with other stakeholders:

- How do you work in collaboration with other stakeholders with similar scope of work to disseminate information?
- How do you ensure that the information reaches all the farmers at the right time?
- Are there any programmes on capacity building for farmers in relation to sustainable agriculture?
- According to your view what challenges do you encounter in the course of your duty?

Interview Guide Forest Extension Officer

- What are your functions?

- What area do you cover? How often do you visit?
- Were you employed in the 1980's? Brief history of the role of the forest extension officer (structural adjustment)
- What do you advise farmers to do? Any specific advices on soil erosion control?
- Do you see farmers implement your strategies and advices?
- Do you offer any financial support?
- How is erosion in this region? under control? better or worse?

Interview Guide Village Elder Ruth

- For how long have you lived in Gikirima/this area?
- What did Gikirima look like when you came?
- Which transitions have taken place in Gikirima? (Labor, population, ownership, crops, land use, farming practices, river, weather patterns)
- Who has been influential in Gikirima?
- Why has transitions/changes taken place?
- Are there any governmental policies which have influenced Gikirima?
- What are the biggest challenges facing farmers today?

Interview Guide Mr. Githinji

- Can you explain the highlights of your life from you were child uptill today?
- Can you explain the most important changes in Gikirima?
- What did Gikirima look like when you moved here?
- Which transformations have taken place in Gikirima? (labor, population, ownership, crops, land use, farming practices, weather patterns)
- What is the role of the church?

Interview Guide Plant Clinic

The interview were conducted by the "plant and disease" group and their interview provided us with the information needed about gender, services for farmers and we asked an additional question about their soil conservation services.

Interview Guide Coffee Factory Manager

General description of functioning

- price of a kg of coffee
- how much profit on a kg of coffee
- loans and conditions (for SWC?)

What do they recommend for erosion control?
What type of extension services do they provide?
Role in the community

- number of members
- how do they influence farmers
- CSR?

Appendix IV: Final Synopsis

Motivational factors behind farmer's choice of soil conservation technology in Kibugu location, Embu County

Interdisciplinary Land Use and Natural Resource Management SLUSE 2017

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Final synopsis February 24th 2017
2,650 words
University of Copenhagen

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1. Introduction

Soil erosion is a worsening problem in sub-Saharan Africa (Lal, 1990), and contributes to significant losses in the agricultural sector that hampers economic development (Pimentel et al. 1995) and heightens the risk of food insecurity (Pimentel, 2006). The issue is difficult to address in a rural context dominated by smallholder agriculture because high rate of time preference (Holden et al., 1998), social considerations (Byiringiro and Reardon, 1996) and extreme aversion to risky investment (Foster and Rosenzweig, 2010) dominate the decisions of the farmers. The returns from investment may not be realized over short timescales, and the gains may be discounted heavily by those in poverty (Holden et al., 1998).

Embu county is situated on the slopes of Mount Kenya, around 120 km North East from Nairobi and its capital is Embu town, a fast-growing metropolitan area. The Kibugu location has a total population of around 5,000 individuals, distributed across 2,651 households. Agriculture is the main source of livelihood for the people in Embu county. Agricultural production is characterized by tea and coffee farming, vegetables and horticultural products, mostly in small scale commercial, subsistence farms. In Kibugu 70% of the population is employed in the agricultural sector, and more than 80% of the households engage in some agricultural activities. Cash crops and livestock farming have been intensified.

Embu county has different agroecological zones. Kibugu is situated at around 1,600 masl, with altitudes increasing South to North and East to West. It has a bimodal rain pattern, with long rain between March and June and short rain between October and December, with rainfall level of around 1,500 mm per annum. The area is mostly composed of deep Nitisol soils, that have a high clay content and a blocky structure. However, those soils can be subjected to low Phosphorus and organic carbon levels and have a low pH. There are high erosion levels in the county because the hills are heavily cultivated (Okoba and Strek, 2006). Previous researchers in Embu county found that 98 % of the farmers experienced soil erosion, despite soil conservation and land management efforts (Okoba and De Graaff, 2004). Appendix 7 describes techniques commonly used in Embu county to address soil erosion.

Land management decisions such as mitigating erosion through conservation techniques depend on several drivers: physical, economic and social. They influence the farmer's perception of erosion as a problem and the choice of techniques they chose to combine. Long-term efficient erosion control can fail due to several factors. Failures in conservation projects can happen for several reasons: (1) lack of extension offices and trained officers, replaced by private providers. (2) lack of financial resources for tools or farm inputs. (3) strategies did not include other stakeholders such as education or local governments, or did not consider the farmers' diverse income strategies. (4) projects did not link environmental issues, social equity and economic development in a sufficient way (Mutisya et al, 2010).

Physical Drivers

The decision of the farmer to invest in erosion control depends on the recognition of erosion as a problem that causes yield losses. Okoba and De Graaf (2004) note that the most frequently identified erosion problems are rills, root exposure and sheetwash. Farmers could identify many reasons for soil erosion in their fields, the most important were (1) high rainfall, (2) steep slopes, (3) no maintenance, and (4) wide spacing. Fewer farmers saw a link between tall trees, lack of soil cover and up to down tillage practices. Farmers were aware of the relation between slope, level of erosion and crop yields.

Social Drivers

Social structures must be mobilized effectively in the context of smallholder agriculture. Coordination among farmers is required to implement controls on the scale that they will be effective (Nyangena, 2007). The negative effects of soil erosion in upland farms may be externalized to plots lower in the watershed, compounding the need for concerted efforts. Examples from the Machakos region of Kenya, once mired by soil erosion, deforestation and poverty show how coordinated collective action and investment were critical for conservation success. The area is now one of the most heavily terraced in Kenya (Zaal & Oostendorp 2002).

Another social aspect is the access to knowledge. 41 % of farmers stated they would go to the local agricultural extension agent, and another 40 % said they would approach friends, neighbors or relatives for relevant information. Both social networks and government policy can influence the initial decision to adopt a technology, and this capacity depends on the trust the community has in those structures. (Tiffen et al. 1994). Institutional isolation directly impacts the adoption of soil conservation techniques along with land tenure security and market access (Kabubo- Mariara 2015). The access to secure tenure is a key factor influencing land conservation investments (Kimaru and Jama, 2006. Alufah et al. 2012.). Okoba and De Graaf showed in their study that most farmers knew several soil and water conservation techniques, but did not necessarily implement them. There were also differences in the farmer's perceptions of the effects of SWC. In the following table, 'prevent soil erosion' is not a perceived effect of such technologies.

What SWC can influence	Yes (%)	No (%)
Increased crop yield	82	18
Improved soil fertility	56	44
Improved soil-water retention	50	50
Add market value of land	46	54
Assured long-term productivity	13	87
Prevent soil erosion	4	96

Figure 1. Farmers' perceived impact of SWC measures. Reference: Okoba and De Graaf, 2005

Policy measures that create incentive for land conservation and involve farmer's participation are needed (Kabubo-Mariara 2006, Okoba et al. 2007). To avoid past unsuccessful attempts to adoption of these techniques, farmer's knowledge and their diagnosis of the issue must be integrated in the interventions (Okoba and Sterk 2010; Moges and Holden 2006). Successful integration of women in SWC is also important because women depend on water and soil resources for their livelihoods. They have also be found to be better adopters than their male counterparts (Alufah et al. 2012).

Economic Drivers

In other districts in Kenya of similar character, approximately 80% of farmers stated that they would adopt a new technology if it were proven to be profitable or proven to produce higher yields. A further small percentage stated they would adopt soil erosion technology if it was shown to reduce future labour inputs (Tiffen et al. 1994). Access to institutional credit is limited in rural areas, often due to a lack of collateral and farmers rely primarily on savings. Farmers with access to credit are more likely to implement SWC techniques (Alufah et al. 2012). Some of the main constraints in Embu were identified to be lack of financial capital and insufficient labour force (Okoba and De Graaf, 2005).

The time frame preference influence the choice of technology. In Embu County, Okoba and De Graaff (2004) found that strips of Napier grass and mulching were the most used soil and water conservation techniques (SWC) because of their short-term returns. Fanya Juu and bench terraces measures were widely known by farmers, but were adopted by only a small percentage of farmers because they are labor intensive. There is a high awareness of agroforestry practices that were not recognized as a major SWC measures to control erosion, despite the high density of trees and crops mixed systems. Trees were valued for fuel woods and non-timber products.

2. Research question

What are the social, economic, and physical factors that influence farmers' decisions to use soil conservation techniques?

1. What are the physical factors that influence a farmer's decision to adopt soil erosion control techniques?
    a. To what degree does slope impact a farmer's decision? Is there a threshold?
    b. Does aspect directly or indirectly influence soil erosion or the perception of soil erosion?
    c. What aspects of landscape position (location in the watershed, slope position) affect a farmer's decision to engage in soil conservation?
2. What are the social factors that influence a farmer's decision to adopt soil erosion control techniques?
    a. How do social groups impact farmer decision?
    b. What forms of social capital influence farmer decision?
3. What are the economic factors that influence a farmer's decision to adopt soil erosion control techniques?
    a. Is access to capital/insurance important?
    b. How strong is the time preference regarding soil erosion?
4. How does the farmer conceive of soil erosion as a problem?
    a. What types of erosion are farmers able to identify?
    b. Is a rational connection made between physical factors that influence erosion and the resultant erosion?

3. Theoretical Background

This chapter introduces our current theoretical background which we find useful for our research.

3.1 Farmer's decision framework

This chapter summarizes the conceptual framework from which we are going to construct our research. Its main purpose is to analyze the different factors and processed involved on the adoption of a certain soil conservation technology by the farmers at Kibugu.

The Figure 2 is based on different frameworks and incorporates the rural livelihoods perspective into the farmer's decision making process for soil conservation technology adoption. For this reason, it comprises the main capitals of the Ellis (2000) and Sustainable Livelihoods Framework (DFID, 2000), the individual choice model described by Ostrom (1990) and the conceptual framework for assessing land management developed by Pender et al. (2006).

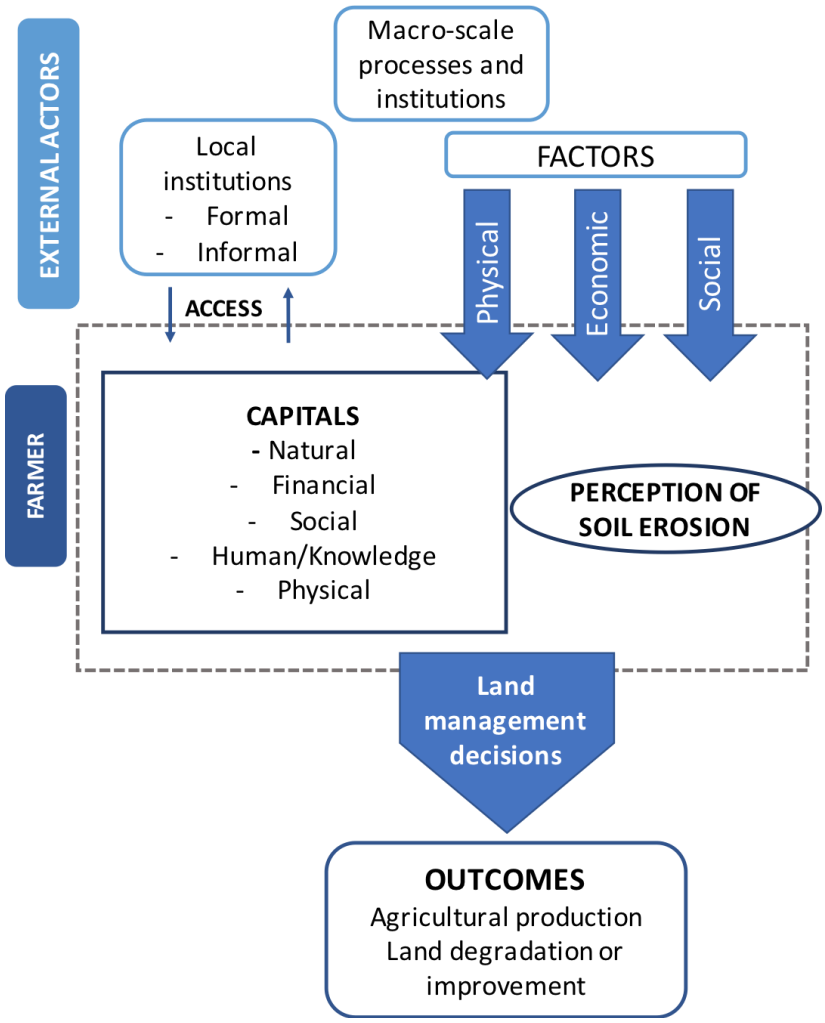

Figure 2: Framework

The farmer is considered as the unit of analysis, since the land in study is arranged as private holdings with different capital endowments. Additionally, the farmer's perception of the issue has been proven to be one of the determinants for the acceptance and adoption of a certain land management strategy (Assefa and Hans-Rudolf 2016).

There are external factors that shape the farmer's decision such as local institutions, understood as formal (e.g. NGOs, local government or cooperatives) but also informal, this last one represents the social norms that underlie people's behavior (Jakimow 2013). These external actors also influence the access to different capitals such as natural resources or knowledge, often influenced by power relations (Ribot and Peluso 2003). Institutional marginalization or gender division of labor can cause unequal access to labor or training opportunities in rural household's present (Gabrielsson et al. 2012, Smucker and Wisner 2007, Eriksen et al 2005). This often results in different adaptation strategies and technologies to reduce livelihoods vulnerability. At a broader scale, global processes such as macro policies, international markets or climate change can also influence rural livelihoods, and thereby the extent that the farmer can implement a certain technology (Scoones, 2009).

Consequently, it is considered that both internal and external contexts are intertwined, resulting in different factors categorized as physical, economic and social that ultimately affect farmers' final decisions on land management.

4. Methodology

An important aspect of the SLUSE course is *interdisciplinarity*, as people come from different academic backgrounds and experiences they are forced to adopt multiple perspectives and approaches. This creates an opportunity to triangulate information from different sources, to integrate different disciplines and expose new forms of critical analysis (Bob et al, 2005).
For this research, we aim to combine natural and social science methods, to employ aspects from our academic backgrounds and to triangulate the data. It should be mentioned, that the most important method for answering our research question is the semi-structured interviews with the farmers, but we are interested in getting information from various sources, why our method choice is quite broad.
The following section introduce the methods of choice, which we aim at using when in Kenya.

4.1 Field observations

Located in the field and staying with local families, gives us the possibility of using observation as an overarching method for the research project. Through observations, informal conversations with locals and participation in daily activities insights and knowledge of structures, traditions, ways of living, and worldviews. In addition, we expect to observe technologies and practices implemented by farmers in their fields as well as topography and vegetation, later this information will be used in our research (Strang, 2010).
During our stay, each of us will note observations of expressions, body language, surroundings and other issues of importance.

4.2 Semi-structured Interviews

As the main component of this research is concerned with farmer's motivation and perception, semi-structured interviews (SSI) with farmers will play a central role. We expect to conduct interviews with both farmers and farmers with insight into the topic of study.
Interviews provides the interviewer with a unique opportunity to engage with the respondent in a structured, yet informal way. As it is open-ended, the interview can take as many directions as the interviewer lets it, which creates opportunities for new knowledge and insights. The major objective of a SSI is to gain knowledge about the individual's point of view (Strang, 2010; Mikkelsen, 2005).
We aim at building trust relations with our respondents, to learn and benefit from one another. Therefore, we wish to engage with the farmers and informants more than one if possible, to go in depth.

4.2.1 Semi-structured interview with farmers

Through the interviews with the farmers, we aim to gain knowledge about conditions of the fields, farmers incentives to adopt technologies, and their perception of soil erosion.
As sampling strategy we expect to use the results of the questionnaire as an overview over people of interest. As it will be conducted within the first days, we will use the information to choose which farmers to talk to.
See Appendix 2 for interview guide.

4.2.2 Semi-structured interview with key informants

The purpose of the SSI with key informants is to gather information about the socioeconomic conditions in Kibugu. We expect that key figures in the community will be able to provide us with information about issues such as: history, economy, institutions, power distribution, farming technologies, and agroecological condition.
See Appendix 3 for interview guide.

4.3 PRA

The PRA sessions aims to involve the local in our study. We want to conduct three sessions with different objectives where we can engage the population in the diagnosis of the context and its issues. The information gathered from the PRA-sessions will be used for triangulation. See appendix 4.

4.3.1 PRA 1: Transect walk

We want to conduct a transect walk around the locality with a key informant. The main objective is to gain an overview of the topography, the different farming systems and facilities within Kibugu as well as any other kind of relevant information. We will use the GPS in order to track our route and possible key points that we might encounter.

4.3.2. PRA 2: General information

The aim of this session is to gather context information about the history of the location, the social structures present and the different agricultural activities. For this purpose, we want to propose the respondents the creation of different maps: social map, a Venn diagram, a crop calendar and a resource map.

4.3.3. PRA 3: Soil conservation technologies

The third session will be centered on the soil technologies that the farmers use. The main information we want to retrieve is (1) how do the perceive the erosion problem in their fields (2) Which technologies are using to control soil erosion and why.

4.4 Questionnaire

Questionnaires will be conducted during the first days in Kibugu in cooperation with the other groups. The questionnaire provides us with quantitative information, creating a baseline for the fieldwork. Each group have had the opportunity to add specific questions making the questionnaire useful for selecting respondents for the semi-structured interviews.
See appendix for questionnaire.

4.5 Slope assessment

As the effects of erosion are more dramatic on slope, we are interested to see whether farmers with steep relief are experiencing worse soil erosion. To this objective, we use a clinometer to measure the angles of slope for each field of study. Each field will be self-defined by the farmer in the case, that one farmer has multiple plots.

4.6 GPS: Waypoints and area calculation

One of the overall objectives for this research is to study the physical factor that motivate farmers to adopt soil conservation technologies. For this objective, we find that a map of the area with

waypoints and area measurements is useful as there may be a correlation between position and area of the farmer's field and their incentive to adopt a certain technology.

5. References

Alufah, S., & Shisanya, C.A., & Obando, J.A. (2010). Analysis of Factors Influencing Adoption of Soil and Water Conservation Technologies in Ngaciuma Sub-Catchment, Kenya. *African Journal of Basic & Applied Sciences 4* (5): 172-185, 2012

Assefa, E., & Hans-Rudolf, B. (2016). Farmers' perception of land degradation and traditional knowledge in Southern Ethiopia—resilience and stability. Land Degradation & Development, 27(6), 1552-1561.

Bob, U., Moodley, V., Traynor, C.H., Gausset, Q. and Chellan, N. (2005). Chapter six: Embracing difference and diversity: interdisciplinary, cross-cultural and group dynamics. p. 59-82.

Byiringiro, F., & Reardon, T. (1996). Farm productivity in Rwanda: effects of farm size, erosion, and soil conservation investments. *Agricultural economics*, *15*(2), 127-136.

DFID (2000) Sustainable livelihoods guidance sheets. *Department for International Development*

Ellis, F. (2000) A Framework to Livelihoods Analysis, Chapter 2 in *Rural Livelihoods and Diversity in Developing Countries*. Oxford University Press.

Eriksen, S. H., Brown, K., & Kelly, P. M. (2005). The dynamics of vulnerability: locating coping strategies in Kenya and Tanzania. The geographical journal, 171(4), 287-305.

Foster, A. D., & Rosenzweig, M. R. (2010). *Microeconomics of technology adoption*. New Haven, Conn: Yale Univ., Economic Growth Center.

Gabrielsson, S., Brogaard, S., & Jerneck, A. (2013). Living without buffers—illustrating climate vulnerability in the Lake Victoria basin. *Sustainability Science*, 8(2), 143-157.

Holden, S. T., Shiferaw, B., & Wik, M. (1998). Poverty, market imperfections and time preferences: of relevance for environmental policy?. *Environment and Development Economics*, *3*(01), 105-130.

Jakimow, T. (2013) Unlocking the Black Box of Institutions in Livelihoods Analysis: Case Study from Andhra Pradesh, India. *Oxford Development Studies*, *41*(4), pp. 493-516

Kabubo-Mariara, J. (2015). Does Institutional Isolation Matter for Soil Conservation Decisions? Evidence From Kenya. *Sage Open,* 5(1), 1-9

Kabubo-Mariara, J. (2007). Land conservation and tenure security in Kenya: Boserup's hypothesis revisited. *Ecological Economics*, *64*(1), 25-35.

Kang, B.T., Reynolds, L. and Atta-Krah, A.N. (1990) Alley farming. *Advances in Agronomy* 43, 315-359.

Kimaru, G., & Jama, B., (2006) Improving land management in eastern and southern Africa: A review of practices and policies. ICRAF Working Paper no. 18. Nairobi, Kenya. World Agroforestry Centre.

Lal, R. (1990). Soil erosion and land degradation: the global risks. In *Advances in soil science* (pp. 129-172). Springer New York.

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

Mikkelsen, B. (2005). Methods for Development Work and Research. A New Guide for Practitioners, 2nd ed. New Delhi, Thousand Oaks, London: Sage Publications. (pp. 87-123)

Moges, A., & Holden, N. M. (2007). Farmers' perceptions of soil erosion and soil fertility loss in Southern Ethiopia. *Land Degradation & Development, 18*(5), 543-554.

Mutisya, T.W, & Luo, Z., & Nenkari, J., (2010) Soil and Water Conservation in Kenya-Operations, Achievements and Challenges of the National Agriculture and Livestock Extension Programme (NALEP). *Journal of American Science, 6*(3), 7-15.

Okoba, B. O., & Sterk, G. (2010). Catchment-level evaluation of farmers' estimates of soil erosion and crop yield in the Central Highlands of Kenya. *Land degradation & development*, *21*(4), 388-400.

Okoba, B. O., Tenge, A. J., Sterk, G., & Stroosnijder, L. (2007). Participatory soil and water conservation planning using an erosion mapping tool in the central highlands of Kenya. *Land Degradation & Development*, *18*(3), 303-319.

Okoba, B. O., & Sterk, G. (2006). Quantification of visual soil erosion indicators in Gikuuri catchment in the central highlands of Kenya. *Geoderma, 134,* 1, 34.

Okoba, B. O., & De Graaff, J. (2005). Farmers' knowledge and perceptions of soil erosion and conservation measures in the Central Highlands, Kenya. *Land Degradation & Development,* 16(5), 475-487.

Ostrom, E. (2015). An institutional approach to the study of self-organization and self-governance in CPR situations. In *Governing the commons* (pp. 37) Cambridge University Press.

Pender, J., Place, F. and Ehui, S. 2006. *Strategies for Sustainable Land Management in the East African Highlands.* Chapter 2: Conceptual Framework and Hypotheses. Washington, D.C.: International Food Policy Research Institute.

Pimentel, D., Harvey, C., Resosudarmo, P., & Sinclair, K. (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science*, *267*(5201), 1117.

Pimentel, D. (2006). Soil erosion: a food and environmental threat. *Environment, development and sustainability*, *8*(1), 119-137.

Ribot, J. & Peluso, N.L. (2003) A Theory of Access. *Rural Sociology, 68*(2), pp.153-181

Scoones, I. (2009) Livelihoods perspectives and rural development. *The Journal of Peasant Studies, 36* (1), pp.171-196

Shanguhyia, M. S. (2015). Population, "tradition", and environmental control in colonial Kenya.

Smucker, T. A. & Wisner, B. (2008). Changing household responses to drought in Tharaka, Kenya: vulnerability, persistence and challenge. *Disasters*, 32(2), 190-215.

Strang, V. (2010). 7. Mapping histories: cultural landscapes and walkabout methods. Vaccaro, I., Smith, E.A. & Aswani, S. Cambridge: Cambridge University Press. 132-156.
Tiffen, M., Mortimore, M., & Gichuki, F. (1994). More people less erosion: environmental recovery in Kenya.

UNEP. Source Book of Alternative Technologies for Freshwater Augmentation in Africa, Chapter 2

WOCAT (2007). SWC Technology: Improved trash lines, Uganda, 121-124

Young, A. (1989). *Agroforestry for soil conservation* (Vol. 4). Wallingford, UK: CAB international.

6. Appendices

Appendix 1: Data matrix

Research Question	**Sub Research Question**	**Sub sub research question**	**Data required**	**Methods**	**Inputs**
What are the social, economic, and physical factors that influence farmer decisions to use soil conservation techniques?	1. What are the physical factors that influence a farmer's decision to adopt soil erosion control techniques?	a. To what degree does slope impact a farmer's decision? Is there a threshold?	Degree of relief	4.6 Slope assessment 4.2 Semi-structured interview with farmers	Clinometer
		b. Does aspect directly or indirectly influence soil erosion or the perception of soil erosion?	Bearing	4.6 Slope assessment 4.2 semi-structured interview with farmers	Compass
		c. What aspects of landscape position (location in the watershed, slope position) affect a farmer's decision to engage in soil conservation?	Landscape, topography, coordinate.	4.7 GPS 4.1 Field observations 4.4 PRA Transect walk	GPS Notebook
	2. What are the social factors that influence a farmer's decision to adopt soil erosion control techniques?	a. How do social groups impact farmer decision?	Social conditions, social factors affecting farmers.	4.2 Semi-structured interview with informants and farmers 4.4 PRA social map	Dictaphone Notebook Piece of paper Pens
		b. What form of social capital influence farmer decision?	Social factors, networks	4.2 Semi-structured interviews with informants and farmers	Dictaphone Notebook

	2. What are the economic factors that influence a farmer's decision to adopt soil erosion control techniques?	a. Is access to capital/insurance important?	Farmer's perception of cost/benefit	4.2 Semi-structured interview with farmers	Dictaphone Notebook
		b. How strong is the time preference regarding soil erosion?	Understanding of Farmer's timeframe in decision-making.	4.2 Semi-structured interview with farmers	Dictaphone Notebook
	4. How does the farmer conceive of soil erosion as a problem?	a. What types of erosion are farmers able to identify	Farmer's perception of soil erosion	4.2 Semi-structured interview with farmers	Dictaphone Notebook
		b.Is a rational connection made between physical factors that influence erosion and the resultant erosion?	Farmer's perception of soil erosion	4.2 Semi-structured interview with farmers	Dictaphone Notebook

Appendix 2: Interview guide for SSI with farmers

Introduction:

- Presentation of our background and research
- Let the respondents know that they can be anonymous, they must feel free to interrupt, they are not obligated to answer the questions.
- Permission to record
- GPS waypoint
- Ask permission to take area measurement of the field
- Note who interview, who is present and where we are

1. Could you describe your land to us?
    a. Soil productivity
    b. Topography
    c. Crops/ trees/ livestocks
    d. inputs? (fertilizers, manure, seeds..)
2. What is the conditions of the land?
    a. Would you consider your land as fertile?
    b. Why? Any challenges to productivity?
    c. Any changes in productivity in the recent years?
3. Do you, or have you experienced soil erosion on your lands?
    a. Do you see a link between soil erosion and soil productivity?
    b. Are you aware of soil erosion on your farm? outside your farm?
    c. Indirect method of assessing soil erosion?
4. Which technologies have you applied on your field?
    a. which technologies do you know?
    b. If you could chose any technology and apply it in your field, which technology would you then apply?
5. How did you come to the decision of implementing these technologies? (take us through the process)

If possible, a second interview will be arranged to follow up and ask new detailed questions of interest.

Appendix 3: Interview guide for SSI with informants

Introduction:

- Presentation of our background and research
- Let the informant know that they can be anonymous, they must feel free to interrupt, they are not obligated to answer the questions.
- Permission to record
- Note who interview, who is present and where we are

The questions will vary according to who we interview, consequently we will create precise question as we find informants. However, we are interested in gathering information about these issues:

Are you providing farmers with tools and equipment?
Are you providing farmers with financial support?
What are the social structures and how they influence the farmers?
What is the most important factor for successful soil conservation?
What are the economic limiting factors?
What government policies compel you to push soil conservation techniques?

Appendix 4: PRA sessions

Transect walk

Introduction:

- Presentation of our background and research
- Note who is present and where we are

Expected output:

- Identify the topography of the area
- Identify different farming systems and technologies implemented
- Learn about local terminology
- Get an overview of the structure of the location
- Identify the state of certain natural resources in the area

Equipment:

- GPS
- Notebook

Participants:

- Informant
- All group members

General Information of the location

Introduction:

- Presentation of our background and research
- Let the participants know that they can be anonymous, they must feel free to interrupt, they are not obligated to answer the questions.
- Permission to record
- Note who is present and where we are

Expected output:

- Participatory mapping and calendar: social map, Venn diagram, history of the village
- Interaction between farmers
- Power relations, gender differences.
- Economic and social context
- Key stakeholders, Important events

Equipment:

- Paper
- Pens
- Post-it

Participants:

- Around 5 participants from the Location
- All group members

Soil conservation technologies

Introduction:

- Presentation of our background and research

- Let the participants know that they can be anonymous, they must feel free to interrupt, they are not obligated to answer the questions.
- Permission to record
- Note who is present and where we are

Expected output:

- Technology ranking, crop calendar, seasonal activities
- Prefered technologies among farmers
- Reasons behind usage of specific technology
- Distinction between new and traditional technologies
- Differences in strategies amongst farmers

Equipment:

- Paper
- Pens
- Post-it

Participants:

- Around 5 farmers from the Location
- All group members

Appendix 5: Questionnaire

GPS-point: x:_____ y:_____ z:_____	**Interviewer:**
Sub-location:	**Group Number:**
Note taker:	**Translator:**
Picture:	**Date and time: / / : :**

Personal information

1. Name: _____

2. What is your gender? Male _____ Female_____

3. How old are you? _____

4. Marital status:
a) Single_____ b) Married_____ c) Widowed_____ d)Divorced_____

5. Which levels of education did you finish?
   - None educational background
   - Primary school
   - Secondary School
   - Bachelor degree
   - Master degree
   - Other: specify _____

6. Are you a part of any of the following networks? (*place an "X" in all choices that apply*)
   - Church
   - NGO
   - Cooperative (Specify_____)
   - Political party
   - Social club(Specify_____)
   - Others _____

Household information

7. How many people are there in your household (including living outside the village)? Please state their relationship to you, ages, gender, occupation and whether they work on your family farm:

Relationship	Age	Gender	Occupation	Does he/she work in the farm?
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				

8. How do you consider your household's income level?
- Low income _____
- Medium income_____
- High income_____

9. What are the **3 main income sources** for your household? (mark 1 for the highest source of income, 2 for medium source, 3 for lesser source)
- Cash crops _____
- Horticulture _____
- Livestock _____
- Handicrafts _____
- Off-farm employment _____
- Services _____
- Remittances _____
- Only subsistence_____
- Other income source, please specify: _____

Farm characteristics

10. How many acres are your farm?
_____

11. How big is your farm compared to the rest of the village?

a) Small _____ b) Medium_____ c) Large_____

12. How did you obtain the land of your farm?
    - Inheritance
    - Purchasing
    - Renting
    - Other:_____

Crop Technology

13. How fertile do you think your soil is?
    Low _____ Medium____ High _____

14. Do you think you are losing topsoil? Yes__ No____
    if yes What signs (types) of erosion can you see in your fields? _____

15. Are you doing anything to prevent soil loss?
    if yes, what are you doing?
    - Terracing
    - Contour lines
    - Across slope tillage
    - Cover crop
    - Planting trees
    - Stone bunds
    - Other _____

16. How would you rate the slope at your farm?
    low - medium - high

Pests and disease Management

17. Have you heard of the Plantwise Plant Clinics organized by Centre for Agricultural Bioscience International (CABI)? Yes __ No__

18. Have you any experience with using the plant clinics? Yes __ No __
    If yes
    - How many times have you visited the Plant Clinics? _____
    - How will you characterize your experience with the Plant clinics?
        - Not satisfied
        - Satisfied
        - Very Satisfied

19. What are your 2 most important crops infected with pests and diseases? (list most important first - please state crop followed by the pest/disease)
    1. _____
    2. _____

Gender

20. Has there been any changes during the last 5 years in what types of hybrids/crops your household is producing?
    - yes, we made changes about the type of crops we are producing
    - yes, we made changes about the type of hybrids we are using
    - No, we don't make any changes
    - I don't know if we made changes

comments: The interviewer has to write here the type of change made (type of crops, type of hybrids) by the household if possible

21. Has there been any changes during the last 5 years in what crops/hybrids your household is selling? Yes __ No __

comments: The interviewer has to write every comments mentioned by the respondent

22. How much are you selling of the total production (of agricultural/horticultural crops)
    - Pie charts: less than 25 %, between 25% and 50 %, between 50% and 75 %, more than 75%

comments: The interviewer has to write every comments mentioned by the respondent (directly sell, use of an intermeedee)

23. Has this amount changed in/during the last 5 years? Yes __ No__

24. Has there been any changes in the labor division inside the household during the last 5 years?
    - Yes, there has been changes in who is selling the crop at the market
    - Yes, it's not the same person producing the same crops as it was before
    - No, there have been no changes.

Livestock Questions
Ruminants = cattle, goats, sheep, (giraffes, antelopes, camels)

25. Number of ruminants in household?
    - Cattle: _____
    - Goats: _____
    - Sheep: _____
    - Total number of ruminants: _____
    - if zero, why not: _____

CATTLE CENSUS	Bohan	Sahi-wal	Gir	Other/ Unkno-wn local breed	Frie-sian (cross)	Ayre-shire (cross)	Jersey	Guern-sey	Other/Unknown improved/eexotic breed
lactating									
dry									
heifer (1st gestation F)									
calves									
bulls									

GOAT CENSUS	Galla/Bora na/Somali eg: Degyir, Degun	Small East Afric an	Other/Un known local breed	Anglo-Nubian (cross)	German Alpine(cr oss)	Toggen burg (cross)	Saanen	Other/Unknown improved/exotic breed
lactating								
dry								
heifer (1st gestation F)								
kids								
bucks								

26, Which household member has the right or responsibility to which areas of ruminant husbandry?
(Place an "X" in the box that applies)

	Daily care				Income from milk sales				Income from animal sale (meat or alive)			
Ruminant	**Husband**	**Wife**	**Shared**	**other**	**Husband**	**Wife**	**Shared**	**other**	**Husband**	**Wife**	**Shared**	**other**
Cow herd												
Goat herd												
Sheep herd												

If you don't have goats, please skip to #6.

27. For how many **years** have you had goats?
28. What are your **3 main reasons for keeping goats**?*(Place an "X" in all choices that apply)*

- Low labor required
- Low feed demands of goat
- Low space demand
- Short generation cycle
- Nutritious milk
- Milk tastes good
- good market for goat milk
- cheap to buy a goat
- was the only ruminant available to buy
- Other reasons. Please specify:

29. Are you **member in a breeding association** or **milk cooperative**?
If yes, please specify:

	Goat breeding/husbandry	Cattle breeding/husbandry	Milk cooperative	other, please specify
Put X if yes				

Post-Harvest Management

30. What are the storage technologies that you use?
    - Plastic containers
    - Plastic bags
    - Wooden boxes
    - Storage baskets
    - Jars
    - Gourd
    - Burlap/Jute sacks
    - Silos (Plastic or metal)
    - Aerial storage
    - Other: _____

31. Have you adopted new storage technologies in the last 3 years? Yes __ No __

32. Over the last 5 years, how many new crops did you began growing? What are they? _____

33. After harvest, what is the main cause/factor of crop losses?
    - Pests, rodents,
    - Rainfall
    - Temperature
    - Other: _____

34. Per harvest season, how big a percentage of harvest crops do you lose on average? And for which crop?
    - 10%
    - 25%
    - 50%
    - 75%

Crop: _____

Appendix 6: Timeline

Activity\date	**24.2**	**1.3**	**2.3**	**4.3**	**5.3**	**6.3**	**7.3**	**8.3**	**9.3**	**10.3**	**11.3**	**12.3**	**13.4**
Submission of synopsis													
Arriving at Langata													
Initial meetings with Kenyan counterparts. Going through interviews and research questions with counterpart													
Travel to Kibugu													
Setting in at our host families													
Fieldwork													
Transect walk													
Find informants													
Questionnaire													
Testing and adjusting interview guides													
Church service													
Interview farmers													
Interview key informants													
GPS Waypoints													
PRA general information													
PRA soil conservation techniques													
Feedback meetings													
Presentations													
Buffer day													
Departing from Kibugu													

Appendix 7: Soil conservation technologies

This section presents an initial characterization of the main soil conservation techniques that we may encounter in the location. The diversity of smallholders cultivated crops is high and highly variable within the location, consequently, a complex understanding of technologies and techniques used is necessary.

Categories of Soil conservation

The technologies can be divided in different categories according to the nature of the decision (Liniger et al. 2011) that can also be used simultaneously:

- Agronomic: e.g. influencing soil cover and tillage management
- Structural: changes in the land arrangement such as terracing
- Vegetative: decisions about the use of different crops with several purposes
- Management: change of land use or production intensity

Main practices in Kenya

Agroforestry: agroforestry systems such as alley cropping can contribute to soil erosion control (Kang et al. 1990). The root systems of the trees stabilize the soil structure and the tree residues can also increase the organic matter of the soil, thereby, increasing resistance to erosion (Young 1989). The use of leguminous trees can also add a double function as fodder for the livestock.

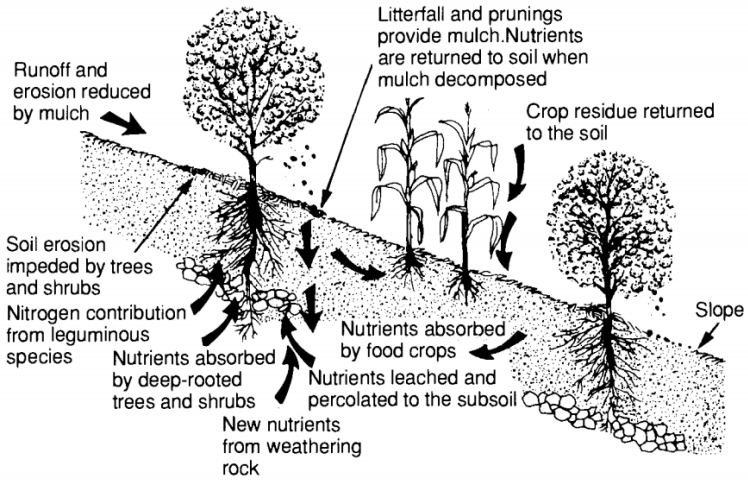

Figure 3: The alley cropping system. Reference: Kang et al., 1989

Fanya juu terraces:

This terracing technique is based on digging trenches along the contour lines and the use of the remaining soil to form bunds upslope (40 - 50 cm height). The distance between bunds may vary depending on the steepness of the slope from 5 to 20 m (UNEP). This technique, associated with traditional knowledge, have been promoted for several decades, beginning in the seventies through the National Soil and Water Conservation Programme funded by the Swedish Development Agency in 1974. The Machakos district is an example of a successful implementation through collective work (Tiffen et al 1994). Saiz et al (2016) showed its positive impact in different areas of South

Eastern Kenya, where the soil organic matter of the soil was also increased compared to the land conventional managed.

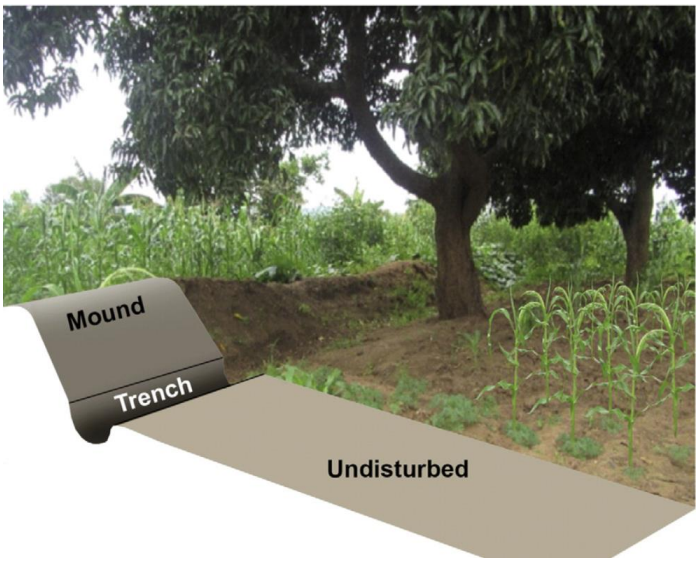

Figure 4: schematic draw of terracing

Cross slope barriers: barriers made from different materials arranged along the contour lines, reducing run-off speed and avoiding topsoil loss. Eventually, terraces can be naturally created from these barriers, reducing the initial investment in labor and implements (Liniger et al. 2011).

- Stone lines or bunds
- Grass strips: this line can be combined with the terracing, stabilizing the slope and providing a double output, used also as fodder.
- Trash lines: the main inputs of this technology are weed and crop residues left across the slope of the crop fields. It is based on traditional practices and it can be intensified by reducing the distance between the lines (WOCAT, 2007)

Cover crops or residues: the use of cover crops can stabilize the slopes reducing the potential erosion. On the other hand, the use of organic mulching can also have a soil conservation function. Both measures can be combined with other techniques such as agroforestry, contributing to build up the soil fertility