Exploring the potential of co-investments in land management in the Central Rift Valley of Ethiopia

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Table of Contents

Chapter 1

Introduction

Introduction

1.1 Ethiopian Agriculture

Ethiopia is one of the largest countries in the horn of Africa (>1 million km^2) with a predominantly subsistence agrarian economy. According to the 2007 population and housing census, Ethiopia's human population was 74 million (CSA, 2008a). The projected population become 84 million in 2012 with an annual growth rate of 2.7% (CSA, 2012; World Bank, 2012). The country is characterized by diverse topographic features ranging from 116 m below sea level at Denakil depression to 4620 m above sea level at Ras Dashen (Awulachew et al., 2007).

Ethiopian agriculture employs over 84% of the population, contributes more than 50% of Gross Domestic Product and 90% of the export revenue of the country (CSA, 2012). Therefore, agriculture continues to remain the main source of livelihood that contributes the largest share to social and economic development of the country. Nevertheless, the average per capita food production has decreased for the last three decades (Ehui and Pender, 2005) and the country becomes one of the major food-aid recipients in the world (Gilligan and Hoddinott, 2007). Rapid population growth and low agricultural productivity have been suggested as main causes of the decreasing trend of per capita food production (Shiferaw and Holden, 2000). Agriculture is dominated by small-scale and subsistence-oriented farmers in which investments in agricultural technologies such as high-yielding varieties, agro-chemicals, and improved land management practices are very low (Teshome, 2006). In addition, land degradation, drought, poor governing organizations and polices have been blamed for the low productivity of Ethiopian agriculture (Slegers, 2008).

The government of Ethiopia has developed a number of strategies aiming at reducing poverty and improving agricultural productivity. As a result, the country has been following an Agricultural Development Led Industrialization (ADLI) policy since mid-1990s (Abdella, 2002). Within the framework of ADLI, several strategies and programmes, such as the Plan for Accelerated and Sustained Development to End Poverty (PASDEP; MoFED, 2006) strategy, the Sustainable Development and Poverty Reduction Programme (SDPRP; MoFED, 2004), Growth and Transformation Plan (MoFED, 2010) and the Productive Safety Net Programme (Gilligan et al., 2009) have been implemented.

For example, the Government of Ethiopia and a consortium of donors (e.g., The World Bank, EU, USAID and WFP) implemented the PSNP to deal with chronic food insecurity since 2005 (Gilligan et al., 2009, FAO, 2010). PSNP reaches over 8 million beneficiaries in 234 districts (Sabates-Wheeler and Devereux, 2010; Pankhurst, 2009) and operates with an annual budget of nearly 500 million USD (Gilligan et al., 2009).The main objective of PSNP is providing cash or food to the food insecure population in a way that prevents asset depletion at the household level, creates assets at the community level, encourage farmers to engage in production and finally to reduce poverty (Gilligan et al., 2009; Jones et al., 2008).

In spite of such efforts, food production is hardly improving and poverty and food insecurity are persistent phenomena (Ramakrishna and Demeke, 2002; Kassie et al, 2009) mainly due to lack of collaboration among stakeholders during the planning and implementation of these strategies and programmes. All strategies and programmes targeted the rural population of Ethiopia and their central objective was to ensure food security at the household level within ADLI. Nevertheless, the implementing agencies have not been aware about the strategies and programmes. The framing of the strategies and programmes was fundamentally desktop and done at national level with limited input from regional states, zones and district level institutions (Teshome, 2006). Moreover, the engagement of NGOs and private sector was superficial and restricted (Jones et al., 2008). This indicates that lack of collaboration among stakeholders at all levels is crucial for the success of these strategies and programmes.

1.2 Land degradation

Land degradation, a decline in the quality of land caused by human activities (UNCCD, 1994), has been a major global agenda and remains an important issue in sub-Saharan Africa because of its adverse impact on crop productivity, the environment, and its effect on food security and the quality of life (Eswaran et al., 1997; Lal, 1998). Productivity impacts of land degradation (e.g. soil erosion, nutrient depletion) is due to a decline in soil fertility and moisture availability on-site where land degradation occurs (Falkenmark, 2009; Stroosnijder, 2009) and off-site where sediments are deposited (Pender and Gebremedhin, 2007).

The situation is severe in Ethiopia where agriculture is the major source of livelihood of the population. Because of land degradation, vast areas of fertile lands have become unproductive (Bewket and Sterk, 2002; Kassie et al., 2009). Water erosion is the most important form of land degradation in Ethiopia (Hurni, 1988; Tekle, 1999). Although estimates of the extent and rate of soil erosion lack consistency, several studies revealed the severity of the problem in the country. The highest rate of soil loss occurs from cultivated lands ranging from 42 t $ha^{-1}yr^{-1}$ (Hurni, 1988) to 179 t ha^{-1} yr^{-1} (Shiferaw and Holden, 1999). In addition to soil erosion, soil nutrient depletion is a serious problem which has a severe economic impact (Stoorvogel *et al.,* 1993). The negative nutrient balances of several studies indicate the severity of soil nutrient depletion in Ethiopia. For example, Stoorvogel and Smaling (1990) estimated the average national nutrient balances of -47 kg N ha^{-1}, -15 kg P_20_5 ha^{-1} and -38 kg K_2O ha^{-1}. Similarly, Haileslassie et al. (2005) estimated national nutrient depletion rate of 122 kg N ha^{-1} yr^{-1}, 13 kg P ha^{-1} yr^{-1} and 82 kg K ha^{-1} yr^{-1}.

On top of these scientific evidences, the occurrence of soil erosion in most parts of the country is directly visible. Most cultivated lands in the hills and mountains of the country have suffered from loss of top soil—leaving bare stones behind. Gullies are also observed everywhere in the deep soils of the country. Moreover, the severity of soil erosion in Ethiopia is visible from the thick mass of soil taken away by major rivers, such as the Nile, Awash, Omo and Baro. These rivers are coloured during the main rain season due to soil erosion from their catchment areas. As a consequence of both soil erosion and nutrient depletion, more than 30,000 ha of croplands become out of production annually (FAO, 1984).

Several authors argue that population pressure and lack of investments in sustainable land management are the most important causes of the on-going land degradation in Ethiopia (Hurni, 1993; Grepperud, 1996). Although population growth could stimulate farmers to increase the intensity of labour and capital investments in land management (Tiffen et al., 1994), intensification in Ethiopia is not well developed to absorb the growing population and make it productive (Amsalu, 2006). Hence, the increasing population pressure has increased land scarcity, contributing shortened (eventual abandonment) of fallow periods, deforestation, and cultivation on marginal lands (e.g. steep and grazing) which leads to further land degradation (Ramaswamy and Sanders, 1992; Amsalu, 2006). Nowadays, expansions of crop production at the expense of forest lands become common phenomena in Ethiopia. This is confirmed by the fact that Ethiopia leased-out 3.6 million ha (2008-2011) for foreign investors nationally (Human Rights Watch, 2012) where majority of this land is from the natural forest of West and South-western parts of the country (Deininger et al., 2011; Human Rights Watch, 2012). Degradation of these areas can be accelerated because these marginal areas are very vulnerable to water erosion (Reij & Smaling, 2008).

Given that agricultural production remains the main source of income for rural communities and the on-going land degradation in Ethiopia, more investments in sustainable land management (SLM) is crucial to provide sustainable livelihoods to the poor and to ensure food security.

1.3 Investments in sustainable land management

Despite the severity of land degradation, investment in SLM in Ethiopia was largely neglected until early 1970s (Shiferaw and Holden, 1998; Beshah, 2003). The establishment of a soil and water conservation division within the Ministry of Agriculture due to the outbreak of famine in 1973/74 was the first initiative of land management investment in Ethiopian history (Berhe, 1996). During that time, land management investment begun in drought prone areas using food-for-work approach which was mainly funded by the World Bank, World Food Program and Food and Agricultural Organization (WFP, 1986). Land management using the food-for-work approach increased since the 1973/74 drought, which was followed by the 1984/85 famine. Specially, since the 1980s, various national land management efforts have been undertaken with the financial support of international donors and mass mobilization of rural communities (WFP, 1986; Holden et al., 2001). The largest land management investment made in the country was during the *Derg* Regime in which more than 1 billion US dollars were invested during 1974-1991 (Rahmato, 1993; 1998). The food-for-work approach was replaced with productive safety net programme since 2005 (Gilligan et al., 2009). In addition to international donors, the Ethiopian agricultural extension system and local non-government organizations have invested substantial resources in land management since 1990s (Beshah, 2003).

Several research efforts have been undertaken to support land management intervention in the country. The soil conservation research project (SCRP), which was jointly financed by the Ethiopian and Swiss governments, was established in 1981 under the Ministry of Agriculture (Grunder, 1988). This project established six research sites in different parts of Ethiopian highlands to assess the extent of soil erosion and test the effectiveness of different land management technologies (Hurni, 1996). The Ethiopian Highlands Reclamations Study (EHRS) invested substantial resources to assess land degradation and land management in the Ethiopia highlands (Constable, 1985; FAO, 1984). Moreover, the Ethiopian agricultural research system has conducted several research activities to generate appropriate land management technologies (EIAR, 2010).

Nevertheless, all these efforts have limited success due to lack of collaboration among governmental and non- governmental organizations and farmers (Admassie, 2000, Mowo *et al*., 2010) and failure to consider the socio-economic and biophysical context of farmers (Asrat et al., 2004). In addition, land management investments to reduce land degradation and increase food production by smallholder farmers have been limited in Ethiopia (Gilioli and Baumgartner, 2007). Farmers' investments in land management are constrained by several factors (Amsalu and De Graaff 2007; Deressa et al., 2009). Generally, these factors can be categorized into household and plot level factors and external factors (Figure 1.1).

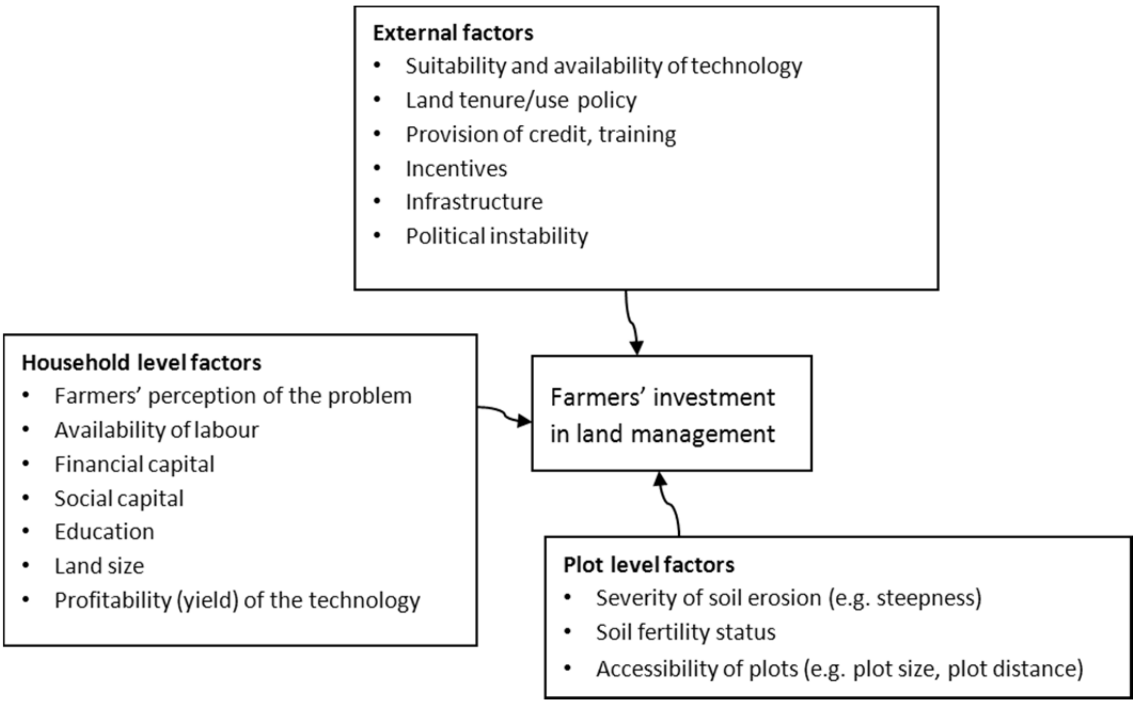

Figure 1.1. Examples of major factors that affect farmers' investments in land management.

Several factors at household level, such as farmers' perception of the problem, availability of labour, financial capital, social capital, education, land size and the profitability of land management technology have been identified as determinants of farmers' investments in land management in Ethiopia (Bryan et al., 2009; Deressa et al., 2009; Pender and Kerr, 1998). At plot level, differences in biophysical conditions among the plots, such as severity of soil erosion, soil fertility status and accessibility of plots influence farmers' choice *where* to invest in land management (Kessler, 2006; Amsalu and De Graaff, 2007). In addition, farmers have often been unwilling to apply land management practices to their land because they believed that other problems, such as drought, are more constraining of crop production than land degradation (Beshah, 2003; Slegers, 2008; Stroosnijder, 2009).

Although households are the ultimate actors that take decisions regarding investments in land management, their decisions are influenced by external factors beyond their control (Figure 1.1). Collaboration among households and other stakeholders facilitates the participation of farmers in land management programs and improves access to information, technologies and credit (Nysngena, 2007; Fleeger and Becker, 2008). The collaborative efforts of stakeholders for successful implementation of land management practices can also be considered as 'co-investments'. Co-investments in this research is conceived as collaborative land management in which farm households, government organizations, non-governmental organizations, private sectors and other stakeholders invest in land improvement in the form of material, labour, finance, knowledge, technology or governance.

1.4 Problem statement and objectives

This study focusses on the Central Rift Valley (CRV) of Ethiopia. The CRV of Ethiopia is part of East African Rift Valley which is characterized by a chain of lakes and wetlands (Hengsdijk and Jansen, 2006). The predominant farming system in the CRV of Ethiopia is rain-fed agriculture with low productivity (Hengsdijk and Jansen, 2006; Jansen et al., 2007). Given that crop production is predominantly rain-fed, variability and unpredictability of rainfall have always been major concerns in the CRV (Biazin, 2012). Over generations, especially where rainfall variability affects livelihoods, farmers have applied several adaptation and coping strategies in response to yield reduction induced by the variation in rainfall (Cooper et al. 2008). These strategies are highly diverse, site specific and influenced by social, economic, institutional and biophysical factors (Deressa et al. 2009; Tittonell et al. 2010). A better understanding of how farmers cope with and adapt to the perceived trends of crop productivity and rainfall is essential to promote successful strategies for agricultural development (Quinn et al. 2003). In the CRV, however, there is a lack of information on farmers' view of the trend of rainfall and crop productivity and strategies to adapt to the perceived changes.

Besides rainfall variability, farmers in the CRV are severely affected by land degradation in the form of soil erosion and nutrient depletion (Meshesha et al., 2012). However, investments in land management made by farmers in the CRV are very limited. More profound understanding of the factors that influence farmers' decisions *how much* and *where* to invest in land management would help to understand why farmers often refrain from investing in their land. It will also enable the formulation of better-targeted intervention and extension strategies aimed at sustainable land management (Bewket and Teferi, 2009; Amsalu and De Graaff, 2007; Shiferaw and Holden, 2000).

Although there are empirical evidences regarding the various factors that affects farmers' investments in land management, much of the studies have been focused in the Ethiopian highlands (Amsalu and De Graaff, 2007; Pender and Gebremedhin, 2007; Shiferaw and Holden, 2000) with less attention to the other parts of the country such as the CRV. Moreover, the results are highly diverse due to socio-economic and biophysical variation in the country (Deressa et al., 2009; Bryan et al., 2009). Hence, findings in one area cannot necessarily be replicated in another area.

Despite urgent calls for co-investment in SLM, governmental and non- governmental organizations are not collaborating and investments in SLM are limited in Ethiopia (Shiferaw and Holden, 2000; Mowo et al., 2010). Why do these organizations continue to work separately? In-depth understanding of the bottlenecks and requirements of different organizations related to co-investments is vital to designing SLM strategies and policies at different levels. Nevertheless, there is limited evidence regarding what factors limit these organizations from investing in SLM.

Although the collaboration of organizations is limited, there are some initiatives (most of them outside the CRV) which have been implemented in the past to demonstrate the possibility of co-investment in the country. Analysing the experiences of these initiatives provide practical experience on the different issues of co-investments in land management. However, the experiences and lessons of previous co-investment initiatives, especially in respect to land management, are not well documented.

Therefore, the overall aim of this study was to explore the potential of co-investments to foster land management and increase land productivity in the Central Rift Valley of Ethiopia. The specific objectives of this study were:

1. Understanding farmers' strategies to their perceived trends of crop productivity and rainfall in the CRV;
2. Assess farmers' investments in land management in the Central Rift Valley of Ethiopia;
3. Explore the key factors affecting farmers' investments in land management in the CRV;
4. Identify the bottlenecks and requirements of co-investments in land management by multilevel public organizations and private sector;
5. Analyse experiences with multi-level collaboration and draw conclusions concerning the prospects for co-investments in land management.

1.5 Key definitions and concepts

This section explains the most important definitions and concepts used throughout this thesis. In Broader tem, *land degradation* is described as the reduction or loss of biological or economic productivity of terrestrial ecosystem including soil, vegetation and other biota (UNCCD, 1994). However, in this study it is narrowly defined as the loss of productivity of soil due to water erosion and nutrient depletion which are the two most important forms of land degradation in Ethiopia (Hurni, 1982).

Perception refers to a range of beliefs and attitudes that an individual builds up an understanding of the environment that is closest to him and makes decisions about how to respond and behave therein based on this understanding, previous experiences and his memory (Burton and Kates, 1964; Thurow and Taylor, 1999).

Water erosion is soil erosion caused by water (Bryan, 2000). *Water erosion control measures* are *p*hysical structures (such as soil and stone bunds) that control both run-on and run-off, and safely drain excess water from the field. *Fertility control practices* are any land management practices that replenish and improve that reduce soil fertility depletion and improve soil fertility.

Land management practices are technologies and activities employed by land users to *control water erosion and fertility depletion.* Sustainable land management (SLM) can be defined as "a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra- and intergenerational equity" (Hurni, 2000).

An *institution* is any structure or mechanism of social order and cooperation governing the behaviour of a set of individuals within a given human community. Institutions are identified with a social purpose, transcending individual human lives and intention by mediating the rules that govern cooperative human behaviour. The term *institution* is commonly applied to customs and behaviour patterns important to a society (in that case also known as 'rules of the game'), as well as to particular formal *organizations* of government and public services. An *institute* is a permanent organizational body created for a certain purpose.

Investment in land management is conceptualized as any effort made by farmers and other stakeholders to control water erosion and improve soil fertility (Kessler, 2006). 'Co-investment' in this research is conceived as collaborative land management in which farm households, government organizations, non-governmental organizations, private sector and other stakeholders invest in land improvement in the form of labour, finance, knowledge, technology or governance.

1.6 Overviews of research areas and methodologies

1.6.1 Research areas

The research for this thesis was conducted in Meskan and Adamitulu Jido-kombolcha weredas, and Galessa watershed. Meskan and Adamitulu Jido-kombolcha weredas are located in the Central Rift valley (CRV) of Ethiopia whereas Galessa watershed is located in the central highlands of Ethiopia (Figure 1.2). Because of the lack of previous initiative regarding land management investments in the CRV, a case study at Galessa watershed was used to get practical experience on the different issues of co-investments. Although this case study is found in the central highlands of Ethiopia, however, many aspects of the case study will be very useful in the other parts of Ethiopia such as in the CRV. This section describes the major characteristics of these study areas (Table 1.1).

Meskan wereda is the home of the Gurage ethnic group, located in the CRV of Ethiopia at an altitude of between 1500 and 3500 m above sea level. It is 135 km to the Southwest of Addis Ababa and administratively in the Southern Nations, Nationalities and People Region (SNNPR). Since the wereda is part of the eastern escarpment of the CRV, it is characterized by relatively undulating landscape especially in the upper part of the wereda. The upper part of the wereda consists of degraded soil while the foot slopes are relatively fertile. The rainfall in Meskan is represented by Butajira weather station and receives 1130 mm mean annual rainfall. Two major farming systems are found in Meskan wereda: enset- and cereal- based systems. Farmers living in the enset-based farming systems are food secure whereas those in cereal-based farming systems are food insecure.

Adamitulu Jido-kombolcha (AJK) wereda is also part of CRV of Ethiopia. It is dominated by the Oromo ethnic group and administrated by the Oromia Region. The topography of the wereda is relatively flat with altitude ranging from 1500-2300 m above sea level. The area is characterized by low annual rainfall (750 mm). The farming system in AJK is entirely cereal-based and most farmers are food insecure.

Figure 1.2. Location of the study areas in Ethiopia.

Table 1.1. Characteristics of the study areas

Characteristics	*Meskan* wereda	*AJK* wereda	*Galessa* watershed
Location	CRV	CRV	Central Highlands
Administration	SNNP region	Oromia region	Oromia region
Distance from AA	135 Southwest	160 South	105 km West
Farming system	Cereal- and *Enset*- based	Cereal-based	Cereal based
Annual rainfall (mm)	1130	750	1400
Ethnicity	Gurage	Oromo	Oromo
Altitude	1500-3500	1500-2300	2820-3100 m.a.s.l.
Latitude	$8^0$0'6"- $8^0$15'52"	$7^0$35'39"- $8^0$2'29"	$09^0$06'54"- $9^0$07'52"
Longitude	$38^0$16'22"- $38^0$31'24"	$38^0$25'07"- $38^0$53'34"	$37^0$07'16"- $37^0$08'54"
Population density	High	Low	Medium

Unlike Meskan and AJK weredas*, Galessa watershed* is found in the central highlands of Ethiopia and administered by the Dendi wereda of the Oromia region. The watershed is part of the Awash basin which is situated at an altitude of 2820 to 3100 m above sea-level and inhibited by the Oromo ethnic group. The watershed is found in the high rainfall zone (1400 mm) where most of the annual rainfall is concentrated in June July and August (Figure 1.3). The farming system is cereal-based but relatively more productive than Meskan and AJK.

1.6.2 Overview of methodology

A mix of methodologies and information sources were used to gain insight in the potential of co-investments in land management to increase soil productivity in the CRV. The study used both secondary and primary data. The primary data were generated using qualitative and quantitative methods.

For **objectives 1-3**, several methods such as key informant interviews, focus group discussions and household survey were employed. The household survey was conducted on 240 farm households in six kebeles of Meskan and AJK weredas of CRV. Similarly, **for objective 4,** data were collected by combining informal surveys and semi-structured interviews. For the semi-structured interview, the sample consisting of 165 interviewees from public organizations at different levels and 42 from the private sector was used.

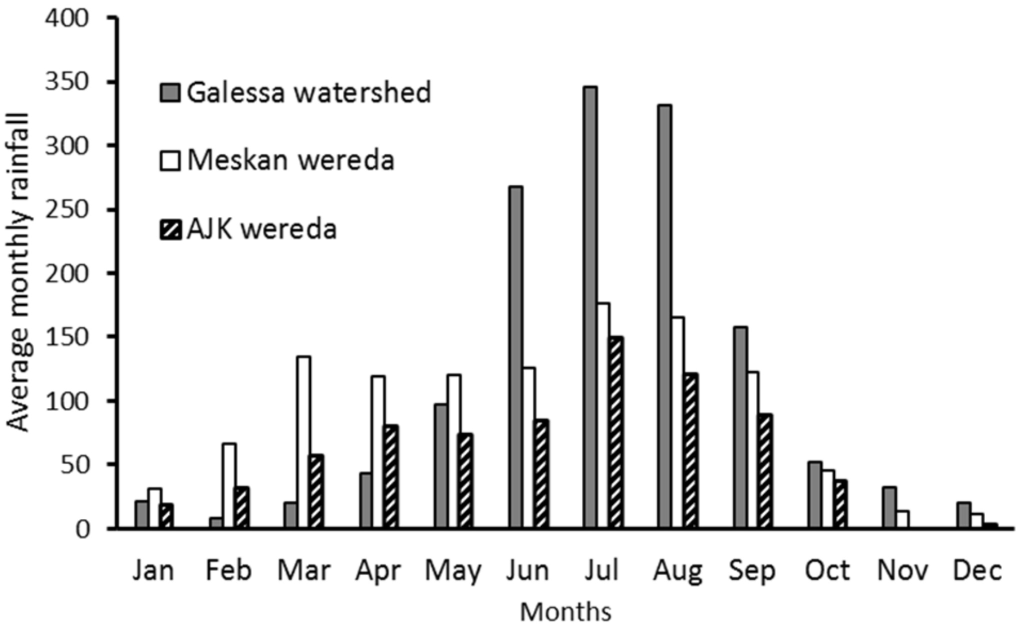

Figure 1.3. Mean monthly rainfall of study areas. Rainfall data were taken from Galessa, Butajira and Ziway weather stations to represent Galessa watershed, Meskan wereda and AJK (Adamitulu Jido-Kombolcha) wereda, respectively.

For **objective 5**, a co-investment initiative was used at Galessa watershed. Informal interviews were carried out with researchers, extension workers, administrators, and farmers. Several documents were reviewed related to the initiative. Moreover, a comparison study was conducted using a household survey to assess the impact of co-investment activities on farmers' investments in land management. The sample consisting of 37 households from experimental groups of farmers (farmers who participated in the co-investment initiative) and 37 from control groups of farmers (farmers who do not participated in the co-investment initiative).

Finally, data were analysed and summarized in descriptive statistics (e.g. percentages, means, standard deviations) were computed. Chi-square and t-tests were also used.

1.7 Thesis Outline

This thesis consists of seven chapters. The first chapter (this chapter) explains the general part of the whole thesis, such as problem statement, objectives, description of the study areas and methodologies. In Chapter 2, farmers' strategies to the perceived trends of rainfall and crop productivity in the Central Rift Valley of Ethiopia are assessed. First, this chapter assesses farmers' perceptions of rainfall and crop productivity in the CRV of Ethiopia. Second, it compares farmers' perception of rainfall and crop productivity with actual data record. Third, it explains the major farmers' strategies to cope with the perceived changes in rainfall and crop productivity.

Chapter 3 looks at farmers' perception of land degradation and their investments in land management. If farmers perceive land degradation as a problem, the chance that they invest in land management measures will be enhanced. So, this chapter presents farmers' perceptions of land degradation and their investments in land management, and to what extent the latter are influenced by these perceptions. Chapter 4 explores factors that determine farmers' investment in land management. Specifically, it devoted to identifying the major factors that determine farmers' decisions *how much* and *where* to invest in land management in three production domains.

Chapter 5 explains the different bottlenecks and requirements of co-investments in SLM. Special emphasis is given to the major bottlenecks of public and private sectors in co-investments in land management. It also discussed the major requirements needed by these stakeholders to improve co-investments in land. Chapter 6 is devoted to the experiences and lessons of co-investments in SLM. This chapter explains and documents the most important co-investment activities that trigger farmers to invest in land management. It also presents the impacts of these co-investment activities on farmers' investments in land management.

The last chapter (Chapter 7) is the synthesis part of this thesis. This chapter focuses the major findings of the study while answering all the objectives mentioned in section 1.4. This chapter also presents major extension, policy and further research recommendations.

Chapter 2

Farmers' strategies to perceived trends of rainfall and crop productivity in the Central Rift Valley of Ethiopia

This paper is under review as:
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Food Security

Farmers’ strategies to perceived trends of rainfall and crop productivity in the Central Rift Valley of Ethiopia

Abstract

Despite decades of international attention to find solutions for the annual food shortages in Ethiopia, the problem still persists. This study, carried out in the Central Rift Valley (CRV) of Ethiopia, focuses on farmers’ strategies to counter yield failures and food shortages. It reveals that farmers indeed perceive a decrease in crop productivity and food production over the last decades, and that they blame a decline in rainfall for this. As a consequence, farmers apply different strategies to cope with, and adapt to perceived rainfall shortages and related expected yield losses: i.e. they sell more livestock, they migrate elsewhere, they change their crops and agricultural practices, and they rely more heavily on food relief programs. However, an analysis of rainfall data in the CRV shows that rainfall characteristics have not changed over the last three decades. Moreover, according to analysis of official data, crop productivity per hectare in the CRV even shows a slight increase over the last decade. The farmers’ perception of a decline in crop productivity and rainfall can be explained by i) the increased demand to grow more crops to feed the rapidly growing population (hence, food availability per capita has declined), and ii) the lower moisture availability for plant growth as a consequence of more intensive farming (often on less suitable fields) and land degradation. The root causes of frequent food shortages are thus not only related to rainfall, but also to soil fertility decline, soil erosion and lack of rainwater storage in the soil. Current farmer strategies are therefore not adequate to cope with the increased food demand in the CRV. There is an urgent need to invest in sustainable land management (SLM) practices that enhance local food production, and this requires further research into how to best motivate farmers and supporting institutions to make this happen.

Keywords: Ethiopia, Crop productivity, Farmers' strategies, Food shortage, Land degradation, Rainfall

2.1 Introduction

Although agriculture is the backbone of the Ethiopian economy, the sector remains low productive and is hardly able to support food demands of the growing population. On average, there is an increase in national food deficit over years and annually the population of the country faces food shortage (Mulat, 1999; Jayne et al., 2002; Ramakrishna and Demeke, 2002). Frequent severe food shortages occur on average each five years due to failure or sharp reduction of the main rain season, affecting high numbers of Ethiopians (e.g. 14.3 million people in 2002/2003) and leading to dramatic situations (MoFED, 2002; WFP, 2010). A food safety net programme is permanently in place in Ethiopia to deal with urgent food shortages (FAO, 2010).

Given that crop production is predominantly rain-fed, variability and unpredictability of rainfall has always been a major concern in the country (Howell, 1998; Shiferaw et al., 2007). Over generations, especially where rainfall variability affects livelihoods, farmers have applied several adaptation and coping strategies in response to the uncertainties induced by variation in rainfall (Cooper et al., 2008). Farmers’ strategies and activities to cope with this unpredictability are very diverse, site specific and influenced by several social, economic, institutional and biophysical factors (Deressa et al., 2009; Tittonell et al., 2010).

Farmers are generally quite flexible and do actually adapt to certain changes. Especially in climate change literature a lot of attention has been given to this topic and adaptation is defined as *adjustments* in ecological and socioeconomic systems in response to actual or expected climatic stimuli, their effects or impacts (Smit et al., 2000). Such adjustments can relate to individuals, groups or institutional behaviour (Pielke, 1998), and can be short-term or long-term (Smit et al., 1996). According to Tol (2005), farmers can adapt if they perceive that there is a change, and if the benefit of using such an adaptation strategy is greater than without it.

However, what are farmers' strategies based on? And are changes in rainfall really the only root cause of lower food production? Literature suggests that what farmers call drought is often more related to land degradation than to changes in rainfall (Stroosnijder, 2008; Stroosnijder, 2009). Hence, they perceive drought, but actually experience a decline in soil productivity resulting from land degradation. This paper studies these phenomena for the CRV in Ethiopia and contributes as such to our understanding of farmers' perception of rainfall and crop productivity, as well as their strategies resulting from this perception. Perception in this sense is understood as a range of beliefs and feelings, and is highly influenced by previous experiences (Taylor et al., 1988; Park, 1999). Therefore, this research will also analyse historical rainfall and crop productivity data for the CRV, with the objective to compare these with farmers' perceptions. As such, this study contributes to enhanced understanding of farmers' strategies, and provides recommendations for further research and development activities in the CRV of Ethiopia. A better understanding of how farmers cope with and adapt to the perceived trends of rainfall and crop productivity is essential to promote successful strategies for agricultural development (Quinn et al., 2003).

2.2 Materials and methods

2.2.1 Description of the study areas

This study was conducted in six villages (or kebeles[1]) in the districts (or Wereda[2]) of Meskan and Adamitulu Jido-Kombolcha (AJK). Both districts are located in a different administrative regional state: Meskan is found in the Southern Nations, Nationalities and People Regional (SNNPR) State[3] while AJK is in the Oromia Regional State. Meskan is located 135 km to the Southwest of Addis Ababa whereas AJK is 160 km south of Addis Ababa (Figure 2.1). The rainfall in Meskan is represented by Butajira weather station and rainfall of AJK by Ziway weather station. The Meskan Wereda receives more rainfall than the AJK Wereda (Figure 2.2) given its higher altitude and location on the slopes of the CRV.

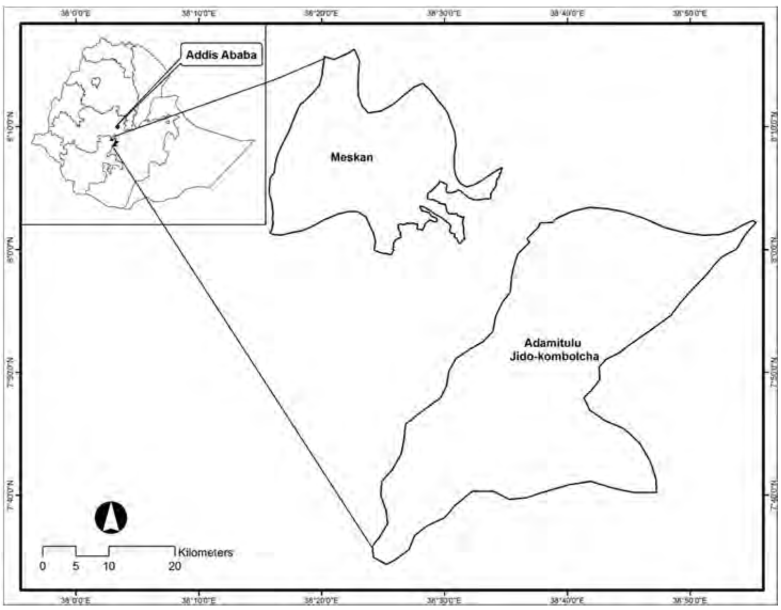

Figure 2.1. The location of Meskan and Adamitulu Jido-kombolcha weredas in Central Rift Valley of Ethiopia.

[1] Kebele is the lowest administrative unit in Ethiopia
[2] Wereda is the local administrative unit above Kebele
[3] Regional state is Ethiopian administrative structure below National Government

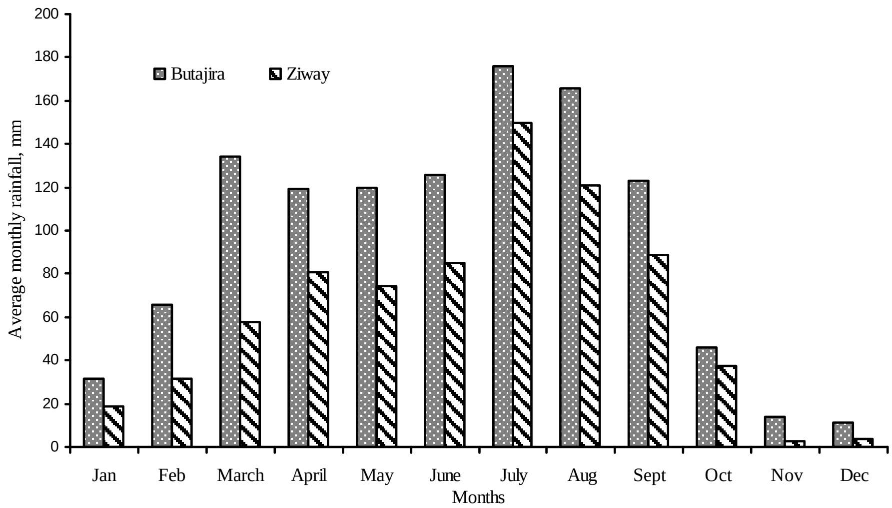

Figure 2.2. Mean monthly rainfall (1969-2006) in Butajira and Ziway weather stations.

2.2.2 Data collection and analysis

For reasons of analysis and in order to provide better insight in the results of this study, six kebeles in the studied areas were randomly selected from three production domains. Domain I comprises Beressa and Drama kebeles (both in the Meskan Wereda) and is characterized by a *cereal-based*[4] farming system. Farmers are relatively food insecure with small livestock number (2.4 TLU[5]) and land holding (0.7 ha). Domain II includes Dobi and Mikaelo kebeles (also both in the Meskan Wereda). Unlike domain I, this domain has an *enset-based*[6] farming system, with farmers being food secure and with medium livestock numbers (3.5 TLU) and land holdings (0.9 ha). Domain III comprises Worja and Woyisso kebeles (both in the AJK Wereda) which are also characterized by a cereal-based farming system and are food insecure due to lower rainfall. But these farmers have larger livestock numbers (5.4 TLU) and land holdings (1.8 ha) than the other two domains.

Quantitative and qualitative information was obtained using different data collection methods such as key informant interviews, focus group discussions, formal household surveys, and secondary data collection. General perceptions gathered from informal survey were propped by in-depth individual household questionnaire interviews. A survey was therefore conducted from 240 randomly selected households within the six kebeles, during October 2009 to April 2010 using structured and pretested questionnaires. The questionnaire contained several questions regarding farmers' opinion on the trend of crop productivity and rainfall over years. It also included farmers' adaptation and coping strategies to counter yield failure and food shortage. The lists of households were obtained from respective kebele administrations and the heads of the households were invited for household survey. Informal survey such as key informants interview and focus group discussions were used to formulate the questionnaire for the formal survey and understand in-depth some of the emerging findings from formal survey. Daily rainfall record of two weather stations (Butajira and Ziway) was obtained from the Ethiopian Meteorology Services Agency (EMSA) and the Ethiopian Institute of Agricultural Research (EIAR). The main reason why only two stations were used is because these are the only stations available around the study kebeles in which farmers' perception of rainfall can be compared. In addition, secondary data on crop production for the last decade (1997-2008) in the study area was obtained from the Central Statistical Agency (CSA) of Ethiopia.

[4] Cereal-based farming system is dominated by cereals, particularly maize, sorghum and *teff.*

[5] Tropical Livestock Units (1 TLU = 250 kg live Weight). Different farm animals have different conversion factor to TLU. Accordingly, Oxen/Bulls=1.1 TLU, cows/horses/mule=0.8 TLU, donkey=0.65 TLU, Heifer=0.36 TLU, Calf=0.2, Chicken=0.01TLU and Sheep/goat=0.09 TLU. (Sharp, 2003).

[6] The enset based farming system is a system consisting of a large number of crop components such as root crops, cereals, fruits and vegetables in intimate association with enset (*Ensete ventricosum* Welw. Cheesman) plant.

Data generated using these methods were summarized and analyzed using the Statistical Package for Social Science (SPSS) and Microsoft Excel. In order to understand the trend of rainfall over years, the annual and seasonal (meher and belg) rainfall data were plotted over years. Coefficient of variation (CV) of annual, *meher* (main and long rain season) and *belg* (short rain season) seasons were calculated for in-depth analysis of rainfall variability. Moreover, dry days and dry spell lengths were calculated using Instat version 3.036 software.

2.2.3 Major characteristics of sampled households

Table 2.1 depicts the major characteristics of the sampled households. The total population of the 240 households was 1513, of which, 80% were men-headed and 20% women-headed households. The average household size for the sampled households was 6.2 which is greater than the national average of 5.2 (CSA, 2008a) with slight variation among kebeles. On average about 50% of the respondents in the area are illiterate.

Land and livestock are the most important sources of livelihood in the study areas. The average land holding of the sampled households is 1.1 ha (the national average is 1.0 ha (CSA, 2008a)), with domain III having larger land holdings than the other two domains because of being located in the valley bottom with considerable lower rainfall and less fertile soils. This is also reflected in the average land size per capita (an important indicator of land shortage), which is considerably higher in domain III. Like in other parts of the country, livestock husbandry is an integral part of the farming system and provides cash income and manure while improving the native diet as well as being a means of accumulating capital and wealth. In terms of TLU, the average livestock holding per household was 3.7.

Table 2.1. Major characteristics and demographic composition of the sample households in the CRV of Ethiopia.

Households Characteristics	Domain I (Meskan)		Domain II (Meskan)		Domain III (AJK)		Aver.
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Farming system [a]	Cb	Cb	Eb	Eb	Cb	Cb	
Two major crops grown [b]	M,T	M,T	E,M	E,M	M,S	M,S	
Men headed households (%)	83	83	88	78	65	87	80
Age of household heads (years)	41	48	52	46	43	39	45
Number of family members	6.2	6.8	5.8	5.7	6.4	6.9	6.2
Land size per households (ha)	0.6	0.8	1.1	0.7	1.5	2.1	1.1
Land per capita (ha)	0.10	0.13	0.20	0.14	0.25	0.32	0.19
Land fragmentation index	0.19	0.24	0.44	0.20	0.52	1.00	0.44
Total TLU per household	2.1	2.6	3.5	3.4	3.8	7.0	3.7

[a] Cb: Cereal-based, Eb: Enset-based.

[b] M: Maize, S: Sorghum, T: Teff, W: Wheat, E: Enset

Table 2.2. Farmers' perception on crop productivity over years in the CRV of Ethiopia.

% farmers that confirm:	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Crop productivity for the last decades							
Declining	61	82	70	66	37	62	63
Fluctuating	32	15	20	17	63	20	28
Remain the same	7	3	10	17	0	18	9
Crop productivity in the future							
Only God knows	58	30	62	55	48	74	55
Declining	12	50	32	20	5	3	20
Fluctuating	10	10	3	5	17	10	9
Remain the same	20	10	3	20	30	13	16

2.3 Results and discussions

In this section we will first analyse farmers' perceptions concerning crop productivity and rainfall. In the second part farmers' coping and adaptation strategies are presented and analysed. Finally, in the third part of this section perceptions and strategies are further discussed and explained by comparing them with actual crop productivity and rainfall data for the study area.

2.3.1 Farmers' perceptions of crop productivity and rainfall

In order to understand the perception of farmers on crop productivity, they were asked to give their opinion on the trend of crop yield per hectare on their own plots for the last 10 years. Results of farmers' perception of the trend in crop productivity over the last decades indicate that a significant majority of the farmers (63%) report that crop productivity has declined over the last decades (Table 2.2). Farmers elsewhere in Ethiopia, e.g. in the Arsi Negele Wereda of the CRV (Garedew et al., 2009) and in the Central highland of Ethiopia (Amsalu and De Graaff, 2006) also believe that crop productivity declined over years. Results however are quite variable among the six kebeles, with Worja (located in the driest part of the study area) showing the smallest perceived decline in crop productivity (only 37%) and Drama the largest (80%). In general, the percentage of farmers perceiving that crop productivity has remained the same over the last decades is low. When farmers were requested to predict crop productivity in the future, a majority was not able or uncertain to give a clear opinion and mentioned that only God knows about the future. It is remarkable that in domain III, the drier part of the study area, farmers were less pessimistic about this future trend than in the other domains. Half of the farmers in Drama kebele believe that there will be a decline in crop productivity in the future. A possible explanation is that farmers in this kebele were so pessimistic because of being affected by frequent yield reductions in the previous years.

Given that decline in rainfall was frequently mentioned as the main cause of declining crop productivity, farmers were also requested to give their opinion on rainfall trends. Indeed, a majority (67%) of farmers reported that the amount of annual rainfall has decreased over the last decades (Table 2.3). Such a perception is quite common for farmers and has been observed also in studies in the Nile Basin of Ethiopia (Bryan et al., 2009; Deressa et al., 2009), Northern Ethiopia (Meze-Hausken, 2004) and Central Ethiopia (Amsalu et al., 2007).

Our findings indicate that farmers directly relate yield reductions and food shortage to a decrease in rainfall. This is also confirmed by the relatively few farmers (30%) in Worja Kebele that sense that rainfall has decreased over the past decades: this percentage is related with the lowest percentage of farmers perceiving crop productivity decline in this kebele (Table 2.2). In the other kebeles perceptions are quite consistent and do not vary a lot.

Farmers were also requested to predict the trend of rainfall in the future. Similar to crop productivity, most farmers were not confident enough to speak about rainfall trend in the future. Majority of them (65%) believe that the future is not predictable. Such thinking is similar to perception of farmers in the Asfachew area of Central Ethiopia (Slegers, 2008): rainfall is beyond men's control and a super natural force (i.e. God) causes its variability. In the two kebeles of Domain III (the driest spots of the study area) farmers are least negative about the future trend with only very few farmers believing that rainfall will decrease (despite having perceived a decline over the past decades).

Table 2.3. Farmers' opinion on trends in rainfall in the CRV of Ethiopia.

% farmers that confirm:	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Trend of rainfall for the last decades							
Decreasing	78	58	75	86	30	76	67
Fluctuating	12	35	20	7	65	16	26
No change	10	7	5	7	5	8	7
Trend of rainfall in the future							
I don't know	75	70	65	60	67	74	65
Decreasing	15	23	28	28	5	8	20
Fluctuating	10	7	7	12	28	18	15

2.3.2 Farmers' strategies to counter perceived trends

With the knowledge that on the one hand most farmers perceive that crop productivity has declined, and on the other hand a perceived decrease in rainfall is seen as the main cause of yield reductions, this study focused on the farmers' strategies to cope with these perceptions. Such strategies are divided into coping strategies and adaptation strategies. Coping strategies are short-term and unplanned in response to unexpected crop failure and yield losses and just for *survival*, while adaptation strategies are long-term and *planned* responding to expected continued decline or uncertainty in future crop productivity and food production (Vogel, 1998). Strategies mentioned by farmers during the survey were categorized into coping and adaptation strategies based on the definitions mentioned above.

Coping strategies

Over decades, where rainfall variability impacts most strongly on livelihoods, farmers have developed coping strategies to buffer against the uncertainties of crop yield induced by annual or seasonal variation in rainfall. Table 2.4 shows the different coping strategies to unexpected crop failure and low yields in the CRV of Ethiopia.

Selling livestock

Most households (63%) sell livestock as a short-term coping strategy during abrupt food shortage. It ranges from 90% of households in Worja to 44% in Beressa. In terms of domains, selling livestock as a coping strategy is highest in domain III (78%), where total TLU and land size per household is also higher (Table 2.1). Crop production in this domain is relatively risky due to low and unpredictable rainfall. According to farmers, sheep and goats are sold first, given that these are more widely available and can always be sold immediately. Only in case of emergencies farmers sell cows and oxen of which they only have few.

Table 2.4 Farmers' coping strategies to unexpected crop failure in the CRV of Ethiopia.

Short-term coping strategies	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Selling livestock	44	45	65	71	90	66	63
Migration	85	67	36	32	53	75	58
Accessing relief programmes	49	35	20	7	60	47	36
Reducing seeding rates	25	10	22	20	13	8	16
Accessing credit	5	3	0	2	68	11	15
Using social security system	20	5	5	17	8	8	10

Migration to relatives

Migration is a coping mechanism used throughout history by Ethiopian societies as part of their resource utilization strategies and as a means of coping with rainfall variability. Migration to relatives from affected (low productive) to unaffected (high productive) areas is a common strategy. Farmers migrate to different parts of Ethiopia: to other parts of the CRV, but also further away and to the Central highlands. These areas are said to be high productive and having a food surplus due to better rainfall and fertile soils. Migrants are working as daily labourers during weeding, harvesting and threshing. The objective is to work and send grain or cash to their families. Generally, 58% of the respondents indicate that one or more of their family members migrated to relatives in unaffected areas during crop failure. Higher migration is observed in domains I (76%) and III (64%) as compared to domain II (34%). This indicates that the enset-based farming system (domain II) plays a significant role in providing food security.

Accessing relief programmes

Relief in the form of cash or food is a common aid provided by governmental and non-governmental organizations in the northern and central parts of the country in the form of food-for-work or free distribution (Gilligan and Hoddinott, 2007). Generally, 36% of households have received relief from both governmental and non-governmental organizations. Domain III is the largest recipient of relief programmes as it is found in a low rainfall area with less fertile soils. Domain II is the lowest recipient because it is found in the food secured (enset-based) farming system. Particularly Mikaelo kebele is relatively food secure and endowed with enset and chat plants.

Reduction of seed density

One of the critical problems of crop failure is shortage of seed for the following cropping season. About 15% of the respondents apply reduced seed density during seed shortage. Sometimes, farmers are forced to apply low seeding density to cover their cultivated land. This has a negative impact on the yield: the lower the seed density (below the optimum level), the lower crop productivity.

Accessing credit

Credit refers to advances, either in cash or as farm inputs to farmers and to be repaid at a later agreed-upon date. Farmers can access credit from both governmental and/or non-governmental organizations during crop failure. Generally, 15% of respondents use credit facilities, with the highest percentage in Worja where 68% of farmers access credit. These households are close to Ziway town where they are often involved in petty trading, and can repay the money. According to farmers, they have also received credit in the form of seeds to compensate seed shortage.

Using the traditional social security system

This system is one of the most important social security strategies to help each other. The system works within extended family and kinship networks where there is compulsory sharing of resources. In the case of crop failure, members with grain or cash reserves share with less endowed members. Old and handicapped individuals are supported by the network members either through rotation feeding or contribution of food. It includes not only compulsory sharing of food resources but also compulsory provision of credit. One of the most important social security systems in Oromo ethnic group is the Gadaa system. In the Gadaa system sharing of resources (locally called 'Buusa Gonofa') is an important coping strategy that has profound impact in making poor households less vulnerable to crop failure. Only few farmers use this coping strategy because there are only few well-to-do farmers.

Table 2.5. Adaptation strategies of farmers in the CRV of Ethiopia, % households.

Adaptation strategies	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Enset expansion	12	18	30	73	0	0	22
Chat expansion	42	10	0	49	0	0	17
Eucalyptus expansion	68	85	73	56	0	0	48
Change in crop variety	14	18	8	2	35	24	21
Adjusting planting dates	24	11	10	7	31	18	26
Dry ploughing and dry planting	37	18	15	10	48	29	26
Diversifying income	49	48	15	20	35	8	29

Adaptation strategies

Besides coping strategies, farmers have several adaptation strategies in response to uncertainty and expected declining crop productivity (Table 2.5). Some strategies are site specific, like the expansion of Enset, chat and eucalyptus, which is only possible in Meskan (domains I and II) because of the climatic and soil conditions. The other adaptation strategies are applied in all studied kebeles.

Enset expansion

Enset (*Ensete ventricosum* Welw. Cheesman) sometimes called 'false banana' is a major food plant in the South and Southwest of Ethiopia and supports an estimated 15 million people (Negash and Niehof, 2004). Enset is a fairly drought resistant herbaceous plant from which three main food products are derived: *Kocho*[7]*, bulla*[8] *and Amcho*[9]. In Mikaelo kebele, most farmers report that enset has expanded over the last decades, given that it is better adapted to rainfall shortage than other crops. Although farmers in domain I and II are found in the same climate, the soils in domain I are sandy and not suitable to grow enset. The climate and soils of Worja and Woyisso are unsuitable to grow enset. Despite its advantages, enset cultivation can be constrained by a devastating disease known as enset bacterial wilt (*Xanthomonas musacearum*). This is a risk for farmers in domain II that heavily rely on enset expansion as an adaptation strategy. Till date scientific research has not been able to control this disease. This suggests that researchers and policy makers should give attention to this important plant in order to explore its potential in the country.

Chat expansion

Chat (*Catha edulis*) is an evergreen tree cultivated for the production of fresh leaves that are chewed for their stimulating properties. It is the third export commodity of the country preceded by coffee and oilseeds. In Ethiopia the area covered by chat increased from 96,000 ha in 2000 to 163,000 ha in 2007 (CSA, 2001; CSA, 2008b), mostly at the expense of coffee in Eastern Ethiopia (Mulatu and Kassa, 2001) and forest in Southern Ethiopia (Dessie and Kinlund, 2008). Also the value of chat export has increased from 3.6 million Ethiopian Birr (ETB) in 1992 to 786.3 million ETB in 2006 (Belwal and Teshome, 2011). Farmers indicate that *chat* has expanded in the area because of its high economic return and minimum risk of failure under variable rainfall. Moreover, it is suitable for intercropping and allows cultivation of food crops between the rows during the main rainy season. Particularly in Beressa and Dobi farmers plant *chat* in their plots, and this has been expanding over the last decades as a response to crop yield reduction. Dobi is quite an exception: although it is suitable for *chat* plantation and farmers know about its economic advantage, chat does not expand in Dobi. This is explained by the fact that the main ethnic group in Dobi are Orthodox (Coptic) Christians, for whom chewing *chat* is prohibited.

[7] *Kocho* constitutes the bulk of fermented plant material obtained from a mixture of decorticated leaf sheaths and the grated and pulverized corm and pseudo stem.

[8] *Bulla* is the small amount of water insoluble starchy product that is separated from kocho during the processing.

[9] *Amcho* is the fleshy inner part of the enset corm, which is eaten boiled.

Eucalyptus expansion

Despite the fact that policy makers at various levels have started to discourage farmers to plant and expand *Eucalyptus* (because of its presumed negative environmental impact), in Meskan district (domains I and II) planting Eucalyptus is the main adaptation strategy. Farmers expand Eucalyptus plantations because of its high economic return and in order to minimize the economic impact of crop failure in the future (Adimassu et al., 2010). About half of the farmers in the study area reported that they have been expanding eucalyptus over the last decades. Like enset, eucalyptus can't grow in domain III due to climatic and soil constraints.

Change in crop variety

Farmers change varieties of a given crop depending on the rainfall conditions (Smit and Skinner, 2002; Deressa et al., 2009). Changes mainly concern a shift from long to short duration varieties; in the CRV particularly for maize. Maize variety *BH-660* is high yielding with a long growing period while variety BH-*540* is a low yielder with short duration. If the *belg* rain starts early, farmers plant *BH-660* and if the *belg* season starts late, they usually plant *BH-540*. Recently two new short duration maize varieties have been developed by the Melkassa Agricultural Research Center. Given that farmers in domain III have better access to this research centre, they have quickly adopted these new crop varieties as an adaptation strategy. This indicates the importance of agricultural research in providing appropriate technology for effective adaptation to rainfall variability.

Adjusting planting dates

Adjusting planting dates as a strategy in response to seasonal variation in rainfall has been reported in Ethiopia and South Africa (Bryan et al., 2009) and in Burkina Faso (West et al., 2008). In our research farmers told they had approximately fixed planting dates when rainfall was reliable. However, nowadays, they follow the pattern of rainfall and adapt to expected rainfall. Some 26% of respondents reported that adjusting planting dates based on the onset of both *belg* and *meher* season is an adaptation strategy to rainfall variability. This is more evident in domain III where rainfall is much lower and more disperse.

Dry ploughing and dry planting

There is a local proverb that says "*Gebere mognu*"- meaning that "a farmer is foolish" when he is planting crops without any rainfall or moisture. Nowadays this is quite common among farmers in Beressa, Worja and Woyisso, where they use dry planting before the rain starts in order to capture the first shower. Nevertheless, the dry planting technique is risky, given that seeds might rot away if moisture is not sufficient for germination during the first weeks of the rain season.

Diversifying income through off-farm activities

Households diversify income from different sources particularly from off-farm activities. These include petty trading, preparation of local drinks *(e.g. Areke, tella*) and engaging in unskilled labour selling. Almost one-third of the interviewed farmers are engaged in off-farm activities. Involvement of farmers varies among kebeles: a relatively small proportion of Dobi, Mikaelo and Woyisso farmers are involved in off-farm activities. The main reason is that Dobi and Mikaelo households are relatively food secure while Woyisso is relatively far from towns where off-farm income opportunities (e.g. flower farms, construction activities) are available. Income diversification through off-farm activities is also a common adaptation strategy in other parts of the country (Holden et al., 2004).

2.3.3 Analysing farmers' perceptions and strategies

To what extent are farmers' perceptions confirmed by actual data concerning crop productivity and rainfall? And are farmers' coping and adaptation strategies really targeting the root causes of food shortage in the CRV? This section will discuss and analyse differences between farmers' perceptions and real data, and explore how these insights can help to recommend certain changes or improvements in farmer strategies for assuring a more sustainable food production. The final discussion deals with the implications of these recommendations for rural development strategies and extension services in the CRV of Ethiopia.

Crop productivity

For the present study, crop productivity data were analysed specifically for the Meskan and AJK weredas from the Central Statistical Authority (CSA) of Ethiopia. Maize (*Zea mays*) and *teff* (*Eragrostis tef*) crops were used to verify the perception of a majority of farmers that crop productivity has declined over the past decade. Both crops are dominant food crops grown in the study areas. Figure 2.3 shows that there is a high variability in the productivity of maize and teff over the past decade. This indicates lack of empirical evidence that supports farmers' perception of declining crop productivity over years. On the contrary, the trendlines however show a slight increasing trend in the productivity of *teff* in both weredas and maize in AJK Wereda. This increase is generally explained by the increased use of improved crop varieties and chemical fertilizers over the past 20 years (Jayne et al., 2002). Moreover, a recent study by De Graaff et al. (2011) shows a considerable increase in productivity of food crops over a 40-year period (1966-2006) in Ethiopia, and even a slight increase in per capita food production over a period where population increased almost 3 fold. However, such a country level analysis doesn't show variations between high productive areas and low productive areas (like the CRV) with erratic rainfall and less fertile soils.

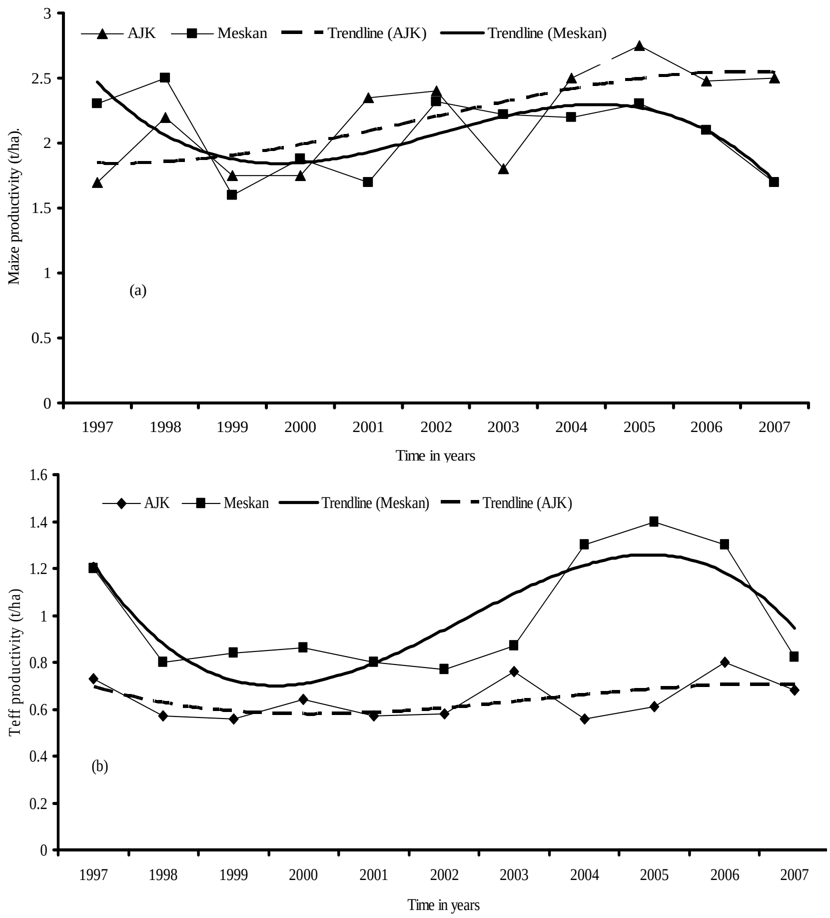

Figure 2.3. Trends of Maize (a) and Teff (b) productivity in Meskan and AJK Weredas. Source: Own analysis based on Zonal data of the CSA record.

The fact that farmers perceive a decline in crop productivity despite the above evidence is due to a decline in food availability per capita. This is confirmed by Meshesha et al. (2012) that grain production per capita decreased from 245kg capita^{-1}y^{-1} in 1965 to 100kg capita^{-1}y^{-1} in 2008 in the CRV of Ethiopia. Farmers need to produce more on the same fields in order to feed more people (their own family size has increased) and to sell part of their production to obtain enough money for their expenses (which are also growing). Moreover, population growth also leads to land shortage, shorter fallow periods, cultivation of marginal land, and land fragmentation (land per capita for example in Beressa is only 0.10 ha). Land will become more susceptible to soil erosion (Ovuka, 2000) and small plots will hinder appropriate land management (Onega-Lopez *et al*., 2011).

In synthesis: although total food production and crop productivity have remained more or less the same or have even increased in the CRV, farmers perceive food shortage and a decline in crop productivity. In fact, what they experience is a decline in food production per capita.

Rainfall and dry spell

Annual and seasonal rainfall trends, as well as the occurrence of dry spell over the past decades, was analysed with data from the local weather stations. Figure 2.4 shows that annual rainfall is quite variable, and that the trendlines show a slight increase in rainfall amount since 1982 in the Butajira weather station (representing domains I and II) and a slight decreasing trend in Ziway station (domain III). When compared to farmers' perceptions, we surprisingly find that in domains I and II – where the annual rainfall trend is positive – farmers are more negative about rainfall trends than in domain III, where the trend is slightly negative. Hence, the rainfall records from the local weather stations do not validate farmers' perceptions on rainfall. Previous rainfall analysis from Ziway and Negele Borena weather stations (both in the CRV) of Ethiopia show high variability rather than a declining trend of annual rainfall over years (Tilahun, 2006).

This discrepancy is because water availability for agricultural crops has decreased over the last decades because of an expansion of the agricultural area to marginal lands and consequently higher overall water demands to grow more crops for the growing population (Meshesha *et al*., 2012). Moreover, this expansion implies farming on more marginal fields which are less suitable for agriculture, and where farmers more directly feel lack or shortage of water. Furthermore, traditional agricultural fields are farmed more intensively, leading to soil erosion and loss of fertility, which will also affect the water holding capacity of these soils. The availability of soil moisture for plant growth can be affected by factors such as soil fertility decline and soil erosion (Falkenmark, 2009; Slegers and Stroosnijder, 2008). It is also found that land degradation resulted from water erosion and nutrient depletion is a problem in the study area (Adimassu and Kessler, 2012; Meshesha et al., 2012). Nevertheless, farmers' investment in sustainable land management to address the problem is quite limited (Adimassu and Kessler, 2012).

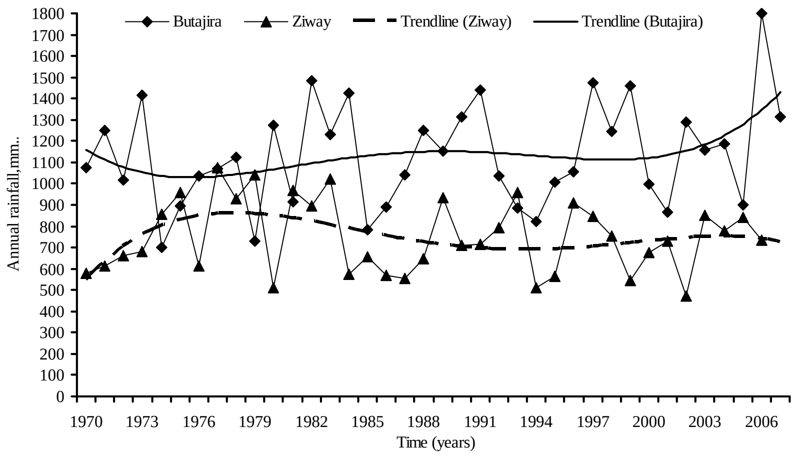

Figure 2.4. Trend of annual rainfall in Butajira and Ziway, CRV of Ethiopia.

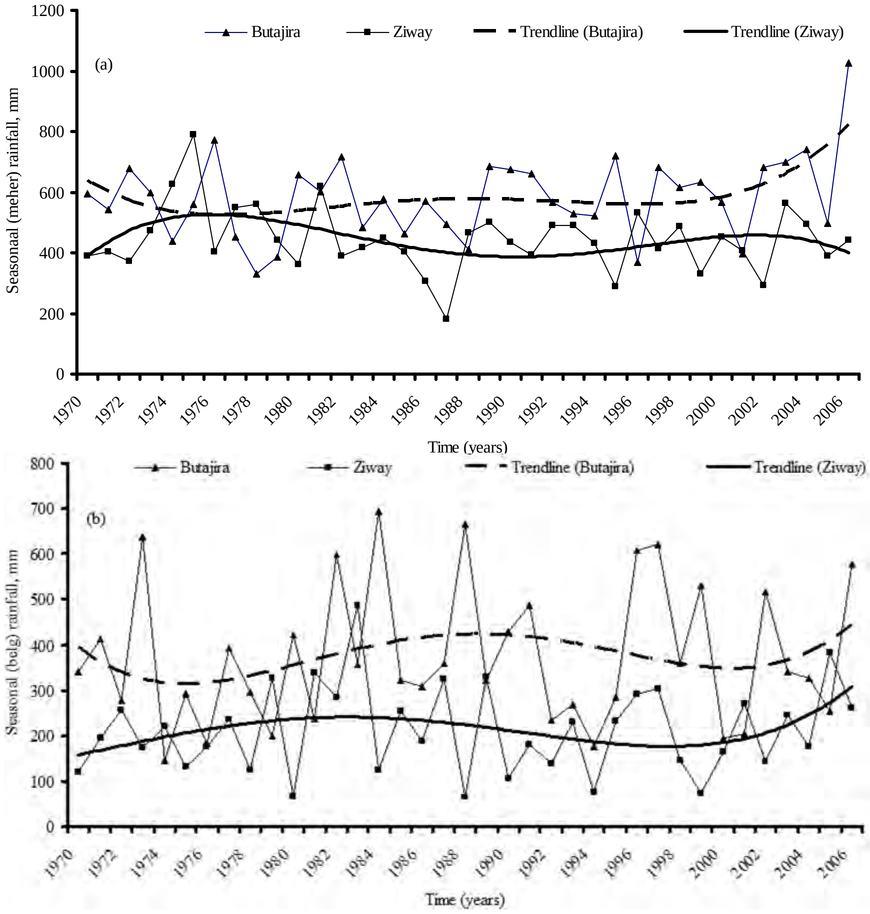

Figure 2.5. Trend of meher (a) and belg (b) rainfall in Butajira and Ziway, CRV of Ethiopia.

Moreover, it has been demonstrated that moisture availability can be improved using land management practices such as tie-rigging in the CRV of Ethiopia (Biazin et al., 2011). Hence, farmers might interpret rainfall amount as moisture availability for plant growth, and thus blame rainfall decline for their perceived decrease in crop productivity and food production for the growing population.

More insight into the relation between farmers' perceptions on rainfall and actual data can probably be obtained by analysing seasonal variability in rainfall amount. In the CRV there are two rainy seasons: *meher* and *belg*. *Meher* is long and the main source of rainfall which lasts from June to September. *Belg* is the short and light rain season, and usually lasts from March to May. Mean seasonal rainfall was obtained by summing the corresponding mean monthly rainfall which was originated from the daily rainfall dataset. As shown in Figure 2.5, the meher and belg rainfall vary over years. But the variability of *meher* season is relatively lower (23% in Butajira and 25% in Ziway) than the *belg* season (41% in Butajira and 46% in Ziway). This indicates that *meher* rainfall is more predictable than belg rainfall. This result is supported by the findings elsewhere in Ethiopia where the variability of belg rainfall is higher (31% to 63%) than *meher* rainfall (19-31%) (Amsalu et al., 2007; Meze-Hausken, 2004). More important for our study are the trendlines: the trendlines for both rainfall seasons increase for Butajira and are more or less even for Ziway. This is similar to the annual rainfall trend in both stations, and again not in line with farmers' perceptions of declining rainfall over years.

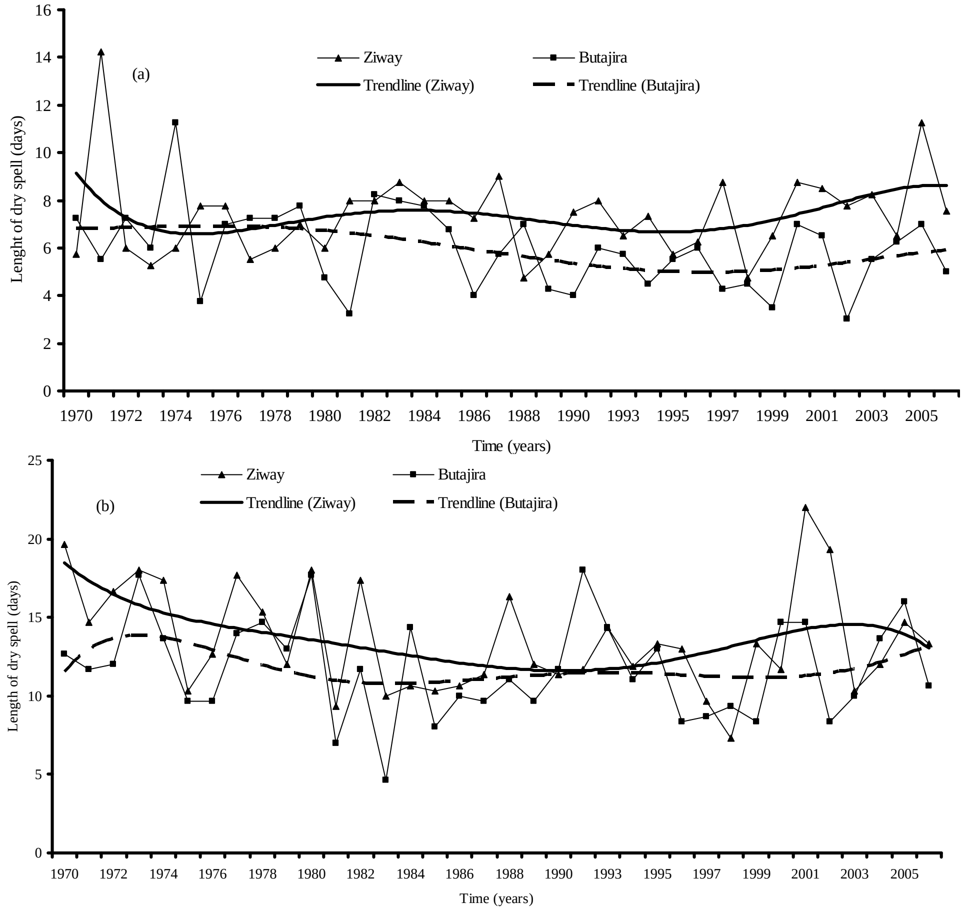

Figure 2.6. Length of dry spells in Meher (a) in Belg (b) and seasons over years.

An analysis of dry spells was conducted in order to assess if a possible increase in this factor could be related to the farmers' perception of decreasing rainfall. A dry spell is defined as a number of consecutive dry days (Gong et al., 2005). A dry day is defined as a day with less than 0.85 mm of rain, and the length of a dry spell is calculated as the maximum average consecutive dry days recorded per month in both seasons. For example, the *meher* dry spell of 1970 is the average of the dry spells of June, July, August and September. Figure 2.6 shows the dry spell length of meher and belg seasons in Butajira and Ziway weather stations. The trendlines of dry spells of both *meher* and *belg* season are mixed. But the trendlines of the *meher* season show that dry spells have slightly increased since 1999 in both stations. The trendlines of the *belg* season show also a variable trend with high dry spell length in the 1970s and a slightly increasing trend since 1980 in Ziway and Butajira. Although the trend for dry spell length is mixed, there is a slightly increasing trend over the past 10 years.

Farmers' strategies

Summarizing the conclusions from the previous two sections we can state that:

- Farmers in the CRV experience regular and increased food shortage, which in their perception is caused by a decrease in crop productivity as a result of decreased rainfall;
- Results show that not crop productivity has declined, but rather per capita food production, as a result of population growth and increased sale of production to the market;
- Results show that not rainfall amount has decreased, but rather water availability to the crops; as a result of land degradation that reduces the water holding capacity of the soil, especially on marginal fields.

This summary makes clear that there are in fact two main drivers of food shortage: population growth and land degradation (Lal, 2009). Adequate strategies should thus focus on arresting both at the same time.

These are complex issues that require (national) coordinated strategies, particularly for population growth. But land degradation is typically something that individual farmers in the CRV can tackle also. However, they do not, partially due to a misperception of the real drivers of food shortages. It is not rainfall that has declined over the past decades, but water availability to the crop due to land degradation. And was it not for the increased use of chemical fertilizers and new crop varieties then indeed this shortage of water availability would have greatly affected crop productivity. This is not yet the case, but might cause more dramatic food shortages in the near future once farmers do not have the means anymore to continue buying fertilizers, especially for the more marginal fields. Moreover, under continued land degradation and decreasing water holding capacity of the soil, chemical fertilizers will no longer sort the desired effects and buying them will be a waste of money. Hence, investment in sustainable land management is critical to cope with increased food shortages and crop failure.

Such investments in SLM might break the vicious circle of ever increasing food shortage and poverty. For example, land degradation can diminish crop production and consequently farmers' income and capacity to undertake critical investments needed to reverse land degradation (Shiferaw *et al*. 2007). This in turn reduces opportunities for addressing nutritional and other necessities and depletes farmers' ability to cope with or adapt to shocks (e.g. yield reduction), thereby increasing vulnerability of livelihoods. Hence, the negative yield impact of rainfall variability can be reduced by positive yield impact of SLM practices (Nyssen et al., 2000). Soil and water conservation practices improve the water holding capacity of the soil and reduce nutrient depletion which in turn increases crop yield (Vancampenhout et al., 2006). This underscores the need to give priority to investments in SLM practices in combination with adequate coping and adaptation strategies.

But to what extent are current farmers' strategies beneficial to SLM? *Migration* can have either positive or negative impact on land management. On the one hand, it might lead to labour shortage on the farm (e.g. for labour intensive activities such as construction of soil and stone bunds) and negatively impact SLM investments (Barry et al., 2000). On the other hand, off-farm income generated through migration enhances farmers' investment capacity in land management (Shiferaw et al., 2007). *Livestock selling* may reduce overgrazing and land degradation (UNEP, 1997), and contribute to investments in SLM (e.g. chemical fertilizer and manure) through increasing farmers' financial capital (Holden *et al*. 2004). Expansion of *eucalyptus* can provide farmers with income and may also increase their capacity to invest in SLM. However, when planted in or nearby agricultural fields, researches show that Eucalyptus inhibits germination and growth of crops and trees (Zhang and Fu, 2009), reduces crop yield (Kidanu et al., 2004) and depletes soil nutrients (Michelsen et al., 1993). Moreover, expansion of eucalyptus often goes at the expense of food crop production (Mekonnen et al., 2007) which leads to a shortage of food crops in the long-term.

The *expansion of enset* and *chat* however will have positive effects on SLM. Traditionally, farmers apply farmyard manure around the *enset* plant in the study area. This is because, on the one hand, they perceive that enset cannot survive without animal manure and, on the other hand, farmers give high priority to improve soil fertility for enset plantation due to the importance of the plant. Furthermore, *enset* and *chat* are perennial plants that can protect the soil from erosion throughout the year due to the presence of prolonged closed canopy cover. Especially *enset* expansion seems an adequate strategy to be combined with increased investments in SLM practices, as it improves the calorie consumption of the farmers due to its high calorie content per ha (Negash and Niehof, 2004). However, *chat* expansion – similarly to *eucalyptus* – might reduce farmland available for food crops. Moreover, there is uncertainty about the future market for both *chat* and *eucalyptus*, and strategies based to expand the area of either of these should be treated with caution.

Although some of the farmers' current coping and adaptation strategies contain some elements of SLM, in none of these strategies tackling land degradation is the main goal. This remains a major challenge.

2.4 Conclusions

This study compared perceived trends of rainfall and crop productivity with historical data records. It also explained several coping and adaptation strategies of farmers as response to the perceived trends. A majority of the farmers perceived a decreasing trend of rainfall over years associated with a reduction in crop productivity. However, these perceptions mismatch with historical data records on crop productivity and rainfall which do not show a declining trend. Some of the reasons for these disparities are that 1) food per capita has declined and that farmers perceive this as a decline in crop productivity, and 2) moisture availability for the crop has declined due to land degradation (which is perceived by farmers as a decline in rainfall).

This underlines the need to raise awareness among farmers about the root causes and drivers of food shortages in the CRV, and to undertake collective action to tackle land degradation. Currently, farmers' investments in SLM are still very limited. Experiences in the area have shown that simply telling farmers about the root cause of food shortage and the role of SLM to improve moisture availability, does not sort effect. This suggests the need for demonstrating farmers the effect of sustainable land management practices to improve moisture availability through participatory research. Support from extension and research institutions in providing appropriate technologies and information on the costs and benefits of strategies based on SLM is therefore essential. While this study focuses on household-level coping and adaptations strategies, actions on multiple levels are needed to promote successful strategies. This requires the involvement of several stakeholders such as governmental and non-governmental institutions, the private sector, and local institutions (such as farmers associations) in promoting successful strategies.

This study also showed that farmers' strategies are highly diverse due to socio-economic and biophysical variations. For example, farmers in domains I and II have more adaptation options than farmers in domain III. This diversity in strategies calls for the need to consider all diversities while planning rural development strategies at local, regional and national levels. In addition, promotion of best adaptation strategies such as enset farming is important to reduce food shortage and improve calorie consumption of farmers. Linking such strategies to the goal of combating land degradation could result very beneficial; once there is common awareness about the way forward of course. Hence, there is an urgent need to invest in sustainable land management (SLM) practices that enhance local food production, and this requires further research into how to best motivate farmers and supporting institutions to make this happen.

Chapter 3

Farmers' perceptions of land degradation and their investments in land management: a case study in the Central Rift Valley of Ethiopia

This paper is under review as:
Adimassu, Z., Kessler, A., Yirga, C. and L. Stroosnijder (2012). Farmers' perceptions of land degradation and their investments in land management: a case study in the Central Rift Valley of Ethiopia. *Environmental Management*

Farmers' perceptions of land degradation and their investments in land management: a case study in the Central Rift Valley of Ethiopia

Abstract

In order to combat land degradation in the Central Rift Valley (CRV) of Ethiopia, farmers are of crucial importance. If farmers perceive land degradation as a problem, the chance that they invest in land management measures will be enhanced. This study presents farmers' perceptions of land degradation and their investments in land management, and to what extent the latter are influenced by these perceptions. Water erosion and fertility depletion are taken as main indicators of land degradation, and the results show that farmers perceive an increase in both indicators over the last decade. They are aware of it and consider it as a problem. Nevertheless, farmers' investments to control water erosion and soil fertility depletion are very limited in the CRV. Results also show that farmers' awareness of both water erosion and soil fertility decline as a problem is not significantly associated with their investments in land management. Hence, even farmers who perceive land degradation on their fields and are concerned about its increase over the last decade, do not significantly invest more in water erosion and soil fertility control measures than farmers who do not perceive these phenomena. Further research is needed to assess which other factors might influence farmers' investments in land management, especially factors related to socioeconomic characteristics of farm households and plot characteristics which were not addressed by this study.

Keywords: Perceptions, water erosion, soil fertility depletion, investments, land management

3.1 Introduction

The production of food to satisfy basic needs of the population of Ethiopia is crucial to overall socioeconomic well-being. However, there is increasing concern that land degradation resulted from soil erosion and soil fertility depletion seriously limits food security and sustainable agricultural production in Ethiopia (Taddese, 2001; Tekle, 1999; Hurni, 1988). Furthermore, farmers' investments in land management are quite limited (Shiferaw and Holden, 1998; Admassie, 2000). Farmers generally begin investing in land management when they perceive that there is water erosion and soil fertility depletion (Ervin and Ervin, 1982; Desbiez *et al*., 2004). Several studies on farmers' perceptions of land degradation and their investments in land management have been carried out in the Ethiopian highlands (Deininger and Jin, 2006; Kassie *et al*., 2009). Results show that farmers do actually perceive land degradation as a problem (Amsalu and de Graaff, 2006; Shiferaw *et al*., 2007), but that there is no consistent association between this perception and investments in land management. For example, Green and Heffernan (1987) reported that if farmers perceive land degradation as a problem they invest more in their land, while other authors reported a lack of association between both factors (Mbaga-Semgalawe and Folmer, 2000; Ndiaye and Sofranko, 1994).

In Ethiopia, studies related to land degradation and land management have been mainly concentrated in the highlands (Herweg and Ludi, 1999; Sonneveld and Keyzer, 2002; Descheemaeker *et al.,* 2006). Consequently, research related to farmers' perceptions of land degradation and their investments in land management is scanty in other parts of the country, such as in the Central Rift Valley (CRV). In addition, farmers' perceptions of land degradation and their reactions to perceived degradation vary from place to place and from household to household due to variations in socio-cultural, economic and biophysical conditions (Pilbeam *et al.,* 2005; Nederlof and Dangbegnon, 2007). So, it is questionable if results from elsewhere are applicable to the CRV.

This study is the first attempt to explore farmers' perception of land degradation and their respective investments in land management in the CRV of Ethiopia. The specific objectives of this study are to: (i) assess different land management measures/practices to control water erosion and soil fertility depletion implemented by farmers, (ii) explore farmers' perceptions of land degradation (water erosion and fertility depletion), (iii) assess the extent of farmers' investments in land management for controlling water erosion and soil fertility depletion, and (iv) test whether farmers' investments in land management are influenced by their perceptions of land degradation.

3.2 Methodology

3.2.1 Study area and households characteristics

This study was carried out in six *kebeles*[1] of Meskan and Adamitulu Jido-Kombolcha (AJK) w*eredas*[2] of the CRV of Ethiopia (Figure 3.1). Beressa, Drama, Dobi and Mikaelo kebeles are found in Meskan wereda, located about 135 km to the south of Addis Ababa and part of the Southern Nations, Nationalities and People (SNNP) Region. Worja and Woyisso kebeles are found in AJK wereda of the Oromia Region; about 160 km to the south of Addis Ababa. The rainfall of Meskan is represented by the Butajira weather station, whereas that of AJK is represented by the Ziway weather station. The long-term average annual rainfall of Butajira and Ziway stations are 1130 mm and 750 mm, respectively. Rainfall occurs in two distinct rainy seasons, '*kremt/meher'* rains (also called the 'big rains') in summer (roughly June to September) and '*belg*' rains (also called the 'small rains') occurring in spring (roughly March to May).

There are two major farming systems in the study areas: *enset*[3]-based and cereal-based. *Enset* (*Ensete ventricosum)* dominates the *enset*-based farming system. In the cereal-based farming system, farmers rotate cereals such as maize (*Zea mays*), sorghum (S*orghum bicolor*) and teff *(Eragrostis tef)* with pulses such as field pea (*Pisum sativum)*, faba bean (*Vicia faba)*, and haricot bean (*Phaseolus vulgaris*). Farmers in Meskan practice intercropping of these cereals with *chat (Catha edulis)*[4] and *enset*.

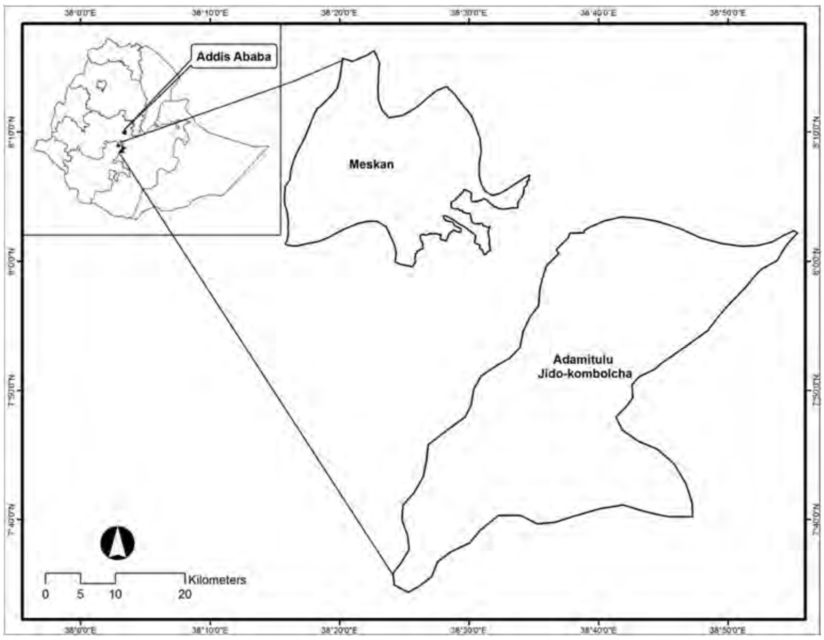

Figure 3.1. The location of Meskan and Adamitulu Jido-kombolcha weredas in the Central Rift Valley of Ethiopia.

[1] *Kebele* is the lowest level administrative unit in Ethiopia.
[2] *Worde* is the next highest -level local administrative unit above the kebele
[3] The *Enset* plant, also called 'false banana', is a giant herbaceous tree which may grow up to 13 m high and a diameter of 2 m or more. It is a single-stemmed tree consisting of an above-ground pseudo stem made from overlapping leaf sheaths, a short, compact and fleshy underground stem called a 'corm,' and conspicuously large leaves.
[4] *Chat* is an evergreen tree cultivated for the production of fresh leaves that are chewed for their stimulant properties.

They also plant trees around their homesteads and outfields for multiple purposes, including construction, fuel wood, fruits and cash generation. The main tree species grown around Meskan homesteads are fruit (e.g., avocado and mango) and high-value cash crop trees (e.g. *chat*), whereas non-fruit trees (e.g., acacia) are grown in the outfields.

More than 80% of households in the sample are male-headed. On average, about 50% of the respondents in the sample are literate (who can read and write). The average household size was 6.2 members. The average livestock and land holdings were 3.7 Tropical Livestock Units (TLU[5]) and 1.1 ha, respectively. The size of land among the sample households is highly varied, ranging from 0.13 ha to 8 ha per household.

3.2.2 Data collection

Two kebeles were randomly selected from three production domains. Domain I (Beressa and Drama) is characterized as food insecure with small land and livestock holdings, whereas Domain II (Dobi and Mikaelo) is food secure with medium-sized land and livestock holdings. Domain III (Worja and Woyisso) is food insecure but features large land and livestock holdings. Domain I and III are characterized by the cereal-based farming system; Domain II features the *enset*-based farming system. Data were collected in two stages by using different techniques of data collection. In the first stage, data were collected through key informant interviews and focus group discussions. In this first stage, farmers' perceptions were assessed concerning land degradation - particularly water erosion and soil fertility depletion - and their respective land management investments were discussed. In the second stage of data collection, household surveys were carried out to generate detailed information concerning the perception of farmers towards land degradation, and their investments in land management practices. Accordingly, a total of 240 households were randomly selected from six kebeles and interviewed using a structured and pretested questionnaire. The sampling was done using a list of households obtained from the respective kebele administrations and the household heads were invited for the survey. Detailed data at household (n=240) and plot level (n=738) were collected.

3.2.3 Determination of land management investments

The major land management practices in the study area are soil bunds/stone bunds, application of organic fertilizers (animal manure and compost) and application of inorganic fertilizers (Di-ammonium Phosphate (DAP) and Urea).

Based on information given by each farmer, the total length of both soil and stone bunds (in meters) per household was calculated by summing-up the constructed lengths for all plots of a particular household. The intensity of use of soil/stone bunds per ha (m ha^{-1}) was obtained by dividing the total length of bunds to the total area on which these bunds were constructed. Investment intensity (man-days ha^{-1}) was calculated according to local working norms, in which one man-day equals three meters of stone bund, or ten meters of soil bund.

Similarly, the amount of organic fertilizers was obtained by asking the farmers the quantity of manure and compost applied to each of their plots. Farmers estimated this amount by using the local measurement called a "*kirchat.*" A "*kirchat"* contains on average 20 kg of manure or compost. All values in local measurements were then converted into standardized units (kg). The total amount of organic fertilizer applied by a household was obtained by summing the amount of manure and compost from each plot. This was divided by the total area of organically fertilized plots in order to obtain the intensity of use (kg ha^{-1}) for manure and compost. For calculating the investment intensity of use of inorganic fertilizers (DAP and Urea) the procedure was the same.

[5] Tropical Livestock Units (1 TLU = 250 kg live Weight). Different farm animals have different conversion factor to TLU. Accordingly, Oxen/Bulls=1.1 TLU, cows/horses/mule=0.8 TLU, donkey=0.65 TLU, Heifer=0.36 TLU, Calf=0.2, Chicken=0.01TLU and Sheep/goat=0.09 TLU (Sharp, 2003).

In order to determine and compare the different land management investments, all of them were converted into a monetary unit (Ethiopian Birr, ETB). For this calculation we used local market prices:

- 1 man-day = 10 ETB
- 20 kg (1 *kirchat*) of manure/compost = 10 ETB
- 1 kg DAP= 10.82 ETB and 1 kg Urea = 8.5 ETB (in 2010)

For the statistical analysis, farmers' investments in land management were categorized into three scales: 1 = no/low (0-250 ETB/household), 2 = medium (251-500 ETB/household), 3 = high (501-1200 ETB/household).

3.2.4 Data analysis

Statistical Packages for Social Sciences (SPSS) software was used to analyse the data. Descriptive statistics - primarily cross tabulation - was employed to summarize the data. Chi-square analysis was undertaken to test the association between farmers' perceptions of land degradation and their investments in land management. Finally, Spearman correlation was used for trend analysis, in this case the association between farmers' perceptions of trends of land degradation and their level of investment in land management.

3.3 Results and Discussion

This section presents and discusses the results in three consecutive sections. The first section deals with farmers' perceptions of land degradation, particularly water erosion and soil fertility depletion. The second section assesses farmers' investments in land management. Finally, the third section discusses the association between farmers' investments in land management and their perceptions of land degradation.

3.3.1 Farmers' perceptions of land degradation

Farmers' perceptions are based on two indicators of land degradation: water erosion and soil fertility depletion. Only these two indicators are used because of being the most important forms of land degradation that affect Ethiopian agricultural production (Hurni, 1988).

Farmers' perceptions of water erosion

Farmers were asked two major questions to gauge their perception of water erosion: (i) whether water erosion is a problem on their land (yes, no), and (ii) how the trend is of water erosion over years (decreasing, no change, increasing). A highly significant (χ^2 = 21.32, p = 0.001) proportion of respondents (92%) noted the problem of water erosion on their land (Table 3.1). During transect walks in the study area it was observed that gullies and rills were abundant on cultivated lands. This observation explains the general awareness among farmers of erosion problems.

Table 3.1. Farmers' perception of water erosion and current trend (% of respondents) in the CRV of Ethiopia.

	Domain I		Domain II		Domain III		Average
Farmers' perception to:	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Water erosion as a problem	100	98	90	81	95	87	92
Trend of water erosion							
Increasing	78	85	85	78	38	31	66
Remaining the same	17	13	12	17	45	65	28
Decreasing	5	2	3	5	17	6	6

Table 3.2 Farmers' perception of soil fertility and current trend (% of respondents) in the CRV of Ethiopia.

Farmers perception to:	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Soil fertility depletion as a problem	90	95	98	80	66	75	84
Trends of soil fertility							
Decreasing	85	93	95	78	48	64	77
Remaining the same	12	5	5	22	47	36	21
Increasing	3	2	0	0	5	0	2

Farmers also indicated the trend of water erosion over the last 10 years (Table 3.1). About 66% of respondents reported that water erosion is increasing. This proportion of households is significant ($p<0.01$) as compared to other responses, and is consistent with studies elsewhere in Ethiopia (Amsalu and Graaff, 2006; Bewket, 2007). An exception is domain III where a low percentage of respondents reported to perceive an increase in water erosion over the years. The main reason is that this area is having low rainfall and a flat topography.

The reasons given for the increase in water erosion over the years include increased deforestation, increased susceptibility of soil and lack of soil conservation activities. Informal discussions with farmers confirmed their general high level of awareness and perception of water erosion as a problem. For example, farmers expressed the opinion that the local government has given minimum attention to land management. Farmers in Dobi and Worja noticed that community mobilization to protect upstream communal lands has been neglected. Farmers reported that in recent years, these upstream communal lands were distributed to landless "youngsters" who began cutting down the trees and grasses that until then had been preserved as communal forest. Moreover, according to farmers, these younger farmers are not investing in land management on the formerly communal lands. Consequently, this upstream land has become a source of run-off for the downstream cultivated lands.

Farmers' perceptions of soil fertility

Two similar questions were asked concerning farmers' perception of soil fertility: (i) is soil fertility depletion perceived as a problem (yes or no), and (ii) what is the current trend of soil fertility depletion (decreasing, no change, increasing). The majority (84%) of farmers reported that soil fertility depletion is a problem on their plots and a significant ($\chi^2 = 29.32$, $p = 0.001$) proportion (77%) affirmed the view that soil fertility has declined over the last decade (Table 3.2). Similar studies have also reported that farmers perceive soil fertility to be declining across different parts of Ethiopia (Amsalu and Graaff, 2006; Eyasu, 1998). Moreover, farmers' perceptions of soil fertility depletion over the years are supported by empirical findings (Stoorvogel *et al*., 1993; Haileselassie *et al.,* 2005; Moges and Holden, 2008). Again, domain III shows to be an exception with a relatively smaller proportion of respondents perceiving a decrease in soil fertility. This is partly explained by the fact that farmers in this domain are more focused on rainfall and water as a limiting factor for crop production than soil fertility.

3.3.2 Land management investments

This section presents farmers' investments in land management measures for controlling water erosion and soil fertility depletion. Land management investments are conceptualized as any effort made by farmers in order to control water erosion and improve soil fertility (Kessler 2006). Most studies in Ethiopia have focused on farmers' investment in land management by only considering percentage of households implementing a given land management measure in at least one of their plots (Amsalu and Graaff, 2006; Bahir, 2010). However, these studies do not take into account *how much* farmers invest in land management and the degree to which they invest in these measures. In this paper, however, we include the proportion of area covered by each measure, as well as intensities of investments in land management in monetary terms (ETB ha^{-1}).

Table 3.3. Investments in water erosion control measures in the CRV of Ethiopia.

	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Households (%)	61	85	40	5	15	18	38
Area covered (%)	34	60	21	3	14	9	20
Intensity of investment (ETB ha^{-1})	330	235	66	58	178	29	150

Land management investments for water erosion control

Water erosion control measures are land management practices that control run-off or run-on. Soil bunds and stone bunds are the two major water control measures undertaken in the study areas. Both are physical soil and water conservation measures that are generally constructed along the contour line. Soil and stone bunds are introduced techniques which can be used alternatively based on the availability of stones and labour.

The survey showed that on average 38% of households constructed either stone or soil bunds in at least one of their plots to counter water erosion. The results vary greatly among domains and kebeles (Table 3.3). In terms of domains, a large proportion of households in Domain I (61% in Beressa and 85% in Drama) constructed water erosion control measures. The small percentage of households (5%) that had constructed water control measures in Mikaelo is due to the flat topography of the area. Similarly, a relatively small percentage of respondents had constructed water erosion control measures in Domain III (15% in Worja and 18% in Woyisso), which is located in an area of low rainfall and flat topography. Moreover, it was discovered through informal discussions that development agents in these kebeles are mainly disseminating soil fertility control measures (e.g. composting) and only in rare cases inform farmers on the importance of investing in water erosion control measures. Concerning the percentage of the area covered by water erosion control measures, the results show that on average only 20% of the total cultivated land in the study area is treated with these measures. Again, the highest percentage is found in Domain I, where respectively in Beressa and Drama 34% and 60% of the farmlands are covered with water erosion control measures.

Nevertheless, both the proportions of households and area covered do not show how much farmers actually invest per hectare of land. Therefore we calculated the intensity of investment (Table 3.3) by taking into account the area covered by water erosion control measures and the costs for constructing soil or stone bunds (in ETB**).** The average intensity of investment was 150 ETB ha^{-1}, with a relatively high intensity in Beressa (330 ETB ha^{-1}) and a low intensity in Woyisso (29 ETB ha^{-1}) kebele. If we use the current exchange rate (1 ETB ≈ 0.06 US$), the average intensity of investments of water control measures equals 8.6 US$ ha^{-1}. As expected, the results indicate that farmers in Beressa and Drama (Domain I) constructed water erosion control measures with a higher intensity of investment than the other kebeles. In these kebeles water erosion control is needed more than in the others. Moreover, in Beressa there is a higher comparative availability of stones which facilitates investments in these measures.

But what does this intensity of investment mean? Is it enough to reduce water erosion to a satisfactory level of control? A study by Gebremedhin and Swinton (2003) estimated that an average length of 700 m of soil bund per hectare is required to effectively reduce water erosion on typical slopes in Northern Ethiopia. Of course, steeper slopes require more bunds, but if we take this 700 m ha^{-1} (which more or less equals an investment of 700 ETB) as our baseline, it results that the average investment in soil erosion control in the CRV is only 21% of the recommended investment. Even in Beressa, where water erosion control is required on almost all fields, this percentage remains below 50%. Moreover, the investment calculated in this study is not a one year investment, but rather it is the cumulative investment over the previous years on a hectare base. Hence, assuming that farmers have been investing in water erosion control measures for the last 5 years, the average investment in water erosion control measures per ha per year is only 30 ETB (1.8 US$) which equals only 3 man-days ha^{-1} y^{-1}.

Summarizing we can state that there is only a small percentage of farmers (38%) who apply water erosion control measures on a very small proportion of their land (20%) and with a low average intensity of investment (only 30 ETB $ha^{-1} y^{-1}$). In conclusion: farmers' investments to control water erosion in this part of the CRV are minimum.

Land management investments for soil fertility control

Soil fertility control measures are land management measures/practices such as application of inorganic and organic fertilizers that replenish and/or improve the fertility of the soil. In addition to water erosion control measures, soil degradation can be reduced through soil fertility control practices because crops can grow more vigorously in well-managed soils, thereby protecting the soil from erosion much more effectively than weak-growing crops. Both organic and inorganic fertilizers are important for conserving the soil and for increasing crop yield. The main soil fertility control practices in the CRV are application of inorganic fertilizers (DAP and Urea) and organic fertilizers (manure and compost). Organic fertilizers are widely used to control soil fertility depletion in the CRV of Ethiopia, and particularly manure application is a traditional soil fertility management practice in crop-livestock farming systems of Ethiopia (Eyasu, 1998).

Table 3.4 presents investments in land management for fertility control measures in terms of percentage of households, area covered and intensity of use. The study showed that 83% of the households applied at least one soil fertility control practice in one of their plots. This percentage varied across kebeles, ranging from 56% in Beressa to 97% in Woyisso (Table 3.4). In terms of domains, the largest proportion of households applying soil fertility control measures is found in Domain III. Better availability of animal manure as a result of high livestock number contributes to this high percentage of respondents applying soil fertility control measures.

Table 3.4 also depicts the proportions of area covered by the different soil fertility control practices in each kebele. In total, on 46% of the cultivated land in the study area soil fertility measures were applied in the 2009/2010 cropping season. Considering that all agricultural fields in the study area would require investments in the form of fertilizers, this percentage is quite low. However, it is on average twice as high as the area covered by water erosion control measures.

Like with water erosion control measures, percentage of households and area covered do not show *how much* is actually invested in soil fertility control practices. By using current local market prices the average intensity of investment of soil fertility control measures was calculated to be 719 ETB ha^{-1} (or 43 US$ ha^{-1}). The highest investment is found in Domain III (1144 ETB ha^{-1} in Worja and 917 ETB ha^{-1} in Woyisso). If we convert the average investment into values of DAP and Urea fertilizers, we find that with 719 ETB we can only buy 47 kg DAP and 47 kg Urea. This is by far lower than the level that is recommended by the national extension service for most crops in Ethiopia (100 kg ha^{-1} DAP and 100kg ha^{-1} Urea).

Nevertheless, farmers' investments (in ETB) in soil fertility control measures are on average five times higher than investments in water erosion control measures. Even in Beressa, where water erosion control is indispensable, farmers invest twice as much in fertility control than in water erosion control. This underlines the importance of soil fertility control and the fact that taking such measures is common cultural practice for most farmers. These measures are also easier to apply as compared to water erosion control measures.

Table 3.4. Investments for soil fertility control practices in the CRV of Ethiopia.

	Domain I		Domain II		Domain III		Average
	Beressa	Drama	Dobi	Mikaelo	Worja	Woyisso	
Households (%)	56	93	68	95	88	97	83
Area covered (%)	34	51	41	22	55	81	46
Intensity of investment (ETB ha^{-1})	647	709	677	687	1144	917	719

However, given that not even half of the total agricultural area is treated with soil fertility control measures, and then even with half of the recommended investment intensity, farmers' investments in soil fertility control measures are still very limited in the study area. Interviewed farmers reported that the main reason for this is a dramatic increase in fertilizer prices coupled with a lack of financial capital, which together constrain their application of inorganic fertilizers. Evidence from elsewhere in the country confirms that Ethiopian farmers use a low level of inorganic fertilizer per hectare (Spielman et al*.,* 2010), and that the amount of inorganic fertilizer use is the lowest of any country in sub-Saharan Africa (Mwangi, 1997). Several studies in different areas of the country indicate that crop productivity has been affected by the increasing price of fertilizer and improved seed (Alem et al*.,* 2010; Spielman et al*.,* 2010).

3.3.3 Do farmers' perceptions matter?

Based on the previous sections there is an apparent contradiction: farmers' awareness of land degradation is high (they perceive it as a problem and generally perceive that water erosion and soil fertility decline are increasing) but their investment in land management (control measures) remains very limited. In order to confirm this contradiction, Chi-square analysis was used to test the association between farmers' investment in land management (yes/no) and farmers' perception of land degradation as a binary choice (yes/no). Furthermore, Spearman correlation was used to test the relationship between the perceived trend of land degradation and farmers' level of investments in land management. In the latter case ordinal variables were used for farmers' perception of the trend of land degradation (decreasing, no change, increasing) and for their level of investment (no/low, medium, high). Table 3.5 presents associations between farmers' investments in land management and their perceptions regarding both water erosion and soil fertility depletion.

Farmers' perception of water erosion vs. investment in land management

In this section two hypotheses were proposed: (i) where farmers are aware of *water erosion* as a problem, they will be more likely to invest in practices for water erosion and/or soil fertility control, (ii) if farmers perceive that *water erosion* is increasing over years, they invest more in practices for water erosion and/or soil fertility control. The Chi-square test shows that respondents' perceptions of water erosion as a problem are not significantly associated with their investments in land management for both water erosion control (χ^2 = 6.40, p = 0.11) and soil fertility control (χ^2=2.14, p=0.21) measures. Furthermore, the spearman correlation shows that farmers level of investment in water erosion control is not significantly correlated (r = 0.053, p = 0.25) with their perception of the trend of water erosion. Similarly, their investment in soil fertility control measures is not significantly correlated (r = 0.062, p = 0.20) with perceived trend of water erosion.

Hence, both hypotheses are rejected: farmers who perceive water erosion as a problem on their land, or farmers who perceive that water erosion has become worse over the past years, do not invest significantly (with $p<0.05$) more in their land than farmers who do not perceive this.

Table 3.5 Associations between farmers' investments in land management and their perceptions of land degradation using Chi-square test and Spearman correlation (p-values are in the parentheses).

Perceptions	Investment in water erosion control		Investment in soil fertility control	
	Chi-square	Spearman	Chi-square	Spearman
Water erosion is a problem	6.14 (0.11)	-	2.14 (0.21)	-
Water erosion increases over years	-	0.053 (0.25)	-	0.062 (0.18)
Soil fertility decline is a problem	6.27 (0.07)	-	0.28 (0.82)	-
Soil fertility depletes over years	-	0.061 (0.20)	-	0.058 (0.22)

Farmers' perception of soil fertility decline vs. investment in land management

Again, two hypotheses were drawn: (i) where farmers perceive *soil fertility decline* as a problem, they will be more likely to invest in water erosion and soil fertility control, and (ii) where farmers perceive *soil fertility* as depleting over the years, they will invest more in water erosion and soil fertility control.

Table 3.5 shows the Chi-square association and Spearman correlations between farmers' investments in land management and their perceptions of soil fertility depletion. None of these analyses do yield significant ($p<0.05$) results. Hence, despite the fact that around 80% of all farmers in the study area perceive soil fertility decline as an increasing problem, this perception does not significantly influence their decisions to invest in land management, neither does it influence *how much* they invest in both water erosion and soil fertility control measures. Only farmers' investments in water erosion control measures are marginally significant ($\chi^2=6.27$, $p=0.07$) correlated with farmers' perceptions of soil fertility decline. Although this might indicate that farmers are aware about the effect of water erosion on soil fertility depletion, we assume that this association is rather a coincidence and far from enough to conclude that there is any association between farmers' investment in land management and their perceptions of land degradation. This shows that there is no sound evidence supporting the two hypotheses mentioned above. Similar findings in the Blue Nile basin of Ethiopia (Bewket and Sterk, 2002), where farmers' perception of land degradation was not sufficiently associated with their participation in soil and water conservation practices, support the rejection of both hypotheses.

Now that all hypotheses have been rejected and perception of land degradation has shown not to be of any influence on farmers' investments in land, it is justified to ask: Why then do farmers fail to invest in land management in the CRV? From studies elsewhere around the globe we know that there are other social, economic and biophysical factors that influence farmers' investments (Gebremedhin and Swinton, 2003; Pender and Gebremedhin, 2007). Given that such factors are often farmer and site specific suggests the needs for further research into exploring the factors affecting farmers' land management decisions in the CRV of Ethiopia.

3.4 Conclusions

The study assessed farmers' perceptions of land degradation and their investments in land management practices in the CRV of Ethiopia. It is clear from farmers' responses that there is widespread awareness of land degradation in the form of water erosion and soil fertility decline. This shows that the water erosion problem is not confined to the highlands but is also a serious issue in the CRV. However, support from research and development institutions to address land degradation in the CRV is very low compared to that of the highlands. This suggests the need for rethinking the distribution of support for land management investments in Ethiopia. Due attention should also be given to the CRV of Ethiopia.

Despite farmers' awareness of land degradation, the use of and investments in land management practices across kebeles is limited. Particularly investments in water erosion control are very low, as demonstrated by the small percentage of farmers who have constructed soil or stone bunds, and the small proportion of land where such measures have been constructed. However, although a relatively large proportion of households applied soil fertility control measures, they did so on a small proportion of the total land area and at a low intensity of investment. This indicates that using the percentage of farmers who applied one or more land management measures to at least one of their plots as the only indicator of investment in land management (i.e. without taking into account the proportion of total land area or the intensity of investment) is misleading.

The study also showed that farmers' investments in land management measures for water erosion and soil fertility control vary among plots, households, kebeles and domains. Farmers' investments in monetary terms are five times higher for soil fertility control measures than for water erosion control measures. This is because soil fertility control has immediate yield effects as compared to water erosion control. Moreover, these measures are easier to apply, they are common practices that all farmers apply over years, and they are needed on all of the plots, regardless of their slope or susceptibility to erosion. We also understand from this study that agricultural experts both at wereda and kebele levels are more focused on promoting soil fertility control practices rather than water erosion control measures. This shows that higher level (e.g. wereda) administrations are foremost interested in soil fertility control measures, mainly because of their immediate impact on crop yield.

The lack of a significant association between farmers' perceptions of land degradation and their investments in land management for all the study kebeles raises the question of why farmers do not invest more to address the land degradation they perceive. The findings indicate that awareness of the problem of water erosion and soil fertility decline is not a decisive factor when farmers decide to invest in land management. Hence, there are other factors – not addressed by this study – that are probably more important in influencing farmers' decisions whether and how much to invest in land management. Further research should be conducted to assess these factors; particularly those related to the socioeconomic characteristics of individual households and biophysical characteristics of plots in the CRV of Ethiopia.

Chapter 4

Exploring determinants of farmers' investments in land management in the Central Rift Valley of Ethiopia

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Exploring determinants of farmers’ investments in land management in the Central Rift Valley of Ethiopia

Abstract

Land degradation, especially water erosion and nutrient depletion, seriously affects agricultural production in the Central Rift Valley of Ethiopia. Farmers’ investments to conserve their land are until now however quite limited. The objective of this study is to identify the major factors that determine farmers’ decisions *how much* and *where* to invest in land management. Exploratory factor analysis and Pearson correlation were used to analyse the data from 240 households operating 738 plots in three different production domains. The study identified five major factors that influence farmers’ decisions *how much* to invest in land management: *(1) households’ resource endowments, (2) farming experience and knowledge, (3) access to information, (4) social capital and (5) availability of family labour*. This result implies that extension strategies aiming at sustainable land management should try to enhance households’ resources endowments and improve their access to information. Moreover, the influence of social capital and availability of family labour indicate the crucial importance of collective action in land management. Similarly, the study revealed that farmers are more willing to invest in plots that (1) are vulnerable to water erosion, (2) have better soil fertility and (3) are larger. However, the influence of these factors on farmers’ investments in land management was highly variable across the considered production domains. Hence, the diversity in social, economic, cultural and biophysical conditions must be taken into account by rural extension programmes. This calls for site-specific land management strategies that can be planned and implemented at micro-level with active participation of farmers.

Keywords: Ethiopia, factor analysis, farmers’ investments, sustainable land management, extension strategies

4.1 Introduction

Land degradation resulting from water erosion (soil erosion by water) and soil fertility depletion is a widespread agricultural problem in sub-Saharan Africa and has far-reaching economic, social and environmental implications due to its on-site and off-site damages (Thampapillai and Anderson, 1994; Pender and Gebremedhin, 2007; Ananda and Herath, 2003). Particularly in Ethiopia, where agriculture is the main source of livelihood of its population, land degradation is a serious problem threatening food security and agricultural productivity (Hurni, 1988; Shiferaw and Holden, 2001; Descheemaeker et al., 2006*).* This resulted in deforestation and expansion of cultivation into marginal lands, such as steep slopes and grazing lands, to fulfil food demand (Zeleke and Hurni, 2000; Bewket and Sterk, 2003; Bewket, 2007). Since these marginal areas are very vulnerable to water erosion, degradation has accelerated (Bishaw, 2001; Tekle, 2001; Reij and Smaling, 2008). To counter on-going land degradation and to increase crop productivity, investments in more sustainable land management are called for.

Until now, however, farmers’ investments in land management remain limited (Adimassu and Kessler, 2012; Bewket, 2007; Tenge et al., 2005). Analysing the factors that influence farmers’ decisions *how much* and *where* to invest would help to understand why farmers often refrain from investing in their land. Many studies indicate that land management investments are most influenced by biophysical characteristics of farm plots and by socioeconomic characteristics of the household (Gebremedhin and Swinton, 2003; Paudel and Thapa, 2004; Kessler, 2006; Requier-Desjardins et al., 2011). At plot level, differences in biophysical conditions between the plots, such as slope, soil fertility status and size of plots, influence farmers' choice *where* to invest. Similarly, differences between farm households concerning social, economic and cultural characteristics lead to differences in *how much* households invest in sustainable land management. More profound understanding of these diversities would enable the formulation of better-targeted intervention and extension strategies aimed at investments in sustainable land management (Shiferaw and Holden, 2000; Amsalu and de Graaff, 2007).

Nevertheless, studies related to land management have been mainly concentrated in the Ethiopian highlands (Amsalu and De Graaff, 2007; Pender and Gebremedhin, 2007; Shiferaw and Holden, 2000). This study focuses on the Central Rift Valley of Ethiopia (CRV), with the objective to identify the major determinants that affect farmers' decision *how much* and *where* to invest in land management, and how they differ across three particular production domains.

4.2 Research methodology

4.2.1 Description of the study area

The primary economic activity of farmers in the CRV of Ethiopia is small-scale and mixed agriculture consisting of crops and animals. Crop production is mainly rain-fed and extremely vulnerable to rainfall variability (Meshesa et al*.,* 2012). Generally, crop and animal productivity is very low in the CRV. On the other hand, however, human population grows continuously with an annual growth rate of 3 per cent (CSA, 2010). As a result, most farmers depend on food aid and off-farm activities, such as petty trading and charcoal production.

The study was conducted in two weredas[1] (districts) in the CRV of Ethiopia (Figure 4.1): Meskan (in the Southern Nations, Nationalities and People Regional State) and Adamitulu Jido-kombolcha or AJK (in the Oromia Regional State). Data were collected in three so-called "production domains" that were classified as such by local wereda officials, with domains I and II being located in Meskan and domain III in AJK.

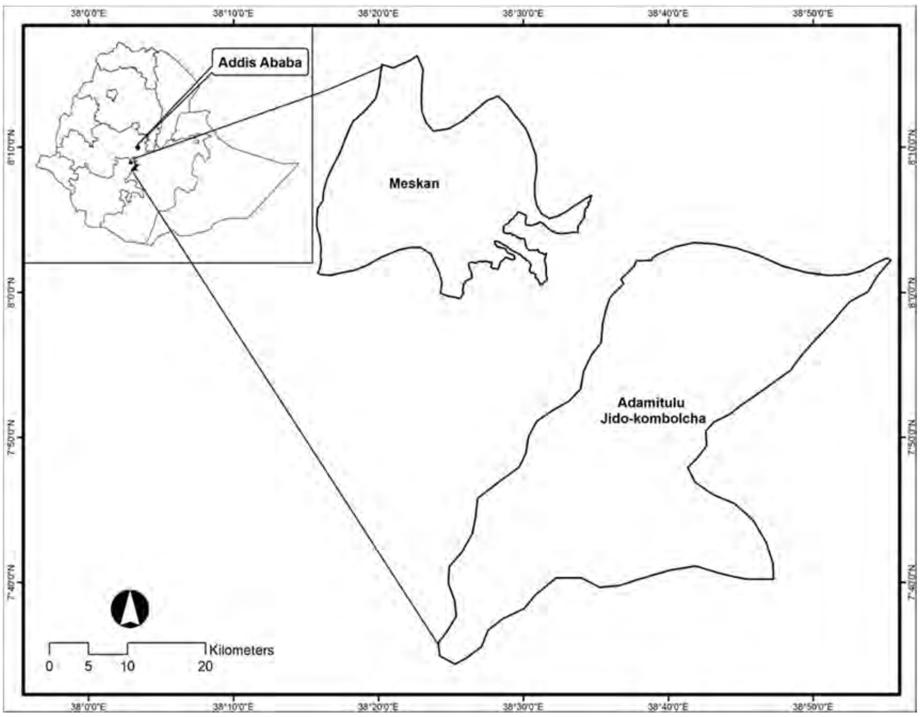

Figure 4.1. The location of Meskan and Adamitulu Jido-kombolcha weredas in Ethiopia.

[1] *Wereda* (district) is the next highest -level local administrative unit above *kebele* (the lowest administrative unit).

Table 4.1. Major characteristics of three production domains in the Central Rift Valley of Ethiopia.

Characteristics of domains:	Domain I	Domain II	Domain III
Name of the Wereda	Meskan	Meskan	AJK
Topography	Steep - undulating	Undulating - flat	Fairly flat
Annual rainfall (mm)	1130	1130	750
Farming system	Cereal-based	Enset-based	Cereal-based
Two major crops grown	Maize, Teff	Enset, Maize	Maize, Sorghum
Food security condition	Insecure	Secure	Insecure
Average land size per households (ha)	0.7	0.9	1.8
Livestock (TLU per household)	2.4	3.5	5.4
Sample size (households)	81	81	78

Domain I is characterised as food insecure with a cereal-based farming system, small land holdings (0.7 ha) and few livestock (2.4 TLU[2]). Domain II however is food secure thanks to its enset[3]-based farming systems; it has medium land (0.9 ha) and livestock (3.5 TLU) holdings. Domain III is characterised by its relatively flat topography and much lower rainfall (750 mm as compared to 1300 mm in domains I and II). As domain I, domain III is also food insecure with a cereal-based farming system, however with average larger land holdings (1.8 ha) and livestock (5.4 TLU) than the other domains. Maize (*Zea mays*), sorghum (*Sorghum bicolor*) and teff (*Eragrostis tef*) are the principal food crops in the cereal-based farming systems in domains I and III, which are regular recipients of food aid, especially when harvest fails. The topography in domain I is quite steep and therefore more susceptible to water erosion than the other two domains.

4.2.2 Data collection

For the three production domains data was collected from six *kebeles.* Two kebeles were randomly selected from each domain: Beressa and Drama (domain I), Dobi and Mikaelo (domain II), and Worja and Woyisso (domain III). With support of the kebele administration and development agents, 240 households in the six kebeles were randomly selected for a household survey (Table 4.1). A sampling frame of household heads was obtained from the kebele administration and households heads were involved for the household survey. With the survey, information was collected at household (n=240) and plot (n=738) level by means of a structured and pre-tested questionnaire. The survey was carried out by six enumerators who were trained for this particular research.

4.2.3 Determination of land management investments

The land management investments considered in this study are water erosion control measures (length of soil or stone bunds) and soil fertility control measures, i.e. the use of organic fertilizers (manure and compost) and inorganic fertilizers (Di-ammonium Phosphate (DAP) and Urea).

Table 4.2. Land management investment classes at household and plot level in the Central Rift Valley of Ethiopia.

Class	Household level investments in land management practices		Plot level investments in land management practices	
	ETB hh^{-1}	% of households	ETB ha^{-1}	% of plots
1	0-250	39.6	0-50	44.3
2	251-500	32.5	51-100	33.7
3	501-1200	27.9	101-500	22

hh = household, ETB = Ethiopian Birr (1ETB = 0.06 US$).

[2] TLU = Tropical Livestock Units (1 TLU = 250 kg live Weight), with oxen/bulls = 1.1 TLU, cows/horses/mule = 0.8 TLU, donkey = 0.65 TLU, heifer = 0.36 TLU, calf=0.2, chicken = 0.01TLU and sheep/goat = 0.09 TLU (Sharp, 2003).

[3] Enset *(Ensete ventricosum) is* also called 'false banana', and grown for its 'corm' (root-like structure). Enset plants may grow up to 13 m high and a diameter of 2 m. Since enset is drought resistant, it is often a last food resort during periods of drought.

Based on information given by each farmer, the total length of both soil and stone bunds (in meters) per plot was obtained by asking the farmers the length of bunds constructed for each plot. Similarly, the amount of organic fertilizers was obtained by asking the farmers the quantity of manure and compost applied to each of their plots. All these values were converted into standardized units (kg) and then into a monetary unit (Ethiopian Birr, ETB). For this calculation, we used local market prices: (1) 10 m soil bund = 3 m stone bund = 1 man-day = 10 ETB, (2) 20 kg of manure/compost = 10 ETB, and (3) 1 kg DAP = 10.82 ETB and 1 kg Urea = 8.5 ETB (in 2010). Plot level investments were obtained by summing-up investments in both water erosion and fertility control measures for a particular plot. Total investments at household level were obtained by summing investments for all plots of a particular household. For the statistical analysis (using Factor Analysis and Pearson correlation), total investments per household and plot were grouped in three classes (Table 4.2): 1 = no/low, 2 = medium, 3 = high.

4.2.4 Description of household and plot characteristics

The choice of household and plot characteristics to be considered in this study was based on the literature and on informal meetings with key stakeholders (farmers, agricultural extension, etc.) prior to the survey in the kebeles (Table 4.3 and 4.4). In total 24 household characteristics and 7 plot characteristics were considered in the analysis. For statistical purposes, household and plot characteristics were grouped in three classes.

Table 4.3. Description of household and plot characteristics.

Household characteristics	Description	Classes		
		1	2	3
Age	Age of household head (years)	≤ 35	35-54	≥ 54
Farming experience	Number of farming years by household head	≤ 15	16-30	> 30
Migration	Number of migrated household members	≤ 1	2	≥ 3
Education	Education of household head (# of years)	0	1-6	>6
Family size	Number of children, husband and wife	≤ 5	6-8	≥ 8
Economically active family members	Number of Economically Active Family Members (EAFM)	≤ 4	5-6	≥ 6
Number of oxen	Number of oxen per household	≤ 1	2	≥3
Livestock size	Total livestock size per household (TLU)	≤ 2	2-4	≥5
Livestock per capita	Number of livestock per family member	≤ 0.5	0.51-1	≥ 1
Land size	Total land size per household (ha)	≤ 0.75	0.76-1.5	>1.5
Land per capita	Total land size per total family size (ha $capita^{-1}$)	<0.2	0.2-0.4	>0.4
Land per EAFM	Total land size per EAFM	≤ 0.3	0.3-0.6	>0.6
Land fragmentation	Average number of plots per ha	< 2	2-4	>4
Access to wereda town	Distance form homestead to wereda town (minutes walking)	> 90	46-90	≤ 45
Access to Development Agents (DA)	Distance from homestead to DA office (minutes walking)	> 40	40-20	<20
Contact with DA	Number of visits by the DA in the last 12 months	0	1	≥ 2
Trainings	Number of trainings received in the past 5 years	0	1	≥2
Off farm income	Estimated off-farm income in last 12 months (ETB)	≤ 300	301-600	>600
Relatives within kebele	Numberof household relatives in kebele	≤ 10	11-20	>20
Relatives outside kebele	Number of relatives of a household outside kebele	≤ 10	11-20	20
Membership	Number of memberships in local institutions	1-2	3-4	≥5
Friend within kebele	Number of friends of a household in kebele	1 < 5	6-10	>10
Friends outside kebele	Number of friends of a household outside kebele	<2	3-5	>5
Leadership	Number of memberships in leadership of local institutions	0	1	2

Table 4.4. Description of plot characteristics.

Plot characteristic	*Description*	*1*	*2*	*3*
Plot size	Area of a plot in hectare	≤ 0.25	0.25-0.5	≥ 0.5
Distance of plots	Distance to the plot from homestead (minutes walking)	<5	5-10	≥10
Slope	Slope of a plot (farmer's perception)	flat/gentle	medium	steep
Soil depth	Soil depth of a plot (farmer's perception)	shallow	medium	deep
Soil fertility	Fertility status of a plot (farmer's perception)	low	medium	high
Trend of water erosion	Trend of water erosion on a plot (farmer's perception)	decreasing	no change	increasing
Severity water erosion	Current water erosion on a plot (farmer's perception)	low	medium	high

4.2.5 Data analysis

Explanatory Factor Analysis (within SPSS) was used to determine major household and plot factors. Factor Analysis is a statistical technique that helps to identify groups of latent variables (factors) based on the patterns of intercorrelations among the household and plot characteristics. It simplifies the correlation matrix by accounting for a large number of relationships with a smaller number of factors. A Varimax orthogonal rotation was employed to obtain a rotated component matrix that facilitate the interpretation of factors. In this rotated component matrix, factor loading for each of the variables are obtained. In the Factor Analysis a variable was retained as long as its factor loadings were 0.4 or more (Kessler, 2006; Field, 2005). The number of factors retained was determined by using screen plot test. The screen plot test involves examining the graph of the eigenvalues and looking for the natural bend point in the data where the curve flattens out. The number of data points above the bend (i.e., not including the point at which the bend occurs) is usually the number of factors to retain. Factor scores were generated for both household and plot factors in the Factor Analysis. To identify determining factors at household level, Pearson correlation was used between household investment in land and these household scores for each production domains. The same procedure was followed for identifying determining factors at plot level. Major factors at both household and plot level were those that resulted in 0.05 or 0.01 significant correlations.

4.3 Results and discussion

This section is divided into two parts. The first part discusses major household level factors that affect farmers' decisions on *how much* to invest in land management. The second part describes the major plot level factors that determine *where* farmers will invest more. Both household and plot level factors are compared across the three production domains.

4.3.1 Factors at household level

For Factor Analysis, 19 of the original 24 household characteristics were considered while five other factors were discarded due to their low value of loadings (< 0.4). After Factor Analysis, we identified five independent and non-correlated factors, which together explain 68% of the total variance in the sample (Table 4.5). The first factor (factor 1) is *resource endowment* and is composed of seven household characteristics related to livestock and land holdings; it accounts for 22% of the variance. The second factor (factor 2) represents the farmer's *experience and knowledge* and comprises three personal characteristics pertaining to the household head, i.e. age of the household head, farming experience and education. The third factor (factor 3) is *access to information*, which is composed of two household characteristics, i.e. distance to wereda town and DA office. The fourth factor (factor 4) relates to migration and all social relationships inside and outside the kebele; it refers to the status of *social capital* of a household. The final factor (factor 5) relates to the *availability of family labour*, and comprises two major household characteristics, i.e. the number of household members and economically active household members.

Table 4.5. Rotated component matrix for the household characteristics (n=240).

Household characteristics	Household level factors				
	Resources endowment	Experience and knowledge	Access to information	Social capital	Availability of family labour
Land per EAFM	0.788				
Land fragmentation	0.747				
Land size	0.74				
Land per capita	0.738				
Livestock size (TLU)	0.737				
TLU per capita	0.695				
Number of oxen	0.605				
Age		0.859			
Farming experiences		0.842			
Education		-0.725			
Distance to DA's office			0.932		
Distance to Wereda town			0.514		
Relatives within Kebele				0.724	
Relatives outside Kebele				0.562	
Friends within Kebele				0.546	
Migration				0.496	
Friends outside Kebele				0.429	
Family members					0.792
Economically active FM					0.588
Explained variance (%)	22	16	10	11	9

To identify explicitly the major household factors that influence farmers' decisions *how much* to invest in land management for each domain, Pearson correlation analysis was employed between farmers' investments in land management and these five extracted factors (Table 4.6). These results are discussed separately for each production domain.

Domain I

In domain I, three major household factors influence farmers' decisions *how much* to invest in land management. A first factor is *experience and knowledge*, which is only positively influencing farmers' investments in land management in domain I, i.e. older farmers with longer farming experience invest more. This may be explained by the fact that water erosion control measures (such as soil and stone bunds) are much more important in domain I than in the other domains because of the steep topography, and that implementing these measures requires farming experiences and knowledge. This result is in line with findings in other parts of Ethiopia where farmers with more farming experience invested more in soil and stone bunds (Bekele and Drake, 2003; Amsalu and De Graaff, 2007).

Table 4.6. Pearson correlation of farmers' investments in land management with household level factors.

Household factors	Domain I (n=81)	Domain II (n=81)	Domain III (n=78)
Resources endowment	0.139	0.111	**0.578****
Access to information	0.04	**0.254****	**0.249***
Social capital	**0.320****	**0.357****	-0.088
Experience and knowledge	**0.255***	-0.164	0.016
Availability of family labour	**0.447****	0.164	0.105

* Correlation is significant at 0.05 level (two-tailed), ** Correlation is significant at 0.01 level (two-tailed).

A similar explanation applies for a second factor, which is only significantly correlated to land management investments in domain I: *availability of family labour*. The availability of family labour is crucial for investments in land management practices that require considerable labour input such as water erosion control measures. The importance of sufficient family labour for investments in water erosion control is supported by literature (De Graaff et al., 2008). Moreover, having a bigger family may encourage farmers to invest in land management because of the higher probability that one of the children will inherit the land and use the future benefits of an investment (Featherstone and Goodwin, 1993).

A final significant factor in domain I that positively influences farmers' investments in land management is *social capital*. First, social capital can promote cooperative behaviour and facilitate flows of information that may be relevant to land management investments (Bowles and Gintis, 2002; Adesina et al., 2000). Second, in the absence of formal credit markets, social capital enhances informal credit exchange among farmers (Knack and Keefer, 1997) and improves farmers' financial capacity to buy fertilizers.

Table 4.6 also shows that farmers' investments in land management are not correlated with *resources endowment* in domain I. This may be explained by the fact that most households in this domain have limited resource endowments (land and livestock holdings) compared to the other domains. Similarly, *access to information* is not a determinant factor in domain I because almost all farmers have equal access to the nearby town (Butajira) where the wereda office of agriculture and rural development is located.

Domain II

Two major household level factors influence farmers' investments in domain II: *access to information* and *social capital*. The positive correlation with *access to information* shows that in this domain the distance to the nearest town and the DA office matters: the closer farmers are to these information sources, the more they will invest in land management. Earlier studies also show that farmers with better access to agricultural experts invest more in land management in Ethiopia (Bekele and Drake, 2003; Kassie et al., 2008). Furthermore, and similar to domain I, farmers with higher *social capital* invest more in land management. However, unlike in domain I, farmers' investments in land management are not correlated with *availability of family labour*, and *farming experience and knowledge* in domain II. This is mainly because farmers in this production domain invest less in (labour and experience requiring) water erosion control measures. Further analysis even reveals that younger and less experienced farmers in this domain often invest more than older farmers; something not observed in the other domains. Food security is apparently an important influencing factor on young farmers' motivations to invest or not in land management. In food secure areas, future prospects are better and young farmers have a longer planning horizon, which differentiates them from young farmers in the other domains, as well as from the older farmers who are often discouraged to invest and have a shorter time horizon (Shiferaw and Holden, 1998).

Domain III

Farmers' investments in land management in domain III are positively and significantly correlated with two major household level factors: *resource endowments* and *access to information.*

Unlike farmers in the other domains, farmers in domain III who have better resource endowments invest more in land management. The interpretation regarding this positive and significant correlation is explained in terms of land and livestock holdings. In domain III, there are several farmers with large land holdings, who generate more cash and can afford to buy fertilizers, especially during good years when rainfall is sufficient for crop production. Other authors in Ethiopia (Shiferaw and Holden, 1998; Bekele and Drake, 2003; Amsalu and De Graaff, 2007) found similar conclusions. Moreover, large land holdings are often related to more livestock, which enhances the availability of animal manure (Shiferaw and Holden, 1998), and it is a source of cash, increasing the availability of farmers' financial capital to invest in land management. Other studies indicated that farmers with more livestock invested more in land management in Ethiopia (Pender and Gebremedhin, 2007). In addition, larger plots are less affected by loss of land for the construction of water erosion control measures (Hengsdijk et al., 2005). This is especially true in Ethiopia where land shortage is a problem and farmers perceive that soil/stone bunds cover much of their land.

In this domain III, farmers' investments are also positively and significantly correlated with *access to information*, where farmers living closer to town have better access to information from agricultural experts (both at wereda and kebele level) and therefore invest more in land management.

In this domain, farmers' investments in land management are not correlated with their farming *experiences and knowledge* for similar reasons as for domain II. Most important is that farmers in this domain invest more in soil fertility control measures (Adimassu and Kessler, 2012), which require relatively less experience and knowledge to apply than water control measures. Furthermore, unlike in the two other domains, *social capital* in domain III is not determinant for farmers' investments in land management. Interestingly, lack of correlation in domain III maybe related to the 'Gadaa' system in the Oromo ethnic group (which is typical for domain III). The '*Gadaa*' system (which is common to all households) is one of the most important cultural systems in the Oromo ethnic group and includes the sharing of resources including credit and labour. Thus, the role of social capital maybe replaced by the *Gadaa* system in this domain and such a cultural system may be equally important to mobilize farmers in land management investments. Finally, farmers' investments in land management in this domain are not influenced by *availability of family labour*. This may be explained by the fact that (i) farmers in domain III hardly construct labour intensive water control measures, and (ii) labour constraints may be resolved by labour sharing in the *Gadaa* system.

In summary, five major factors at household level determine and affect farmers' decisions regarding *how much* to invest in land management, but the importance of these factors varies across the domains.

4.3.2 Factors at plot level

Similar to household level, Factor Analysis was performed at plot level to identify major factors that affect farmers' decision regarding *where* to invest in land management across three different domains. Using Factor Analysis, plot characteristics are reduced into three major plot level factors explaining 60% of the total variance (Table 4.7). The first factor (factor 1) is composed of three plot characteristics that are proxies to *vulnerability* of plots to water erosion, i.e. the severity of erosion, slope and erosion trend. The second factor (factor 2) is characterized by two plot characteristics collectively called *soil fertility condition* of plots, comprising soil fertility status and soil depth. The third factor (factor 3) represents *accessibility and size* of plots comprising two plot characteristics that indicate how easy or convenient it is to carry out land management investment on specific plots (Table 4.7).

Table 4.7. Rotated component matrix for the plot characteristics in three domains (n=738).

	Plot level factors		
	Vulnerability to water erosion	*Soil fertility condition*	*Accessibility and size*
Severity of water erosion	0.797		
Slope	0.796		
Trend of water erosion	0.429		
Fertility status		0.818	
Soil depth		0.707	
Distance to plots			0.795
Plot size			0.753
Explained variance (%)	21	20	19

Table 4.8. Pearson correlation of plot level factors with investments in land management in three different domains.

Plot level factors	Domain I (n=286)	Domain II (n=256)	Domain III (n=196)
Vulnerability to water erosion	0.006	0.010	**0.178***
Soil fertility condition	-0.112	**0.396****	-0.002
Accessibility and size	0.039	-0.083	**0.296***

** Correlation is significant at the 0.05 level (two-tailed), ** Correlation is significant at the 0.01 level (two-tailed)*

Table 4.8 presents Pearson correlation coefficients of farmers' investments in land management with plot level factors resulting from Factor Analysis. Like the household level factors, factors that determine farmers' decisions regarding *where* to invest in land management vary among the three domains as discussed below.

Domain I

In domain I, as shown in Table 4.8, farmers' investments in land management are correlated with none of the plot factors. *Vulnerability* of plots to water erosion may be explained in terms of the severity of water erosion, slope of plots and the trend of water erosion. The main reason for lack of correlations in domain I is that most plots in this domain are found on steep slopes with high rates of water erosion. Nonetheless, even on these vulnerable plots farmers have hardly invested in erosion control (Adimassu and Kessler, 2012) which explains the lack of correlation between investments and the vulnerability of plots to water erosion. Likewise, lack of correlation between farmers' investment in land management and *soil fertility condition* is found for this domain, implying that – despite the fact that plots are homogeneously infertile - the investments made are carried out regardless the fertility status of a plot. Finally, farmers' investments in domain I are not influenced by the accessibility and size of plots, meaning that plot distance and size are not determinant factors influencing the decision where to invest.

Domain II

Farmers' decisions in domain II regarding *where* to invest in land management are affected by only one plot factor— *soil fertility condition* of plots. Farmers in domain II invested more in fertile soils than infertile soils. This may be explained in two ways: (i) farmers in domain II are mainly depending on *enset* that usually receives animal manure, and (ii) the expected returns of investment are higher in fertile soils and hence farmers invest more in order to maximize crop production. Earlier studies in Rwanda (Clay et al., 1998) and the central highlands of Ethiopia (Amsalu and De Graaff, 2007) also showed higher investments in fertile soils as compared to infertile soils. Similar to farmers in domain I, farmers' decision regarding *where* to invest in land management in domain II is not influenced by the *vulnerability of plots* to water erosion. Although farmers in domain II have large areas vulnerable to water erosion, their investments in water erosion control measures are very limited and making this correlation insignificant. Furthermore, farmers' investments are influenced neither by the accessibility nor by the size of plots in domain II. Farmers in this domain apply animal manure in the nearby and small plots (usually *enset* plants) and inorganic fertilizers in distant and large plots; apparently in more or less similar monetary values.

Domain III

Domain III is very different from the other two: in this domain, farmers' investments in land management are positively correlated with *vulnerability* of plots to water erosion. This means that farmers invest more on plots with steep slopes, high magnitude of water erosion and on plots where water erosion is intensifying over years. The reason for this significant correlation of farmers' investments with vulnerability of plots is that most of the land in domain III is flat with only a small proportion situated on steeper slopes and vulnerable to water erosion. Farmers constructed water erosion control measures in almost all of these plots, which make the correlation positive and significant.

Unlike the other two domains, the size of plots but not the accessibility of plots in domain III influences farmers' investments in land management. Farmers invest more in large and distant (less accessible) plots than small and nearby (better accessible) plots in domain III. The explanation may be that application of inorganic fertilizer does not require much labour and the effect of distance is not important. Therefore, farmers apply organic fertilizers (financially cheaper, but requiring much more labour) in nearby plots while distant plots receive expensive but less labour-demanding inorganic fertilizers. However, farmers' investment in land management in domain III is not influenced by *soil fertility condition* of plots. This seems logical because the soils in this domain are homogenously infertile and farmers' investment in land management cannot be correlated with fertility condition of the soil.

4.4 Conclusions

The results of Factor Analysis reveal five major household level factors that affect farmers' decisions *how much* to invest in land management, but with different effects across the domains. Farmers with better *resources endowment* (related to land and livestock holdings) invest more in land management only in domain III. Usually, farmers invest in land management when they have financial surplus from their primary needs such as food, clothing, shelter and health care. Given this result and limited financial resources of farmers in the CRV, there is a need to *include asset accumulation strategies* while land management strategies are planned. It is also shown that farmers with better *farming experience and knowledge* invest more in land management in domain I, while better access to information enhances investments in domains II and III. This implies that *training and knowledge transfer* is a crucial factor in sustainable land management strategies. One way of providing information in the study areas is through the DA. However, DAs are usually very busy with non-agricultural activities that call for new and more effective ways to promote sustainable land management and to the observation that there is a need to find out how to best involve them in promoting agricultural technologies.

This study also shows that farmers' investments in land management are enhanced by available *social capital* in a village, except in domain III where farmers are more dedicated to cattle raising than to agriculture. This suggests the need to find approaches for farmers to access a wide network of information and technical support from different sources and advice to strengthen social networks. Finally, farmers' investments in land management investments are influenced by the availability of *family labour* especially in domain I where water erosion control – a very labour demanding activity – is of prime importance for agricultural production. Hence, in kebeles similar to the one in domain I the use of community mobilization for land management activities requiring much labour is crucial.

In addition to household factors, we found three major plot level factors that determine farmers *where to invest* in land management. The study shows that farmers in domain III invest more in land management (particularly water control measures) in plots that are vulnerable to water erosion. This confirms findings from other studies, namely that farmers do perceive water erosion, and it indicates that if they are capable in controlling it (as in domain III where only few plots suffer from water erosion due to steep slopes) they will invest in water erosion control measures. In domain I with similar problems of water erosion but on a much larger scale, farmers need resources to support and trigger them to invest in erosion control measures.

The diversity of determinant factors across the domains is due to differences in social, economic, cultural and biophysical characteristics of these domains. This indicates that the current blueprint (one size fits all) approach to sustainable land management in the CRV is not useful. Land management strategies designed at macro level should be adapted to the local circumstances in the specific kebeles, based on their local situation. This implies that local administrations and DAs should be trained and empowered to plan and implement land management at local level - under macro strategic frameworks. Besides the mentioned household and plot factors, it is important to underline that farmers' investment decisions are also influenced by external factors that are beyond their control; factors not taken into account by this study. External factors limiting households' investments in land management include lack of (appropriate) technologies, limited extension services, poor agricultural policies and weak institutional support. This indicates that, although farmers are the ultimate actors that take decisions regarding their land use, sustainable land management warrants contributions from other – external – stakeholders. Collaboration among farmers and different institutions involved in sustainable agriculture is crucial. Nowadays farmers and other stakeholders in the CRV are frequently working in isolation and collaboration is limited. Further research is therefore needed to understand the bottlenecks that hinder institutions to collaborate and support sustainable land management.

Chapter 5

Exploring co-investments in sustainable land management in the Central Rift Valley of Ethiopia

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Exploring co-investments in sustainable land management in the Central Rift Valley of Ethiopia

Abstract

In Ethiopia, not only farmers but also the public and private sector are still hesitant to invest in sustainable land management (SLM). This study focuses on the Central Rift Valley and explores the potential for co-investments in SLM, where public and private sector partners support farmers with material, capital, knowledge, etc. A survey revealed current bottlenecks for co-investments and requirements needed to collaboratively invest in SLM. It covered 165 public sector partners (*micro, meso and macro* level institutions) and 42 private sector partners (banks, exporters and local traders). Results for the public sector show a gap between macro and micro/meso level actors concerning co-investments in SLM. Macro-level institutions do not acknowledge the bottlenecks identified by micro and meso-level institutions (e.g. lack of accountability, top-down approaches and lack of good leadership). Similarly, opinions on requirements for co-investments in SLM differ considerably. Most factors are related to governance issues, showing that bridging the institutional micro-macro gap is a precondition to co-investments. This requires improving governance at all institutional levels, with specific attention to capacity building and enhancing a common understanding on barriers to SLM. Results for the private sector reveal that economic bottlenecks limit possibilities to co-invest in SLM, and that enabling policies at governmental level are required to trigger private investments. Hence, the potential for co-investments in SLM is available in Ethiopia at micro and meso-level and within the private sector, but profound commitment and fundamental policy changes at the macro-level are required to exploit this potential.

Keywords: Sustainable land management, co-investments, governance, public-private collaboration, Central Rift Valley of Ethiopia

5.1 Introduction

Agriculture serves as a springboard to achieving broad-based economic growth; it currently employs 84% of the Ethiopian population and generates half of the country's Gross Domestic Product (GDP) and more than 90% of its export revenue (CSA, 2010). Despite the importance of agriculture in the economy (CSA, 2010), land degradation in the form of water erosion and nutrient depletion has been threatening this sector for the last three decades (Dessie et al., 2012). Accordingly, development and research institutions have recognized the need to invest in Sustainable Land Management (SLM), and they have devoted substantial resources to promote SLM technologies, minimize land degradation and increase crop productivity (Vancampenhout et al., 2006; Beshah, 2003; Shiferaw et al., 2007). Nevertheless, these efforts have had limited success in reversing the situation (Shiferaw and Holden, 2000), with a growing rural population not being able to cope with the causes of low productivity and food shortages, and not having the means to invest in SLM.

It is widely acknowledged that not only farmers are responsible and should be involved in SLM, but that particularly public institutions have a crucial role. In Ethiopia much emphasis has always been given to agricultural extension (Belay and Abebaw, 2004). However, the top-down approach of rural extension – with little room for genuine farmer participation in rural development – together with a lack of collaboration among institutions at different institutional levels are often considered as the main causes for the failure of rural development efforts in Ethiopia (Bekele, 2001; German et al., 2010; Mowo et al., 2010).

Particularly collaboration – if carried out well and in partnership – is essential for successful implementation of SLM activities: it can mobilize resources outside the farming community, improve farmers' access to information, technology and credit, as well as create enabling conditions through good governance and appropriate policy (Lubell, 2004; Fleeger and Becker, 2008).

Collaboration implies that all partners invest to contribute and achieve common goals. Such co-investments, or joint efforts of public and private sector institutions in support of SLM, can take place in the form of material, capital, labour, knowledge, technology or governance. In this research a co-investment in SLM is conceived as collaborative SLM (in partnership), in which farm households, government institutions, non-governmental institutions and private sector partners share responsibility for the management of a specific area or set of natural resources (Bouwen and Taillieu, 2004; IUCN, 1996), including individual plots of farmers, communal lands and national conservation areas.

Co-investments in SLM are urgently required in the Central Rift Valley (CRV) of Ethiopia, the study area of this research. First of all because farmers' current investments in land management are strongly limited by several socioeconomic and biophysical factors (Adimassu et al., 2012a; Adimassu and Kessler, 2012) which farmers are often unable to cope with (hence, farmers cannot do it alone). Furthermore, the services provided by SLM have a public-good nature (such as providing potable water) and benefit society as a whole, including future generations (Pagiola, 2008; Wang et al., 2009; Van Hecken and Bastiaensen, 2010; Wiley and Przybylowicz, 2010). This study explores the potential for co-investments in SLM in the CRV of Ethiopia, by unravelling the bottlenecks that limit institutional collaboration and support to farmers, as well as the related requirements that need to be put in place to foster these co-investments. It will do so by studying different perceptions and views of both public and private sector institutions in Ethiopia on the main bottlenecks for co-investments in SLM, and how these differences affect the potential to foster SLM in the CRV. Conclusions focus on what should be done in order to overcome these differences and tackle the identified bottlenecks.

5.2 Methodology

5.2.1 Interviewees

Figure 5.1 presents the major potential investors in the Ethiopian context, as well as their forms of investment in SLM. Investors include farmers themselves (primary investors), extension institutions, research institutions, non-governmental organizations (NGOs), policy makers and the private sector. In order to gain insight concerning differences in perception along the administrative hierarchy, the public institutions are categorized into *micro-, meso- and macro*-level institutions (Table 5.1). *The micro level comprises kebele (village) and wereda (district) level institutions. The meso level comprises public institutions working at zone-level, the research centres and NGOs. The macro level includes national and regional institutions, which are generally very remote from the farm households' reality.*

Table 5.1. Public institutions at micro-, meso- and macro level.

Level	Institutions
Micro	- Wereda Offices of Agriculture and Rural Development
	- Development Agents (DAs)
Meso	- Zone Departments of Agriculture and Rural Development
	- Research Centres
	- Non-Governmental Organizations (NGOs)
Macro	- National Agriculture and Rural Development
	- Ethiopian Institute of Agricultural Research (EIAR)
	- Regional Bureaus of Agriculture and Rural Development
	- Regional Agricultural Research Institutes (RARIs)

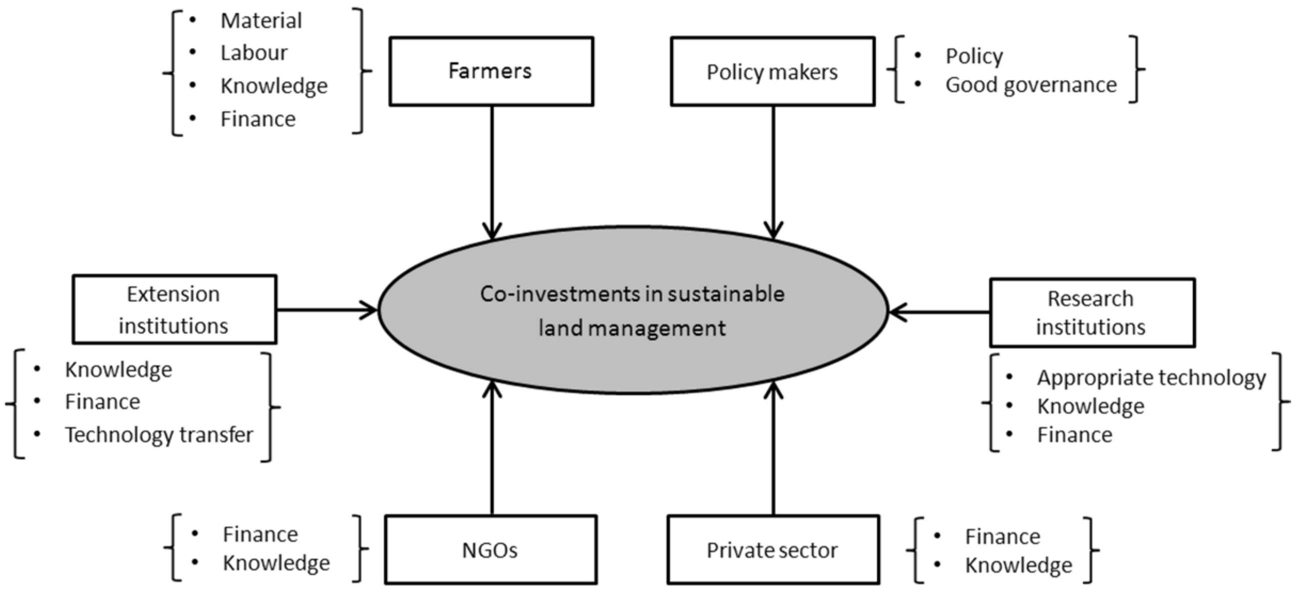

Figure 5.1. Conceptual diagram of possible co-investments in sustainable land management in Ethiopia. The bulleted text describes the forms of co-investment from different co-investors.

In addition to the public sector, within the private sector three potential co-investors in SLM were taken into account: banks, exporters and local traders. Although these private-sector partners are currently often not aware of their stake in SLM, they are all affected directly or indirectly by land degradation, e.g. by a decrease in the quantity and quality of agricultural products; the reduced income of farmers and potential number of customers who can save and borrow money; reduced revenues of exportable commodities (e.g. sesame, coffee) due to land degradation; reduced supply of commodities for local consumption; etc.

5.2.2 Data collection

A combination of informal surveys and semi-structured interviews was used to collect empirical data regarding bottlenecks and requirements of co-investments in SLM. As a first step, during an informal survey, representatives from all institutional levels were asked to suggest bottlenecks that in their view hinder them to invest in SLM, and requirements needed to foster co-investments. Based on this survey, a shortlist was prepared of most mentioned bottlenecks across all institutional levels, as well as the requirements mentioned to co-invest in SLM.

This shortlist of factors was used as input to the semi-structured questionnaire, which was carried out in order to gauge the agreement of respondents on the identified bottlenecks and requirements. In total, 165 respondents from public institutions were selected from different administrative levels for this questionnaire interview (Table 5.2). At the *micro* level, development agents (DAs) from the kebele[1] level, as well as experts and officials from Weredas were interviewed. At the *meso* level, experts and officials from zones, representatives from NGOs, and researchers from research centres were taken into account. At the *macro* level, officials and representatives from the Bureaus of Agriculture and Rural Development (BARD), Regional Agricultural Research Institutes (RARIs), the Ministry of Agriculture and Rural Development and Ethiopian Institute of Agricultural Research (EIAR) were interviewed.

[1] Kebele is the lowest formal administrative unit in Ethiopia. Four kebeles from Meskan (Beressa, Drama, Dobi and Mikaelo) and four kebeles from AJK (Worja, Woyisso, Chelemo, Rapee) were used for this study.

Table 5.2. The description of respondents from micro-, meso- and macro-level institutions.

Levels	Description	Sample size
Micro	DAs from 8 kebeles in Meskan and Adamitulu Jidokombolcha weredas	23
	Experts and officials from Meskan and Adamitulu Jidokombolcha weredas	36
Meso	Experts and officials in Gurage (Wulkite) and East Shewa (Nazreth) zones	31
	Representatives from NGOs in Gurage and East Shewa zones	6
	Researchers from Adamitulu, Holeta and Melkassa Research Centres	43
Macro	Officials and representatives from BARD of Oromia and Southern Nation and Nationalities and Peoples' region (SNNP)	14
	Research directors and representatives from RARIs of Oromia and SNNP	6
	Research directors and representatives in EIAR	3
	Representatives from Ministry of Agriculture and Rural Development	3

The interviewees were selected using purposive sampling in order to obtain perspectives of respondents who were knowledgeable. The criteria for participation included the requirement that individuals have a minimum of 3 years of work experience. Since our focus was on the CRV, respondents at the micro and meso levels were selected from institutions involved in this region. A 5-point Likert scale (with 1 = strongly disagree; 2 = disagree; 3 = undecided/neutral; 4 = agree; 5 = strongly agree) was used to gauge the respondents' opinions about the strength of their agreement/disagreement with each of the bottlenecks and requirements.

In addition to the public sector, 42 respondents from the private sector were interviewed: bank employees (n=9), exporters (n=17) and local traders (n=16). Most of the respondents in this sector were business owners and managers. A s*nowball* sampling procedure was used to interview these respondents. In this procedure, each respondent was asked to name one other individual to be interviewed (Vogt, 1999). This sampling technique was used because it was difficult to get an adequate overview of possible private sector partners involved in SLM, particularly the names of exporters and local traders. Semi-structured questions with binary choices ("Yes" or "No") were used to gain insight regarding bottlenecks and requirements of co-investments of these private sector partners.

5.2.3 Data analysis

The data from the questionnaire survey were analysed and summarized using Statistical Packages for Social Science (SPSS). Descriptive statistics (e.g. frequencies, percentages, means, standard deviations and modes) were computed. Chi-square test was used to test if respondents who agreed for each bottleneck and requirement were statistically different from those who do not agree. For the ease of Chi-square analysis, the 5-point Likert scale responses were categorized into binary choice variables (1 = agree/strongly agree, 0 = disagree/strongly disagree).

Table 5.3. Descriptive statistics of bottlenecks for co-investments in SLM micro-, meso- and macro-level institutions, % of respondents.

Statements regarding bottlenecks in co-investments	*Mean*	*Standard deviation*	*mode*
Lack of knowledge concerning co-investments in SLM	4.4	0.6	5
Lack of accountability on achievements in SLM	4.2	0.8	4
Frequent organizational restructuring	4.2	1.0	5
Use of top-down approach by the Government	4.0	1.1	4
Lack of commitment at all institutional levels	3.9	0.8	4
Lack of good leadership	3.8	1.0	4
Existence of different mandates	3.6	1.3	5
Staff turnover	3.2	1.0	4

The mean value for each bottleneck was obtained from 5-Point Likert-scale scores based on statements for each bottleneck. Scores were: 1 = strongly disagree, 2 = disagree, 3 = undecided/neutral, 4 = agree, 5 = strongly agree.

Again, in order to gain insight about the responses along different institutional levels, the analysis was done for each level (*micro, meso, and macro*) and the whole dataset. The analysis for the private sector was carried out separately from the public institutions due to differences in the dataset. In this case, proportions of respondents (percentages) were used to explain the bottlenecks for co-investments and requirements needed by different private sector partners. This analysis was done for banks, exporters and local traders separately and for the whole dataset.

5.3 Results and discussion

This section explains why public institutions and the private sector often fail to co-invest in SLM, and what they require in order to invest in SLM. This section is divided into three subsections. The first subsection describes the major bottlenecks of multilevel public institutions to co-invest in SLM, while the second subsection explains the major requirements of these institutions for co-investment. The last subsection highlights the bottlenecks and requirements identified by the private sector.

5.3.1 Major bottlenecks to co-investments in SLM by public institutions

Table 5.3 presents major bottlenecks that are hindering (in order of importance) public institutions from co-investing in SLM in Ethiopia in general and in the CRV in particular. Overall, the mean value of a 5-point Likert scale of these bottlenecks ranged from 3.2 to 4.4 with modes of 4 and 5 (Table 5.3).

Chi-square statistics using binary choice data (1= agree/completely agree and 0= disagree/strongly disagree) were employed to test whether the group of respondents who agreed on the bottlenecks of co-investments was statistically greater than those who did not agree (Table 5.4). When datasets of all levels were considered together, a significantly large number of respondents agreed on the importance of several bottlenecks of co-investments as presented in Table 5.4. Further analysis was carried out to gain insight regarding the relative importance of bottlenecks along the administrative levels (Table 5.4). These bottlenecks are discussed as follows.

Lack of knowledge concerning co-investments in SLM. Respondents from all institutional levels agreed that the idea of “co-investments” is new in Ethiopia, and that institutions and individuals lack experience with any form of collaboration in support of SLM. There is an enormous knowledge gap concerning issues of sustainability and particularly concerning the importance and benefits of SLM for society as a whole. There is currently no common understanding among public institutions on the way forward to achieve a more sustainable agricultural production, which on it turn leads to a lack of insight into the potential role and added value of collaboration. Given that almost all interviewees (93%) agreed with this bottleneck, it is ranked in this study as the main factor that hampers the willingness of public institutions to co-invest in SLM.

Lack of accountability on achievements in SLM. Accountability has been defined in different ways (Wallington and Lawrence, 2009). In this study, we adopted a conventional definition in which individuals, officials and institutions are held responsible when they fail to fulfil their responsibilities or fail to perform what they promised (Agrawal and Ribot, 1999). Accountability is crucial for SLM because it provides a means to monitor and control what should be done, whether the desired activities are being carried out effective and efficiently and whether SLM interventions have been able to influence changes at the grassroots level (Wallington and Lawrence, 2009). A significant proportion (87%) of respondents in this study stated that co-investments in SLM are affected by a lack of accountability of officials and institutions. Macro-level respondents, however, did not acknowledge this as a hurdle to co-investment. Moreover, according to micro- and meso-level respondents, officials and institutions at all levels are evaluated mainly based on their political commitment rather than their achievements in SLM. This accountability for political commitment is upwards to superior authorities in the administrative structure of the government; not downwards to the grassroots level. For example, Kebeles are accountable to Wereda authorities, Weredas to Zones and so on.

Table 5.4. Major bottlenecks for co-investments in SLM of micro-, meso- and macro-level institutions, % of respondents.

Key bottlenecks of co-investments	*Micro* (n=59)	*Meso* (n=80)	*Macro* (n=26)	Total (n=165)
Lack of knowledge concerning co-investments in SLM	**95**	***91***	**96**	**93**
Lack of accountability on achievements in SLM	**85**	**98**	58	**87**
Frequent organizational restructuring	**98**	**90**	35	**84**
Use of top-down approach by the Government	**97**	**91**	4	**79**
Lack of commitment at all institutional levels	**73**	**84**	42	**73**
Lack of good leadership	**81**	**80**	23	72
Existence of different mandates	**64**	56	54	59
Staff turnover	**66**	41	23	47

The bold numbers are significant at $p<0.05$, Pearson Chi-square test.

Frequent organizational restructuring. Respondents reported that there has been organizational restructuring every two years or more frequently in Ethiopia without evaluating the impact of the previous restructuring. This has resulted in the merging and splitting of bureaus, departments, offices and sections; freezing of positions and reallocation of professionals to inaccessible areas. Although government officials state that restructuring of organizations aims at improving the quality of service provision, most respondents expressed the view that restructuring has been used as a means of political revenge through firing staff affiliated with opposition parties. Generally, when an organization goes through frequent restructuring, it will significantly affect the stability and job satisfaction of employees (Adams, 1990). It also creates tension for employees, who are scared of being fired or reallocated to inaccessible areas. All this might discourage professionals' motivation to serve and strive toward institutional goals (Adams, 1990). Moreover, frequent restructuring affects the continuity of SLM programmes and projects. In this study, a substantial proportion of respondents (84%) reported that frequent organizational re-structuring contributed to the limited success of SLM investments in Ethiopia. However, macro-level respondents did not recognize this as a major bottleneck to co-investments in SLM.

Use of top-down approach by the Government. The essential features of a top-down approach are that it starts with policy decisions by government officials at the national level (Sabatier, 1986) and it neglects involving the main actors (farmers and micro-level institutions) in designing and planning strategies to solve their own problems. According to Burby and May (2010), SLM investments can only be successful if planned and implemented by the primary stakeholders (farmers) and local governments. In principle, all decision-making related to social and economic policies and strategies in Ethiopia was transferred to regional states following the establishment of a federal administration in 1991, with the Constitution of the Federal Democratic Republic of Ethiopia (1995) stating that adequate power is given to the lowest unit of government (*wereda*). In practice, however, a top-down approach is still common in the country. Most activities related to SLM (and agriculture in general) are channelled from the macro level as a kind of quota system in which the type and quantity of SLM activities for micro-level institutions are decided at the macro level (Bati, 2009). Often, frontline professionals at the micro level are mandated neither to modify these packages depending on their local specific conditions nor to integrate the packages with other activities for better results (Bati, 2009). As a whole, most respondents (79%) agreed that this top-down approach negatively influences co-investments in SLM. Again, macro-level respondents did not agree with these opinions; being the top-level decision makers in the country, they obviously do not want to blame themselves. Previous authors have suggested that a top-down approach has contributed to the failures of many SLM initiatives (Admassie, 2000; Bekele-Tesemma, 1997; Mowo et al., 2010), something that higher-level decision makers are reluctant to admit.

Lack of commitment at all institutional levels. This factor refers to a lack of commitment of officials assigned by the government (political party). When officials are not committed to making appropriate decisions to finance and facilitate SLM, the lower-level stakeholders also will be reluctant to invest in rural development activities, such as SLM (Berke et al., 2006; Morison and Brown, 2010). A majority of respondents (73%) in this study reported that this is the case in the CRV, with government officials uncommitted to promoting co-investments in SLM. However, the result varied again along the administrative ladder. Macro-level respondents less frequently mentioned lack of commitment as a bottleneck to co-investments than did *micro* and *meso* level respondents. Several *macro*-level respondents reported that there is strong commitment from the government to enhance co-investments in SLM. An anonymous respondent from the micro level noted that ... *"Government officials are busy with political activities, and I am not so confident about the commitment of the government regarding SLM in Ethiopia...".*

Lack of good leadership. Leadership is not about authority or position; rather, it is about the relationship between the leader and followers that enable them and their actions to bring about change (Zaccaro and Horn, 2003). Therefore, a good leader is essential to establish such a relationship and bring about change. However, according to a few respondents, leaders in Ethiopia at all levels are assigned based on their political affiliation rather than on their talent, performance and educational qualifications. As a result, they may not be capable of addressing all possible alternatives to the issues that arise regarding SLM. Moreover, according to respondents, these leaders do not have time to think about SLM, as they are too busy with political issues. Most of the respondents (72%) reported that lack of good leadership contributes to the lack of co-investments in SLM. Similarly to the other bottlenecks mentioned above, lack of good leadership was not acknowledged by the macro-level respondents, who generally reported that they had assigned good leaders at all levels.

Existence of different mandates. This refers to the existence of different legal mandates for each institution. For example, research institutes are mandated to conduct research and generate agricultural technologies, while the mandate of agricultural extension institutions is to scale up these technologies. In principle, both research and extension institutions are working towards the same intended impact. Nevertheless, these institutions have different mandates, and they are under different ministries. Moreover, the mandates of kebele-, wereda-, zone-, region- and national-level stakeholders are different in Ethiopia. As compared to other bottlenecks explained above, respondents less frequently reported that the existence of different mandates is a bottleneck to co-investments. Overall, 59% of the respondents agreed that the existence of different mandates for institutions hinder co-investments in SLM. The response varied among the administrative levels and ranged from 64% at the micro level to 54% in the macro level.

Staff turnover. In this context, staff turnover refers to replacement of trained workforce by new personnel. Staff turnover can affect co-investments in several ways. Staff turnover is not only a loss of trained and experienced human capital; it is also a form of depletion of social capital (Pollack, 2008). It requires time for the newly recruited staff to acclimatize to a new job and new area and to build social capital with existing employees. As a whole, less than half of the respondents (47%) agreed that staff turnover is one of the bottlenecks to co-investments, with the percentage of positive response decreasing as the administrative hierarchy ascends: 66% (micro), 41% (meso) and 23% (macro) level. If we consider staff turnover at Holeta Agricultural Research Centre for the last five years (2006-2011), an average of nine researchers have left per year (10% of the total number of researchers). A major concern is that researchers leaving the research centres are generally among the highly educated. For example, out of 45 researchers who have left Holeta Research Centre in the last five years, 50% held a PhD and 40% a Master's degree. The main reason for staff turnover in the Ethiopia is low job satisfaction in governmental institutions as a result of a relatively low salary (Reisberg and Rumbley, 2010).

Table 5.5. Descriptive statistics of requirements needed by public institutions for co-investments in SLM.

Requirements	Mean	Standard deviation	Mode
Capacity Building	4.4	0.51	4
Common understanding about co-investments in SLM	4.4	0.70	4/5
Policy support	4.4	0.73	5
Interdependencies among institutions	4.2	0.67	4
Accountability	4.0	0.88	4
Written agreement	4.1	0.80	4
Stable organizational structure	4.1	0.91	5
Commitment	3.9	1.04	4
Good leadership	3.5	1.11	4

The mean value for each requirement was obtained from 5-Point Likert-scale scores based on statements for each requirement. Scores were: 1 = strongly disagree, 2 = disagree, 3 = undecided/neutral, 4 = agree, 5 = strongly agree.

Table 5.6. Major requirements needed by micro-, meso- and macro level institutions for co-investments in SLM, % of respondents.

Requirements	Micro (n=59)	Meso (n=80)	Macro (n=26)	Total (n=165)
Capacity Building	**100**	**99**	**100**	**99**
Common understanding about co-investments in SLM	**100**	**100**	**65**	**95**
Policy support	**93**	**91**	**89**	**92**
Interdependencies among institutions	**95**	**81**	**96**	**89**
Accountability	**85**	**96**	54	**86**
Written agreement	**83**	**81**	**73**	**81**
Stable organizational structure	**92**	**83**	23	**76**
Commitment	**73**	**84**	42	**73**
Good leadership	**68**	**70**	46	**66**

The bold numbers are significant at p<0.05, Pearson Chi-square test.

5.3.2 Requirements of public institutions to improve co-investments in SLM

This section describes what public institutions mention as requirements to enhance their investments in SLM. Table 5.5 portrays descriptive statistics of the major requirements based on a 5-point Likert scale. The mean score of these requirements ranged from 3.5 to 4.9 (with a mode of 4 and 5), showing a high level of agreement among most respondents. Table 5.6 shows the Chi-square statistical analysis for each administrative level and for the whole dataset. The nine major requirements to improve co-investments in SLM are discussed below.

Capacity building. A weak capacity to coordinate initiatives, to make appropriate decisions regarding SLM policies and strategies, and to disseminate SLM technologies is quite common in developing countries (Ebohon, 1996; Stig and Rexford, 2003). In this study capacity building was the only requirement receiving full agreement (99%) among all institutional levels. It shows that there is a general awareness in Ethiopia that the success and continuity of SLM depends on the human capacity within all relevant institutions, and that respondents acknowledge that capacity building is an enormous necessity. The fact that co-investing in SLM is a relatively new concept in Ethiopia was often mentioned as the main reason to agree with this requirement, emphasizing that at all levels people should be trained in how to plan, implement and evaluate co-investments. Hence, not only training at higher education institutions is important, but also short-term trainings and visits through which public sector staff can gain experience about how to deal with and foster co-investments in SLM.

Common understanding about co-investments in SLM. Before requesting stakeholders to co-invest in SLM, it is crucial to have a common understanding among institutions and individuals about the merits of such investments. This creates common interest and mutual responsibility. This factor is closely linked to the previous factor, and it is therefore no surprise that 95% of the respondents agree that there is a need for common understanding about co-investments. There is however a notorious difference between micro/meso-level (where 100% of respondents agree with this requirement) and the macro-level with only 65% agreeing.

Policy support. This study shows that co-investments require formalized processes and agreements that clarify rights and responsibilities of all stakeholders at all levels. In addition, enforcing rights and responsibilities of all co-investors is essential for successful SLM. This can be realized by a good policy environment with workable enforcing mechanisms. Until now, however, there is no enabling policy in place to promote co-investments in Ethiopia. A highly significant number of respondents (92%) said that setting an enabling policy that proactively supports co-investments at different levels is essential. Previous research has also underlined the importance of adequate policy support regarding SLM in Ethiopia (Shiferaw and Holden, 2000).

Interdependencies among institutions. In Ethiopia, institutions have been working in isolation partly due to a lack of interdependencies among these institutions (Mowo et al., 2010). The majority of respondents (89%) reported that creating better-defined linkages among institutions could induce to work together. Interdependencies among institutions enforce co-investments by avoiding divergent mandates and by creating mutual responsibility as well as accountability. Nevertheless, this may require a merging of institutions, as well as government commitment. During informal discussions, respondents from the Ministry of Agriculture and Rural Development suggested the merging of extension and research institutions in Ethiopia as a way to create interdependencies between these institutions.

Accountability. Accountability implies that "some actors have the right to hold other actors to a set of standards, to judge whether they have fulfilled their responsibilities in light of these standards, and to impose sanctions if they determine that these responsibilities have not been met" (Grant and Keohane, 2005). Accountability has been found to be crucial for the success of SLM (Kasanga and Kotey, 2001; Cocklin et al., 2007). A significant proportion of respondents (86%) consider that holding institutions, officials and individuals accountable is a crucial requirement to fostering co-investments in SLM. The response varied again along the administrative levels, with higher positive responses found at the micro and meso levels. During informal discussions, some respondents noted that officials at all levels talk about co-investments in SLM, but it is hard to see their commitment through actions. An interviewee also commented that *"...The Ethiopian Government has advocated the existence of accountability at all levels. Nevertheless, this is simply a slogan that has not been realized."*

Written agreement. More than three-fourths of the respondents (81%) stated that written agreements outlining responsibilities and accountabilities of the different co-investors are required. Since different institutions control different resources and activities, use of written agreements is important to plan SLM activities and allocate resources. It is also used as a means of monitoring and evaluation for such initiatives. An anonymous official at zone level noted that *"... There have been several initiatives, such as the Research-Extension-Farmer Linkage Advisory Council (REFLAC), to link research and extension in Ethiopia. Nevertheless, these initiatives have not been successful, partly due to a lack of written agreement regarding responsibilities and accountabilities of the two institutions."*

Stable organizational structure. Organizational structure refers to the division of labour as well as the patterns of coordination, communication, workflow, and formal power that direct organizational activities (Grossi et al., 2007; McShane and Von Glinow, 2008). The results of this study show that the creation of a stable institutional structure is required for effective co-investments in SLM, with more than three-fourths of respondents (76%) agreeing that this is one of the major requirements for fostering co-investments. The more stable an organization, the higher the stability of its employees and their job satisfaction (Adams, 1990); hence, a *stable* organizational structure will also be beneficial for the success of SLM initiatives. Nevertheless, reasonable restructuring is essential to improve the services that are provided by institutions.

Commitment. The importance of commitment from the government is essential for successful natural resources management (Burby and May, 2010). Nearly three-fourths of respondents (73%) agreed that commitment of institutions, managers, leaders and professionals is a requirement for successful co-investments in SLM. However, in contrast to the micro and meso level, not even half of the macro-level respondents agreed that commitment is required. This signals to one of the major governance problems in Ethiopia, namely that public officers are not really dedicated to become involved in solving public issues, such as rural development in general and SLM in particular. They often have short time horizons, are cut-off from the rural reality, and lack capacity to really deal with problems. Given the current social, economic and political context in Ethiopia, it is not realistic to expect that this will change in the near future.

Good leadership. The presence of good leadership is increasingly being acknowledged as one of the most important factors for fostering more sustainable natural resources management (Gray et al., 2005; Kan and Parry, 2004). Good leadership can promote interaction, integrate different cultures, coordinate initiatives, facilitate collective action, resolve conflicts, and promote mutual social and environmental values (Pero and Smith, 2008; Krishna, 2002). More than two-thirds of the respondents (66%) agreed that establishing good leadership is one of the main requirements to eliminate existing bottlenecks and enhance co-investments in SLM. Good leadership can be achieved through appointing capable and inspirational leaders at all levels (Pero and Smith, 2008). However, in this study, macro-level respondents did not fully agree with the need for good leadership, considering that it is already in place.

5.3.3 Bottlenecks and requirements of private sector

In principle, the private sector is a profit-oriented sector. However, there are cases where the private sector may also play an important role in land management investments. Their businesses and profit are directly or indirectly affected by land degradation and could be stimulated by SLM. This section highlights the major bottlenecks and requirements of private sector partners to co-invest in SLM. In this study, the four different forms in which the private sector can invest in SLM were: providing credit to farmers; using benefit-sharing agreements; payment through income tax; and separate payment (Table 5.7).

Opinions concerning the importance of these forms of co-investments varied among the private sector partners. All respondents from the banks (100%) but less than half of the exporters (47%) agreed that provision of credit to farmers is one way of co-investing in land management. About 35% of the exporters stated that contractual agreements regarding co-investments and co-benefits with farmers could be appropriate. For example, some exporters showed their interest to co-invest in the production of high-quality, exportable commodities, such as organic coffee, sesame and linseed. However, if they co-invest, they require at the same time contractual agreements between exporters and producers (farmers) regarding the costs and benefits of such investments. More than one-third of the exporters (37%) and nearly two-thirds of the local traders (63%) preferred to pay for SLM through the annual income tax. Only a small proportion of local traders (25%) preferred a separate payment for SLM.

Table 5.7. Proposed forms of co-investments by private sector partners, % of respondents.

Forms of co-investments	Banks (n=9)	Exporters (n=17)	Local traders (n=16)	Average (n=42)
Provision of credit to farmers	100	47	0	41
Using benefit sharing agreement	0	35	0	14
Payment through income tax	0	37	63	45
Separate payment	0	0	25	9.5

Note: Total more than 100% is due to multiple responses of respondents.

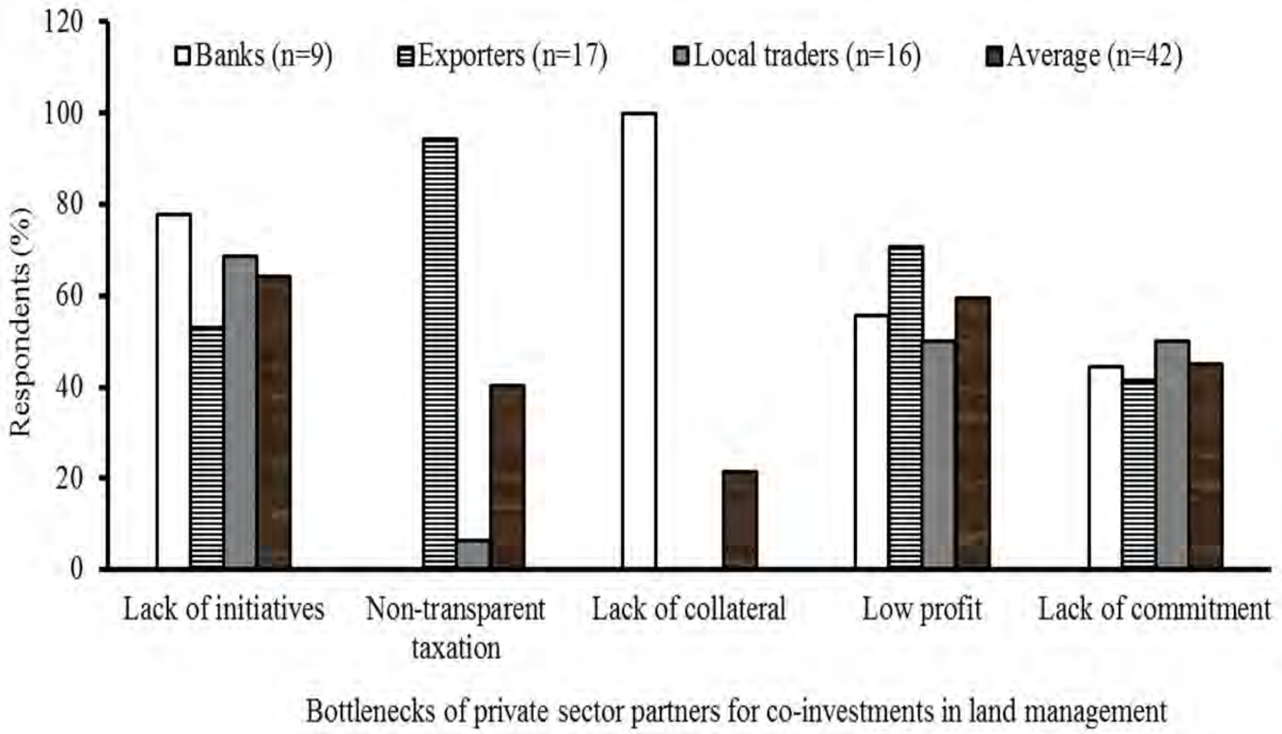

Figure 5.2. Main bottlenecks of private sector partners for co-investments in SLM, % of respondents.

Although private sector partners are willing to co-invest in SLM through different mechanisms, they also identified five major bottlenecks (Figure 5.2) that currently constrain their co-investments. The first bottleneck is *lack of initiatives* by government institutions to facilitate efforts for SLM. Two thirds of the respondents agreed that there is a lack of initiatives to motivate the private sector to become involved in SLM investment. One local trader referred to the importance of rehabilitating degraded lands: *"If you give me degraded land, I can rehabilitate it and plant trees for my future use*."

The second bottleneck identified by the private sector was the existence of a *non-transparent taxation system*. Generally, 94% of the exporters and 63% of local traders identified the existence of a non-transparent taxation system in Ethiopia as a constraint. During the interview, most responses, particularly from exporters, noted that the taxation system is a lump sum, and that some part of the tax should go to SLM investment. They reported that there is not a transparent system to determine how much tax each taxpayer owes to pay per year. Moreover, some respondents reported that they found that the estimation of annual tax by the Revenue and Custom Authority of Ethiopia to be biased. This lack of a transparent taxation system creates mistrust between the government and private sector, and aggravates corruption in the taxation system. This suggests the need to establish a transparent taxation system by establishing good governance at all levels of the Revenue and Custom Authority of Ethiopia.

The third bottleneck reported by all banks was *lack of collateral.* These banks are profit-oriented share companies. According to respondents from the banks, their institutions can currently only provide credit for construction purposes, exporters and large-scale flower farms. And although they are interested to provide credit to smallholder farmers, they do not do it because farmers have no collateral. Land is the only asset most Ethiopian farmers have. Unfortunately, however, Ethiopian farmers cannot collateralize their land for loan. This is because, under Ethiopia's land tenure system, the government owns all land and provides only use rights to the farmers. Therefore, it is necessary to develop a better land tenure system that enables farmers to use their farmlands as collateral in order to get loans from the banks. This would require radical changes in land policy in Ethiopia, aiming at providing farmers with ownership rights to their land.

The fourth bottleneck identified was *low profit* which was reported by 56% of the banks, 71% of the exporters and 50% of the local traders. Respondents from banks reported that the controlled interest rate set by the national bank of Ethiopia is a partial cause of low profits. Exporters and local traders reported perceiving that commodities/inputs are becoming more expensive and their profit is decreasing over years. They also stated that the introduction of the value-added tax (VAT) of currently 15% contributed to their low profits. According to the respondents, VAT has decreased the number of their customers.

The last bottleneck frequently mentioned by some private sector partners was the lack of commitment from the government. Respondents stated that the government is not committed to SLM. In general, nearly half of the respondents (45%) complained about the lack of commitment of the government regarding SLM. One coffee exporter commented that *"The coffee tree is an environmentally friendly and valuable plant. But the current expansion of private farms for tea plantation and rice production has devastated the forest land in the coffee-belt areas." We are also watching through Ethiopian television that the government is rewarding farmers who have increased their crop production. So, why is government not rewarding farmers who conserved their land using a coffee plantation? This shows that the government is not committed to motivating farmers for sustainable land management."*

In addition to these bottlenecks, the private sector identified five major *requirements to* enhance co-investments in SLM (Figure 5.3). The first requirement was *the need for sharing benefits (co-benefits)*. One-third of private sector respondents (31%) and nearly half of the exporters (47%) reported that benefit sharing is required to improve co-investments in SLM. In principle, there already exists benefit sharing in terms of environmental services. Nevertheless, respondents from the private sector argued that they are profit-making entities and need to receive direct economic benefits from SLM investments.

The second requirement proposed by exporters and local traders was the need for a *transparent taxation system*. According to these respondents, the decision-making process and reasoning behind the amount of tax they are supposed to pay are not clear. This has led, in their opinion, to unfair and biased tax payments that have affected the profit of the private sector. The great majority of the exporters (94%) and 6% of the local traders argued that the government should find a way to implement a transparent taxation system in Ethiopia.

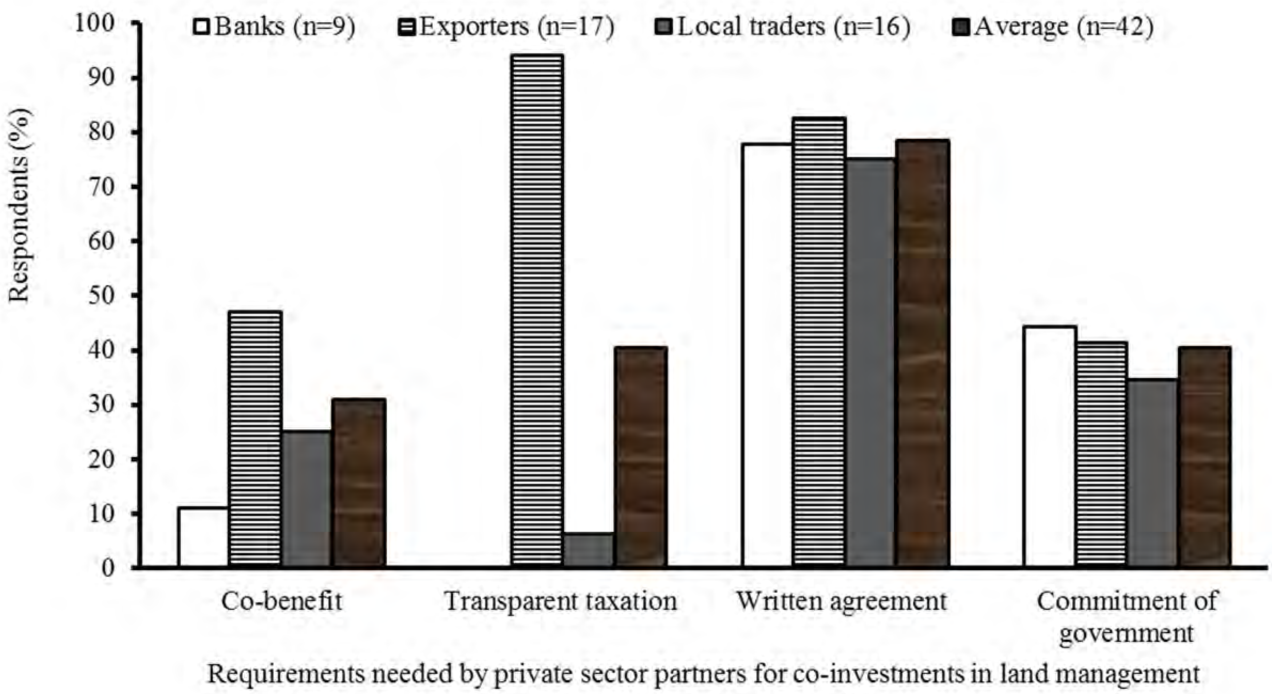

Figure 5.3. Requirements needed by the private sector partners for co-investments in SLM, % of respondents.

The third requirement needed by the private sector to encourage SLM investments was *written agreements* with both farmers and the government. Most respondents (79%) consider such written agreements concerning how to deal with the benefits of the land ("who gets what") essential before willing to co-invest in SLM.

The last requirement mentioned by the private sector to start investing in SLM was *significant commitment* from the government and implementing institutions (41%). Hence, the private sector will not take the lead in fostering co-investments in SLM with public institutions. Respondents said that unless the government is committed to SLM investments, the money they contribute may not go to SLM activities. This suggests that these respondents lack confidence in the government.

5.4 Conclusions

This paper advances our understanding on the potential of co-investments in SLM, with specific attention to the CRV of Ethiopia. We conclude that there is a gap between micro/meso level and macro-level institutions concerning the bottlenecks and requirements related to co-investments in SLM. Important bottlenecks (such as lack of accountability, top-down approaches and lack of good leadership) are not acknowledged by macro-level institutions. This suggests serious governance problems in the public sector, with a need to put in place good governance at all institutional levels. Only this might bridge the micro-macro gap and bring the possibility closer of starting co-investments in SLM. Hence, instead of focusing on endless organizational restructuring, policy makers should address issues related to governance. For this to happen, first of all, macro level institutions must be committed to transferring power to micro-level institutions. Without the active involvement of micro-level institutions, achieving sustainable results on land management and rural development remains difficult. Special attention should also be given to capacity building and attaining a common understanding on current limitations to SLM.

Like the public institutions, the private sector identified several bottlenecks and requirements for co-investments in SLM. Out of these bottlenecks, the non-transparent taxation system in Ethiopia discourages private sector (e.g. exporters) to co-invest in SLM. Moreover, the prospect of private banks lending money to smallholder farmers is not promising due to a lack of warranty from these farmers. Although most requirements by the private sector are related to economic issues, these potential investors foremost need appropriate enabling conditions at governmental level to start co-investing in SLM. This study has made clear that bridging the micro-macro gap within public institutions (i.e. establishing an improved governance structure) is a precondition for rural development in Ethiopia. This will require profound changes in the current management and governance of public institutions. However, given the current social, economic and political context in Ethiopia it is not realistic to expect such changes in the short-term.

Considering the potential for co-investments in SLM in Ethiopia we conclude from this study that at the micro and meso level and within the private sector there is enough willingness to act and invest in SLM, as well as awareness about the necessity to collaborate, but that first of all profound commitment and fundamental policy changes at the macro level are required to exploit this potential.

Chapter 6

Co-investments in land management: lessons from the Galessa watershed in Ethiopia

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Co-investments in land management: lessons from the Galessa watershed in Ethiopia

Abstract

This study presents a co-investment initiative for sustainable land management in the Galessa watershed in Ethiopia. It documents successful co-investment activities that trigger farmers to carry out land management practices, and assesses the impact of these activities on farmers' land management investments. The most important co-investment activities that trigger farmers to invest in land management are co-investments in *awareness creation, water provision, technology and governance.* All these activities are implemented by means of macro, meso and micro level collaboration. Of these activities, co-investing in *water provision* is most successful, because it directly solves one of the basic needs of farmers in the watershed. Results reveal that the *experimental* group of farmers (participants in the co-investment initiative) – compared to the *control* group (non-participants) – invested significantly more in land management practices such as soil bunds, composting and tree planting. The article concludes that use of multiple co-investment activities is crucial to trigger farmers to invest in land management in Ethiopia.

Keywords: Co-investments; motivating farmers; sustainable land management; Galessa watershed; Ethiopia

6.1 Introduction

More than 85 million people living in Ethiopia (CSA, 2012) depend on agriculture for their livelihood (Shiferaw and Holden, 2001). Since increased agricultural productivity is highly dependent on the status of the land resource base, the country's food and social security are heavily dependent on how land resources are managed. Available evidence suggests that land degradation in the form of soil erosion and nutrient depletion presents a threat to food security and sustainability of agricultural production in Ethiopia (Descheemaeker et al*.,* 2006; Kassie et al., 2009). Several development institutions have invested substantial resources to promote Sustainable Land Management (SLM) practices as part of efforts to combat land degradation and increase agricultural production (Nyssen et al., 2000; Pender and Gebremedhin, 2007). Moreover, research initiatives, such as the Ethiopian Highlands Reclamation Studies (EHRS) (FAO, 1984) and the Soil Conservation Research Project (Grunder, 1988; Hurni, 1988) invested significant human and financial resources to assess the extent of land degradation and test land management technologies at plot and watershed scales.

Unfortunately, both development and research initiatives have been criticized for their limited success, which has been mainly attributed to a lack of collaboration among the different stakeholders (Mowo et al., 2010; Shiferaw and Holden, 2000). Collaborative efforts of several stakeholders (including farmers) to invest in land improvement in the form of material, labour, finance, technology, knowledge and governance are "co-investments" (Adimassu et al., 2012b). Such collaborative efforts in land management are being advocated as a promising way to deal with land degradation problems (Van Noordwijk and Leimona, 2010; Wiley and Przybylowicz, 2010; IUCN, 1996) through cost sharing, technical support, provision of credit and technology (Weber, 2000; Lubell, 2004; Campbell et al., 2011).

Table 6.1. Major stakeholders involved in the co-investment initiative at Galessa watershed in Ethiopia

(Co-) investors	Description of stakeholders	Forms of investment
Farmers	- All farmers in the Galessa watershed	Labour, material, finance, knowledge
Micro	- Administration (*Galessa-Koftu* kebele) - Development agents (*Galessa-koftu* kebele) - Dendi wereda extension - Dendi wereda administration	Governance Knowledge Knowledge, finance, governance Governance
Meso	- West Shewa zone of extension - West Shewa zone Administration - Holeta Agricultural Research Centre (HARC) - Farm Africa (at the initial stage)	Knowledge, finance, governance Governance Finance, knowledge, technology -
Macro	- Ethiopian Institute of Agricultural Research (EIAR) - African highlands initiatives (AHI)	Finance, Governance Finance, knowledge

The use of co-investment activities to motivate farmers to carry out land management is increasingly recognized (Kessler, 2007; German and Taye, 2008). Documenting the lessons and experiences of previous initiatives where stakeholders have collectively invested in land management, is crucial for further scaling out of sustainable land management. Moreover, the success of these co-investment initiatives should be supported by evaluating practical examples (Conley and Moote, 2003; Koontz and Thomas, 2006; Campbell et al., 2011).

This research is based on a case study of integrated watershed management in the Galessa watershed in the central Highlands of Ethiopia (here after called ‘co-investment initiative’). This co-investment initiative was started in 2004 by the Holeta Agricultural Research Centre (HARC) of the Ethiopian Institute of Agricultural Research (EIAR) in collaboration with African Highlands Initiative (AHI), in order to demonstrate the added value of collaboration. Hence, in this initiative, farmers and other stakeholders at *micro-, meso-* and *macro*-level jointly invested in land management in different forms (Table 6.1), as such being currently the best available example of a co-investment initiative in land management in Ethiopia. However, the experiences in the Galessa watershed and the most successful activities (here after called ‘co-investment activities’) employed to motivate farmers to invest in land management have never been documented, nor has the impact ever been assessed. The objectives of this study were meant to fill this gap, aiming at: (i) documenting the most successful co-investment activities that trigger farmers to invest in land management and (ii) assessing the impact of the co-investment activities on farmers’ investments in land management.

Although this case study is found in the central highlands of Ethiopia, many aspects of this study will be applicable to the other parts of Ethiopia such as in the Central Rift Valley.

6.2 Description of the case study

6.2.1 Why the case study is considered a “co-investment” initiative?

The initiative in Galessa is unique compared to other SLM activities in Ethiopia. This section explains why the approach of this initiative is completely different from conventional land management interventions carried out in Ethiopia, and why it is considered a co-investment initiative.

At the outset, the initiative involved several relevant stakeholders including farmers, research institutions, extension institutions and governmental institutions at *micro, meso* and *macro* levels. At the *micro* level, development agents and administration from *Galessa-koftu* kebele[1], as well as extension and administration from Dendi wereda (district) were involved. At the *meso* level, extension and administration

[1] *Kebele* is the lowest formal administrative unit in Ethiopia

from West Shewa zone[2], and HARC were involved in this initiative. At the *macro* level, EIAR and AHI were involved. All these stakeholders invested in the initiative, being it in the form of material, labour, finance, technology, knowledge or governance (Table 6.1). Holeta Agricultural Research Center was the catalyst agency and took the coordinating role of this initiative.

Concerning some basic differences between this initiative and conventional (extension) activities aiming at sustainable land management, the *first* important difference refers to the involvement of different stakeholders. In the conventional extension approach, only farmers and extension institutions at different levels are involved. In this initiative, however, relatively more stakeholders at different institutional levels were involved also; and from the beginning.

The *second* difference is related to problem identification, prioritization and planning. In the conventional extension approach, prioritization of agricultural problems is top-down: activities are prioritized at the *macro-level* (national and regional) and implemented by farmers and *micro-level* institutions. In this initiative however, problem identification, prioritization and planning were undertaken jointly by farmers, researchers and extension workers at watershed level.

The *third* difference refers to the implementation of land management activities. In the conventional approach, development agents and kebele administration actively mobilize farmers (often with incentives or food-for-work programmes) to implement SLM practices considered as "the best"; i.e. farmers often cannot choose themselves which practices suites them best. This co-investment initiative however started by tackling the top-priority problems identified by farmers (e.g. lack of quality and quantity of drinking water) and tried to motivate farmers to invest in SLM practices themselves by employing different collective (motivating and enabling) activities.

The *fourth* difference concerns the monitoring and evaluation (M&E) of SLM activities. Nowadays, M&E is recognised not only as an important tool to understand and document results of development initiatives, but also as a learning tool (German et al., 2006). Hence, M&E in the Galessa watershed was conducted with the farmers and representatives from participating institutions during field days, meetings and workshops at micro, meso-and macro-levels. As such, stakeholders learned from each other and from the obtained results, which contributed to their motivation to take the initiative themselves and invest in SLM. In the current extension system in Ethiopia – and in numerous NGOs – there is no such use of M&E: written reports to the upper administrative level are usually sufficient and there is no feedback loop to the stakeholders or any form of validation on the ground.

6.2.2 Major procedures followed

The co-investment initiative was started by organizing an inception workshop for awareness creation. The workshop was organized by HARC in collaboration with AHI. During this workshop, potential stakeholders were invited and the objectives of the initiative as well as the approaches to be followed were discussed. In addition to the formal inception workshop, several meetings were organised for awareness creation and consensus building among the different stakeholders.

Team formation and site selection. After the inception workshop, the second step was the formation of a multidisciplinary team with all institutional stakeholders. Based on secondary data and a topographic map, the team selected the Galessa watershed as intervention site. After selecting the site, the team contacted different local stakeholders including community leaders, local elders, religious leaders and the local government. These local stakeholders were informed about the aim of the initiative. The team delineated the boundary of the watershed in consultation with the watershed community. The delineation was not strictly hydrological and was flexible to include villages that were dissected by the hydrological boundary (in *Ameya and Tiro villages*), so as to include parts of villages falling outside hydrological boundaries in the delineated watershed. In this case, the role of the local people was crucial.

[2] *Zone* is the administrative unit in Ethiopia between the *region* and *wereda* (district)

Problem identification and planning. A next step was problem identification and prioritization. *First*, all farmers in the watershed were grouped according to age, wealth and gender in order to capture watershed problems from all diverse groups. *Second*, representatives (n=30) from each category were randomly selected and their problems identified using semi-structured questionnaire (German et al., 2007). At this stage, several lists of watershed problems were identified by these categories from different villages. *Third*, these watershed problems were lumped into a single list with a manageable number of issues for subsequent ranking. *Fourth*, a representative sample of watershed residents from each category (n=60) were again approached to rank the relative importance of identified problems. *Fifth*, data were summarized and analysed to prioritize watershed problems. *Finally*, the result of the analysis was approved by farmers in the watershed using community meetings. At this time, eight important watershed issues were identified.

Similarly, planning was done with the active participation of the watershed community. During planning, attention was given to the top priority watershed issues which cannot be done by farmers alone and with high ranks from most social groups (the problem of water provision). An integrated planning approach was used for fostering synergies between different system components (e.g. trees, crops, water, soil, livestock) to address the identified watershed issues. The major activities in planning were annual breakdowns of major activities including the costs involved, time line, detailed activities and expected outputs. Also, the responsible individuals and institutions were assigned for each activity. This plan was done with relevant stakeholders including farmers, research institutions, extension institutions and officials at different levels. The action plan was revised every year based on the result of monitoring and evaluation.

Implementation. Although there have been several activities implemented in the watershed, the focus in this paper is related to land management activities. Before implementing land management practices, several activities were employed to enhance farmers' awareness regarding land degradation and motivate them to invest in their land. *Firstly*, cross site visits were employed to create awareness about the existence and potential of alternatives to tackle soil erosion. *Secondly*, empirical research was used to demonstrate farmers the effects of soil erosion and the impact of land management practices in reducing soil erosion. *Thirdly*, practical trainings were provided to farmers on how to design soil bunds, prepare compost and techniques of tree planting. After awareness creation, several other co-investment activities were implemented, which details are discussed in Section 4. A community facilitator from the watershed (who speaks the local language Oromiffa) was employed to facilitate all these activities.

Monitoring and evaluation (M&E). This is a process in which co-investment activities were evaluated by different stakeholders at different levels every year, serving as such as a learning instrument. At the watershed level, M&E was done by farmers, a multidisciplinary team and other micro-level stakeholders. At this level, M&E was conducted during village meetings, community meetings and field days. At the national level, a large number of stakeholders participated at different levels using annual and biannual review meetings and workshops.

6.3 Methodology

6.3.1 Background of the study area

The Galessa watershed is situated in the Awash basin, in Dendi wereda (district), West Shewa zone of the Oromia region (Figure 6.1). The watershed has been seriously affected by water erosion and soil fertility depletion (German et al*.,* 2007) and farmers' investments in land management are limited (Adimassu et al., 2012c). The watershed covers 340 ha with 170 households. The watershed receives high annual rainfall (>1400mm) mainly concentrated in June, July and August (Adimassu *et al*. 2012b). The farming system is a typical mixed crop-livestock system that is carried out on a subsistence scale. The dominant crops grown in the area are barley (*Hordeum vulgare*) and potato (*Solanum tuberosum*). Livestock including cattle, sheep and equines are also an important part of the farming system.

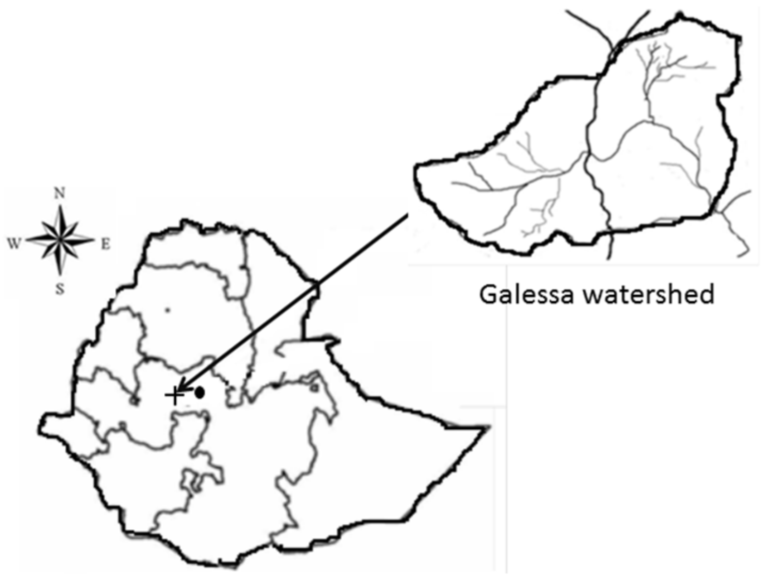

Figure 6.1. The location of Galessa watershed in the central Highlands of Ethiopia.0 = Addis Ababa

6.3.2 Data collection

Qualitative data collection methods were employed to generate information about the different co-investment activities employed for motivating farmers to invest in land management. Informal interviews were carried out with researchers, extension workers, administrators and farmers who have been involved in the initiative. In addition to informal interviews, several documents were reviewed related to the initiative.

A household survey was carried out to assess the impact of the co-investment initiative on farmers' investments in land management. Previous experiences show that both with-without or before-after comparison approaches can be used to assess the impact of such initiatives (Napier and Bridges, 2002; Copestake et al., 2001). In the with-without approach, data from participating farmers are compared with non-participating farmers at a given time after intervention. In the before-after approach a comparison can be made before and after the implementation of the initiative on the same sample of farmers. A proper before-after comparison depends on the baseline data from the time when the initiative is started.

In this case study baseline data were not available; hence, a with-without approach was used. For this purpose, thirty-seven households were randomly selected from the watershed residents who participated in the co-investment initiative (hereafter called the "experimental group"). The same number of households (n=37) were randomly selected outside the watershed who did not participate in the initiative (hereafter called the "control group"). A structured and pre-tested questionnaire was used to carry out the survey. Two surveys were conducted in different years. The first survey was conducted in February 2007 and the second in April 2011. The same questionnaire was used to interview the same respondents in both years.

This study considered the following land management investments: construction of soil bunds, application of animal manure, composting, use of inorganic fertilizers (Di-ammonium Phosphate or DAP and Urea), and tree planting. The total length of soil bunds (in meters) per household was calculated by summing-up the constructed lengths for all plots of a particular household based on information given by each farmer during the survey. Similarly, the quantity of animal manure, compost and inorganic fertilizers was obtained by asking the farmers the amount applied to each of their plots. The total amount of each measure (manure, compost or inorganic fertilizer) applied by a household was obtained by summing the amounts of these measures from each plot since a land holding consist of several plots. Again, the total number of trees and tree species per household were obtained by summing the number of trees and tree species for all plots of a household.

Table 6.2. Main characteristics of both experimental group and control group of respondents in 2007

Characteristics	Experimental group (n=37)	Control group (n=37)	Average	t	p
Male respondents	92	89	90.5	-	-
Age of respondent	42.8 (13.9)	40.0 (15.5)	41.4 (14.7)	1.14	0.256
Total family size	6.2 (2.1)	6.4 (2.7)	6.3 (2.4)	-0.34	0.733
EAFM	3.1 (1.3)	2.9 (1.3)	2.99 (1.3)	0.66	0.146
Land holding (ha)	2.1 (1.6)	1.9 (1.2)	2.0 (1.4)	0.57	0.568
Livestock (TLU)	4.6 (3.3)	5.3 (2.8)	4.9 (3.1)	1.44	0.151

The p-value is for an independent t-test between experimental and control groups of farmers. Values in the parentheses are standard deviations.

6.3.3 Data analysis

Statistics using SPSS was employed to analyse and summarize the data. Descriptive statistics such as percentage, mean, standard deviation and frequency were obtained using Crosstabs procedure in the SPSS. An independent t-test was used to compare land management investments carried out by experimental and control groups of farmers. In an independent t-test procedure, means of land management investments were compared between control and experimental groups of farmers. An independent t-test was also used to compare some major characteristics of households between these two groups of farmers. In the analysis, equal variances were assumed because the Levene's tests were greater than 0.05 for all land management investments considered.

6.3.4 Major characteristics of the sampled households

Table 6.2 presents the characteristics of the sample households of both experimental and control farmers. A majority of the household heads were male in both experimental (92%) and control (89%) groups. The average age of respondents in the experimental group was 43 years and that of control farmers was 40 years. The average family size was 6.2 and 6.4 for experimental and control groups, respectively.

Economically active family members (EAFM[3]) came out to be 3.1 and 2.9 for the experimental and the control group, respectively. The average land holding was 2.1 ha for the experimental group and 1.9 ha for the control group. Similarly, the average livestock holding was 4.6 TLU for the experimental group and 5.3 TLU for the control group. The t-test shows that there was no significant difference between the household characteristics of the experimental and the control group. This implies that both groups are homogenous in terms of most of their household characteristics, and that the use of a with-without comparison is appropriate.

6.4 Results and discussion

6.4.1 Co-investment activities

This section explains the most successful co-investment activities that were employed in the Galessa watershed to trigger farmers to invest in land management: co-investing in awareness creation, water provision, technology and governance.

Co-investing in awareness creation

For effective land management, it is very relevant that land users (farmers) are aware of the problem of land degradation, the importance of land management practices and how to implement these practices. Awareness creation can motivate farmers to control soil erosion and enhance their capacity to deal with the problem. In an effort to create awareness of farmers in the Galessa watershed, investments in awareness creation through cross-site visits, use of empirical research and practical trainings were carried out.

[3] EAFM (Economically active family member), the total number of family members whose age are ≥15 and <65 years

Two *cross-site visits* were undertaken for farmers (n=53) to create awareness and share experience with farmers in other parts of the country where land management investments are successful. There were visits to *Debresina* and *Ankober* (in the Amhara region) and to *Konso* (in the Southern Nations Nationalities and People region). These three weredas were chosen because they are well known in land management investments in Ethiopia and the impacts of land management practices are visible (Beshah, 2003). The excitement of farmers about the bench terraces in Konso was exemplified by this statement of one of the farmers: "*If I had not been to this place, I would not believe human beings can construct terraces across the whole wereda in such an artistic manner.*" In addition, farmers who participated in the cross-site visits shared their experiences to the watershed communities during reflection meetings that were organized in the watershed. These visits and reflection meetings stimulated farmers' interest and had also a profound impact on farmers' awareness of what is possible regarding land management. Financial expenditure for these cross-site visits was covered by HARC and AHI, while the Dendi wereda extension office facilitated the visits. HARC researchers, Dendi wereda extension experts and development agents organized reflection and feedback meetings in the watershed.

Empirical research can also facilitate attitude change by making biophysical processes (such as soil and water losses) visible to farmers (Adimassu et al., 2007). In this regard, a comparative experiment conducted in the Galessa watershed on plots with and without soil bunds demonstrated farmers what is lost from their fields and what is retained as a result of soil bunds (Figure 6.2). The colour of runoff and the sediment accumulated behind the soil bund were used to convince farmers that soil bunds are important to reduce soil erosion in the area. This co-investment activity is like "*killing two birds with one stone*" because the empirical research generates basic information (e.g. soil, water and nutrient losses) and, at the same time, it enhances farmers' awareness regarding soil erosion and the role of measures such as soil bunds. Since this is an empirical experiment, finance and knowledge came from HARC and AHI. The willingness of farmers to conduct this experiment for three years on their land was crucial.

Finally, *practical trainings* were provided for interested farmers (in a voluntary way) regarding design and construction of soil bunds, preparation of compost and techniques of tree planting at different times. These trainings were given by researchers from HARC and extension workers from the Dendi wereda. This is an investment mainly in the form of knowledge and technology.

Figure 6.2. Farmers observing and discussing with a researcher what is lost from their field due to water erosion and what is retained as a result of soil bund in Galessa watershed, Ethiopia.

Figure 6.3. A spring before protection (a) and after protection (b) in the Galessa watershed (Lege-abatibo spring), Ethiopia.

Co-investing in water provision

Provision of drinking water, defined as the quantity of water needed for continued survival of farmers and comprising a minimum requirement of water for their domestic and livestock use (Streeten and Burki, 1978), was identified as the main priority of the community during problem prioritization in the Galessa watershed (Ayele et al., 2007; German and Taye, 2008). Satisfying this basic need, by reclaiming and protecting watering points in the watershed, became the first priority for collective investments. Research institutions, governmental institutions, the watershed communities and adjoining kebeles came together to find solutions for the declining quantity and quality of water in the area. Three watering points (springs) were selected for reclamation and protection; given the high costs involved, co-investments were crucial to execute this activity. Farmers contributed local resources such as stones, sand and labour. The design and construction of cemented structures on watering points were done by the zone and wereda extension (mainly department of rural water development). HARC and AHI contributed financially to purchase cement and pipes. Accordingly, three springs were physically protected with cement structures (Figure 6.3). In addition to physical protection, springs were rehabilitated using construction of soil bunds in the catchment of these springs (mainly in the *Lege-abatibo* spring). This reduces on-site soil erosion and increases the recharge of springs through enhanced infiltration, and contributes to having better quality drinking water. These soil bunds were constructed by farmer groups, without any incentive or retribution.

Given that this was all done collectively, the activity not only ensured access to safe and adequate drinking water, but also served as an entry point to build trust between the community and external actors (research and extension), and as a catalyst of community interests in other land management activities (Ayele et al., 2007; Amede et al., 2009).

Co-investing in technology

Several activities were carried out in the Galessa watershed concerning technology transfer. The most important activity that triggers farmers to invest in land management was the introduction of proven crop and livestock technologies in the watershed. The introduction of high-yielding varieties of crops was linked with land management technologies to ensure compatibility between what farmers need (better yield) and what land management is demanding. The introduction of high yielding varieties of crops, such as barley (*Hordeum vulgare*) and potato (*Solanum tuberosum*), with soil fertility management practices (composting) was used as a strategy to satisfy farmers' demand for food and to improve the fertility status of the soil. As a result, three high yielding varieties of barley (*Shegie, HB 42 and HB 1307*) and potato (*Budene, Gudene and Tolcha*) were introduced. Simultaneously, farmers were demonstrated about preparation and application techniques of compost by the researchers from HAR and the development agents.

Livestock is also a crucial livelihood component for farmers in the study area. However, the productivity of livestock, milk yield in particular, is generally very low (Gojjam et al., 2008). Therefore, the introduction of dairy cows to the farming system was one of the strategies to improve the productivity of livestock. Consequently, cross-breed (*Holstein-Friesian* with local *Borena* breed) dairy cows were introduced for their ability to produce more milk than the local cows. Since the price of these cross-breed dairy cows is costly, the cost was shared by the HARC (75%) and the benefiting farmers (25%). With the introduction of cross-breed cows, farmers have planted forage trees/shrubs particularly Tree Lucerne (Chamaecytisus palmensis) around their homestead (Adimassu et al., 2008) in order to link livestock production with tree/shrub planting. These two co-investment activities are also a means of satisfying farmers' basic-needs of food.

Co-investing in governance

Co-investments in governance in this initiative were made by all macro, meso and micro level officials from the participating institutions. They created the enabling context for the initiative activities and facilitated all co-investment activities. These co-investments in governance were of crucial importance. Next to these co-investments, there were also specific individuals at the lowest level who co-invested in governance. The *first* individual in the Galessa watershed was the *kebele administrator; a very influential person*. The experience in Galessa shows that it is difficult to mobilize communities without the active involvement of kebele administrators. In 2004, a community meeting was organized at Galessa watershed to discuss issues concerning the initiative. However, on that date, no farmer appeared in the meeting. Rather, another meeting was organized deliberately by the kebele administrator on the same date. Although the administrator was consulted about the objective of the initiative at the early stage, he was not happy about it. He felt that he could not benefit from the initiative since he was residing outside the watershed. Once this problem was recognised, it was found that his inclusion as member of the watershed community is crucial regardless of his location of residence. Hence, he became involved in all watershed activities and benefited from the initiative by participating in trainings and cross-site visits. The administrator played a major role in the facilitation of the co-investment process over years.

The *second* individuals in the watershed were the *Gere-missomas* leaders. *Gere-missoma* (in *Oromiffa* language) or *Mengistawi budin* (in *Amharic* language) is informal and the lowest administration unit for each village (*mender*). The Galessa watershed has four *Gere-missomas*, and they played a crucial role in community mobilization. These two examples suggest the need for inclusion of most influential individuals for the success of land management activities.

6.4.2 The impact of co-investment activities on land management

This section describes the impact of the co-investment activities on land management; particularly the investments that farmers make to improve or sustainably manage their land (i.e. their land management investments). Measureable indicators are crucial for assessing the impact of land management projects (Conley and Moote, 2003). In this research, the proportion of households and the quantity of each land management investment made by a household are used as measureable indicators. Major land management investments considered in this study are grouped in to three categories: (i) investments to control water erosion, (ii) investments to control soil fertility depletion, and (iii) tree planting. The general hypothesis in this study was that *farmers who are involved in the co-investment initiative will have higher land management investments than farmers that are not involved.* In order to test this hypothesis, land management investments were compared between the experimental and control group of farmers.

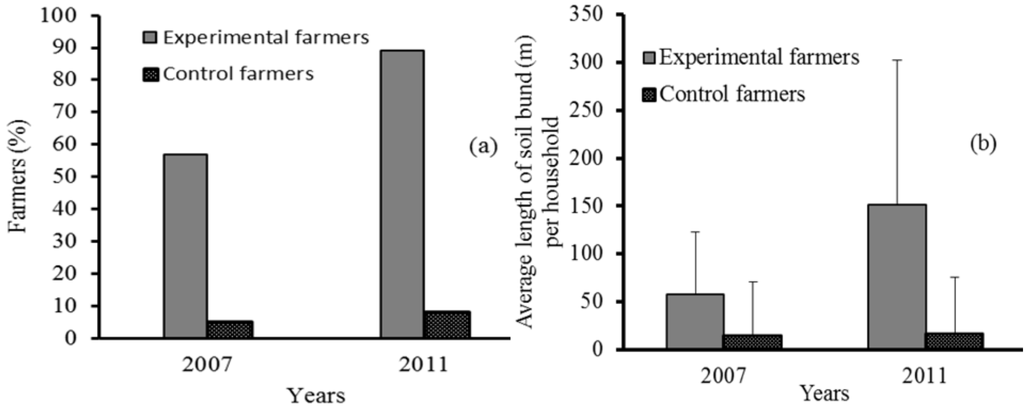

Figure 6.4. Percentage of households who constructed soil bunds (a) and average length of soil bund per household constructed by experimental and control groups of farmers (b) in Galessa, Ethiopia.

Investments in water erosion control measures

Soil bunds are the main water erosion control measure in the Galessa watershed (Adimassu et al., 2012c). Figure 6.4a presents the proportion of households who constructed soil bunds while figure 6.4b presents the average length of soil bunds per household. The proportion of households who constructed soil bunds in 2007 was 57% (n=21) in the experimental and 5% (n=2) for the control group (Figure 6.4a). This increased in 2011 to 89% (n=33) for the experimental and 8% (n=3) for the control group. Similarly, the average length of soil bunds per household was 57 m for the experimental and 13 m for the control group in 2007. In 2011, the average length of soil bunds was 155 m for the experimental group and 15 m for the control group. Both the proportion of households and the average length of soil bunds in 2011 were cumulative values (including the result in 2007). The independent t-test shows that the average length of soil bunds constructed by the experimental groups of farmers was higher ($p = 0.001$) than the control farmers in both years (Figure 6.4b).

Concerning the trend of investments over years between these groups of farmers, between 2007 and 2011 the percentage of farmers constructing soil bunds in the experimental group increased by 32%, while this was only 3% for the control group of farmers. Similarly, the average length of soil bunds constructed by the experimental group increased by 93 m while that of the control group by 2 m. The t-test shows that the average length of soil bunds for the experimental group of farmers in 2011 was significantly higher ($p = 0.001$) than in 2007. However, the t-test does not show any significant differences ($p=0.871$) between mean length of soil bunds in 2007 (13 m) and in 2011 (15 m) for the control group of farmers.

In general, the study shows that the co-investment initiative positively influenced farmers to construct soil bunds on their plots. All the above results are in line with the hypothesis that farmers' involved in the initiative have a higher rate of investments in land management (in this case in soil bunds) than farmers who were not involved.

Investments in fertility control measures

Investments in fertility control measures include application of compost, animal manure and inorganic fertilizer (Urea and DAP). Table 6.3 shows proportions of households (%) who applied fertility control measures in 2007 and 2011. In 2007, less than half of the experimental group of farmers (46%) and 19% of the control group applied compost in at least one of their plots. In 2011, this proportion increased to respectively 73% and 35%. Similarly, in 2007, the average quantity of compost applied per household by the experimental group was 513 kg while that of the control group was 101 kg. In 2011, it was respectively 1261 kg and 355 kg. The t-test shows that average quantity of compost applied by the experimental group was higher than the control group in both 2007 ($p = 0.03$) and 2011 ($p = 0.01$). For both experimental and control groups of farmers, the application of compost by both experimental and control groups of farmers increased over years. This indicates a positive spill-over effect of the co-investment initiative beyond the watershed.

Table 6.3. Investments in soil fertility control measures made by experimental group (EG) and control group (CG) of farmers in Galessa area, Ethiopia

Investments in fertility control practices	2007			2011		
	EG	CG	p	EG	CG	p
Compost (household, %)	46	19		73	35	
Compost (kg household^{-1})	*513 (492)*	*101 (170)*	***0.003***	*1261 (907)*	*355(428)*	***0.001***
Manure (household, %)	46	37.8		51.4	51.9	
Manure (kg household^{-1})	240 (203)	225 (229)	0.852	237 (178)	243 (213)	0.906
Inorganic fertilizer (household, %)	89.2	73		78.4	81.1	
Inorganic fertilizer (kg household^{-1})	8.9 (6.0)	8.8 (11.5)	0.95	8.3 (6.8)	11.5 (13.1)	0.195

The value of 'p' is for an independent t-test. Both number of trees and species in 2011 are cumulative values from 2007. Values in the parentheses are standard deviations.

The result for application of animal manure shows that 46% of the experimental group of farmers and 37% of the control group of farmers applied this in 2007, while in 2011 a nearly equal proportion of both groups (51%) applied animal manure. The average quantity of animal manure applied by the experimental group was 240 kg while that of the control group was 225 kg in 2007. The independent t-test does not show any significant difference regarding the quantity of animal manure applied by both groups in both years. This minor difference is due to the fact that the application of animal manure is a traditional soil fertility control practice and does not require additional knowledge in the study area.

Concerning the application of inorganic fertilizers (DAP and Urea), the study found a proportion of 89% for the experimental group and 73% for the control group in 2007. In 2011 there was a slight decline in the experimental group (78%) and a slight increase in the control group (81%). An explanation for this is that the experimental group increased the application of compost at the expense of inorganic fertilizers (shown by the increase of compost use). The amount of inorganic fertilizer applied is very low in the study area, with an average of nearly 9 kg per household in 2007 (and 8-11 kg in 2011).

Investments in tree planting

In the Galessa watershed, like in other parts of Ethiopia, farmers are heavily dependent on trees as source for fuel wood, construction and income (German et al., 2006; Taddese, 2001). Lack of trees and loss of indigenous tree species were identified as the major problem in the study area (German et al., 2008). Limited access to appropriate tree seedlings and free grazing are considered as the main bottleneck for household tree planting in Ethiopia (German et al., 2006; Kidane et al., 2008). As a result, promoting tree planting in the watershed was one of the main activities of the initiative in Galessa. In order to solve the shortage of tree seedlings, farmers established two community nurseries in 2004 with appropriate tree species (Kidane et al., 2008). These seedlings were equally available for all farmers in the watershed.

Figure 6.5 shows the average number of trees and the number of species planted per household in 2007 and 2011. In 2007, the average *number of trees* per household was 369 for the experimental and 197 for the control group. The number of trees increased in 2011 to respectively 440 and 285. Nevertheless, the t-test does not show significant differences between both groups for the years 2007 (p = 0.150) and 2011 (p = 0.300). Concerning the *number of tree species*, in 2007 the experimental group had an average of 1.8 tree species as compared to 1 for the control group. In 2011 this was respectively 2.7 and 1.7. The independent t-test shows that the experimental group of farmers had a higher number of species in both 2007 (p = 0.007) and 2011 (p = 0.003) than the control group of farmers (Figure 6.5b). This suggests that involvement of farmers in the initiative promotes diversification of tree species. The increase in the number of tree species by the control group also shows that there is a spill-over effect to non-involved farmers outside the watershed, especially through social networks and communicating the (apparently) positive experiences.

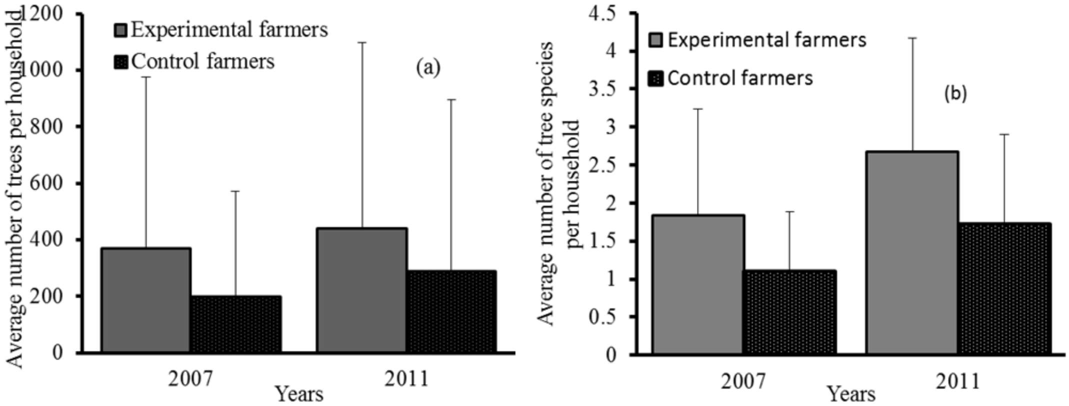

Figure 6.5. Investments in tree planting by experimental group of farmers and control group of farmers at Galessa watershed, Ethiopia. The values in 2011 are cumulative values from 2007.

Nevertheless, all farmers only plant trees directly around their homesteads, leaving the outfields underutilized due to the on-going free grazing of livestock and open access during the dry period (Adimassu and Haile, 2011; Yami et al., 2011; Adimassu et al., 2012c). This supports the need for a new land use policy that restricts free grazing and encourages tree planting in the outfield.

In summary, the results reveal that the involvement of farmers in the co-investment initiative increases their investments in land management. Of the selected land management practices, the experimental group of farmers invest more in soil bunds and compost than the control groups of farmers. In addition, the experimental group of farmers possess more tree species than the control group.

6.5 Conclusion and recommendations

This study documented successful co-investment activities in the Galessa watershed in Ethiopia, and it assessed the impact of these on farmers' investments in land management. We conclude that co-investments in awareness creation, water provision, technology and governance are successful in triggering farmers to invest in land management. Although this case study is located in the central highlands of Ethiopia and conducted in only one watershed, these co-investments can be applicable also in the other parts of the country, such as in the CRV. This is because Galessa and most part of the CRV are located in the Oromia region with the same administration and similar socio-economic setting. The results revealed that farmers involved in the co-investment initiative invested more in land management than others, which supports the idea that a co-investment initiative works and has a positive impact on farmers' investments in land management. Such initiatives should therefore be undertaken in other parts of Ethiopia as well.

However, in order to upscale the experience from the Galessa watershed to other parts of Ethiopia, four important requirements should be fulfilled. Firstly, it is important for all stakeholders to recognize that an *integrated approach* is fundamental for effective land management. Given the complexity of land management and farmers' financial constraints, overcoming the problems of piecemeal initiatives and adopting an integrated rural development approach is of paramount important. Innovative co-investments which address livelihood improvements while fostering sustainable land management are therefore crucial. Secondly, given the holistic approach and the variety of co-investment activities to be excuted, *a strong catalyst agency* that initiates and coordinates the overall co-investment process is crucial for the success of such an initiative. This case study shows that HARC played this catalysing and coordinating role in Galessa quite well. Thirdly, *investing in top priorities* of farmers and addressing basic needs of beneficiaries (such as water needs and increasing agricultural productivity) is necessary. Such type of investments also build trust between the community and external actors and catalyses community interests in other land management activities. Fourthly, *financial support* outside the farming community is crucial for sustainable land management (Stroosnijder, 2012). There is currently a large gap between the actual and required level of financial expenditure on land management in sub-Saharan Africa (UNCCD and FAO, 2009). In Ethiopia, the national government and regional states must be committed to allocate more financial resource to land management, to be mobilized from external donors and amalgamated with national and regional budgets allotted for land management.

Furthermore, the study successfully examined role of local administration in mobilizing farmers and facilitating co-investments in the watershed. This study revealed that co-investments in land management cannot be successful without the willingness of the local level public administration and it indicated that working with lower level officials is a precondition for success.

Finally, it is important to note that this study did not include analysis of land productivity and livelihood impacts resulting from land management practices. Most land management practices, such as soil bunds, will take a relatively long time before generating an impact on land productivity and livelihoods. This warrants the importance of further research to evaluate the impact of land management practices on land productivity and livelihood improvement in the Galessa watershed.

Chapter 7

Synthesis

Synthesis

7.1 Problem, main aim and objectives

This last chapter synthesizes the major findings of the previous chapters and reflects on the objectives of the research. It also suggests major extension and policy implications of this study, as well as recommendations for further research.

Given that agriculture is the backbone of the Ethiopian economy, investments to reduce land degradation and improve soil productivity are imperative. Nevertheless, the success of efforts made by Governmental and Non-Governmental Organizations to mitigate land degradation and improve soil productivity has been very limited. Most mentioned causes are the lack of collaboration among the stakeholders involved (Mowo et al., 2010; Admassie, 2000) and insufficient investments in land management by farmers themselves due to various socio-economic and biophysical constraints (Adimassu et al., 2012a; Requier-Desjardins et al., 2011; Kessler, 2006). This calls for joint efforts of farmers and institutions in order to foster sustainable land management in Ethiopia. Such joint efforts, in which farmers and other stakeholders collaborate and invest their share in land management, are called 'co-investments,' i.e. investments in the form of material, finance, labor, knowledge, technology or governance (Chapter 5). The overall aim of this research was to explore the potential of such co-investments for fostering sustainable land management and increase soil productivity in the Central Rift Valley (CRV) of Ethiopia. The specific objectives were:

1. Understand farmers' strategies to their perceived trends of crop productivity and rainfall in the CRV of Ethiopia (Chapter 2);
2. Assess farmers' investments in land management in the CRV of Ethiopia (Chapter 3);
3. Explore the key factors affecting farmers' investments in land management in the CRV of Ethiopia (Chapter 4);
4. Explore the bottlenecks and requirements of co-investments in land management by multilevel public organizations and the private sector (Chapter 5);
5. Analyze experiences with multi-level collaboration and draw conclusions concerning the prospects for co-investments in land management (Chapter 6).

In this synthesis chapter, the above five objectives are discussed in the following three sections. The first objective is discussed in section 7.2, the second two objectives (objective 2 and 3) are discussed in section 7.3, and the last two objectives (objectives 4 and 5) are discussed in section 7.4.

7.2 Farmers' strategies to their perceived trends of crop productivity and rainfall

The initial intention of this PhD research was to deal solely with land degradation and investments in land management in the CRV of Ethiopia. During the preliminary informal survey, however, farmers mentioned frequently "a decrease in crop productivity over the last decades is due to a decline in rainfall". We then realized that it was of foremost importance to focus first on understanding farmers' perceptions of rainfall and crop productivity, as well as farmers' strategies resulting from these perceptions. Therefore, the first objective (Chapter 2) analyzed historical crop productivity and rainfall data for the CRV, and compared these with farmers' perceptions. Farmers in the CRV experience regular and increased food shortage, which in their perception is caused by a decrease in crop productivity as a result of decreased rainfall. Previous research also shows that farmers believe that annual rainfall amount (Bryan et al., 2009; Amsalu et al., 2007) and crop productivity (Garedew et al., 2009; Amsalu and De Graaff, 2006) declined over years in different parts of the country. However, results from the analysis of historical crop yield and rainfall data show that neither crop productivity nor rainfall amount has decreased in the area (Chapter 2). Similar results are found elsewhere in Ethiopia, with annual rainfall and crop productivity not showing a decrease for the last two decades (De Graaff et al., 2011; Tilahun, 2006). This implies that farmers' perceptions concerning these factors are not confirmed by actual data. According to our study, farmers' perceptions of decreased rainfall and crop productivity are rather the result of two other rural realities: 1) the increased demand to grow more crops to feed the rapidly growing population (Meshesha et al., 2012), and 2) land degradation leading to lower moisture availability and soil fertility depletion for plant growth (Falkenmark, 2009; Slegers and Stroosnijder, 2008).

In order to cope with and adapt to the perceived trends of crop productivity and rainfall, farmers apply several coping and adaptation strategies in the CRV of Ethiopia (Table 2.4 and 2.5). The most important coping strategies are selling livestock, migration, and accessing relief programs. Main adaptation strategies include expansions of Enset (*Ensete ventricosum*), Chat (*Catha edulis*) and Eucalyptus (*Eucalyptus* species) plantations. Nevertheless, none of these strategies are focusing on reducing land degradation and improving the availability of soil moisture for plant growth. This leads us to the question of how much farmers actually invest in land management and what determines their decisions (section 7.3).

7.3 Farmers' investments in land management

Before assessing farmers' investments in land management, it is important to understand if and when farmers perceive land degradation as a problem (Chapter 3). This is pertinent because farmers start investing in land management only if they perceive land degradation as a problem (Desbiez et al., 2004). The results in Chapter 3 show that a majority of the farmers in the CRV are well aware regarding land degradation, particularly soil erosion by water and soil fertility depletion. This awareness of farmers is consistent with other findings elsewhere in Ethiopia (Amsalu and Graaff, 2006; Eyasu, 1998) and is also supported by empirical findings (Moges and Holden, 2008; Haileselassie et al., 2005).

Nevertheless, farmers' investments in land management are notoriously low in the CRV (Chapter 3). For example, 38% of the farmers actually invested an average of only 30 ETB (≈1.8 US$) $ha^{-1}\,y^{-1}$ to control soil erosion in the study area. Furthermore, farmers' awareness of both water erosion and soil fertility decline as a problem is not associated with their investments in land management. Following this result, another research question emanated: what other factors determine farmers' investments in land management? This question leads to objective 3 (Chapter 4) of this thesis that explored the determinants of farmers' investments in land management. Based on Explanatory Factor Analysis, the results revealed that there are several household and plot level factors that determine farmers' investments in land management.

Household level factors affect farmers' decisions *how much* to invest, whereas plot level factors determine *where* to invest. From the household level factors, five factors resulted most determent for the decision how much to invest in land: resources endowments, access to information, social capital, availability of labor, and experience and knowledge. For all these factors counts that the more a farmer has of each of them, the more this farmer will invest in land management (Table 4.6). Similarly, farmers' choice *where* to invest in land management is influenced by the vulnerability of agricultural plots to water erosion, their soil fertility condition, and their accessibility and size. The study revealed that farmers are more willing to invest in plots that are vulnerable to water erosion, better accessible and larger in size (Table 4.8). Previous studies also found that farmers invest more in plots which are vulnerable to soil erosion (Amsalu and De Graaff, 2007; Asrat et al., 2004; Bekele and Drake, 2003), better accessible (Pender and Gebremedhin, 2007; Pender et al., 2004; Gebremedhin and Swinton, 2003) and larger in size (Gebremedhin and Swinton, 2003). The result also revealed that farmers invested more on fertile plots than infertile plots mainly due to the fact that the expected return of investment is higher in fertile plots and hence farmers invest more in order to maximize crop production. This finding is in line with earlier findings where farmers invest more in fertile plots than infertile ones in Eastern (Bekele and Drake, 2003) and Central (Amsalu and De Graaff, 2007) Ethiopia.

Despite these general insights from Chapter 4, the results also clearly show that factors affecting farmers' investments in land management vary greatly within the CRV. There is thus a clear need for site specific land management strategies in Ethiopia. Such site specific strategies should also take serious account of the fact that farmers prefer to invest in short-term coping strategies rather than in long-term land management practices.

Studies confirm that physical land management structures are often not economically attractive in the short term: e.g. soil and stone bunds reduce the effective cultivable area and introduce a yield reduction at least in the first three years (Adimassu et al., 2012c; Hengsdijk et al., 2005; Shiferaw and Holden, 2001). The combined effect of the reduction in effective area planted and the high initial investment cost (mostly labor) imply that returns to physical land management measures may be negative, especially in the first few years.

7.4 The potential of co-investments in land management

This section highlights the potential of co-investments in land management (objective 4 and 5). As defined earlier, co-investments in land management are collaborative investments in land improvement by farmers, public institutions and the private sector in different forms, such as material, finance, labor, knowledge, technology or governance (Chapter 5). In order to explore the potential of co-investments in land management, two separate studies were conducted. The first study (Chapter 5) explored the potential for co-investments in land management in the CRV of Ethiopia by investigating the bottlenecks that limit public and private sectors to support farmers, as well as their requirements to start co-investing themselves. The second study (Chapter 6) was based on a case study in the Galessa watershed and its main focus was to document the most successful co-investment activities that motivate and trigger farmers to invest in land management. It also assessed the impact of co-investments on farmers' investments in land management.

The results show that both public institutions and the private sector face several bottlenecks and requirements related to co-investments in land management (Chapter 5). For the public institutions, most of the these bottlenecks and requirements are related to governance issues, while these for the private sector are more linked to economic issues. Table 7.1 presents relations between bottlenecks on the one site and requirements on the other site. It shows that for the public sector particularly capacity building (CB), accountability (AC), policy support (PS) and good leadership (GL) are the most required and urgent actions to tackle the identified bottlenecks and as such promote co-investments in land management.

The result of a case study of a co-investment initiative in the Galessa watershed (Chapter 6) shows that there are several effective co-investment activities that trigger farmers to invest in land management. The most important activities include co-investing in awareness creation, provision of water, technology and good governance. The successes of these co-investment activities are confirmed by their impact on farmers' investments in land management. The result revealed that farmers who are involved in this co-investment initiative invested more in land management than the ones who were not involved (Chapter 6). This experience implies that although public and private sectors require several preconditions to improve co-investments, there is considerable potential for co-investments in land management in Ethiopia.

Table 7.1. Key bottlenecks for co-investments in land management of both public and private sectors and requirements to improve co-investments in Ethiopia.

Bottlenecks of co-investments (public sector)	Requirements for co-investments (public institutions)								
	CB	CU	WA	CO	AC	SO	ID	PS	GL
Lack of knowledge concerning co-investments in SLM	*	*							
Lack of accountability on achievements in SLM			*		*				
Frequent organizational restructuring						*			
Use of top-down approach by the Government								*	*
Lack of commitment at all institutional levels				*	*				
Lack of good leadership	*				*				*
Existence of different mandates			*				*	*	
Staff turnover	*							*	*
Total count	3	1	2	1	3	1	1	3	3

Bottlenecks of co-investments (private sector)	Requirements for co-investments (public sector)			
	BS	TT	WA	CO
Lack of initiative by government institutions				*
Lack of transparent taxation system		*		
Lack of collateral for farmers			*	*
Low profit	*		*	
Total count	1	1	2	2

__Note:__ CB= Capacity building, CU= Common understanding about co-investments in SLM, WA=Written agreements, CO=Commitment, AC=Accountability, SO=Stable organizational structure, ID=Interdependencies among institutions, PS=Policy support, GL=Good leadership, BS=Benefit sharing, TT=Transparent taxation.

7.5 Co-investments in farmers' key priorities and asset accumulation

Multidimensional factors affect farmers' investments in land management (section 7.3). The experiences in the Galessa watershed confirm that farmers must be supported by other stakeholders who are willing and able to co-invest in land management. Although there are numerous options for specific co-investments related to sustainable land management, this study concludes that there are two categories that are most important: 1) co-investments in farmers' top priorities and 2) co-investments in farmers' asset accumulation. In both categories, co-investment activities are generally quite costly (hence farmers cannot invest alone in these activities) and have a very high motivating potential (as such triggering farmers to invest in land management after completion of the activity).

7.5.1 Co-investment in farmers' top priorities

Several researchers identified that the top priorities of smallholder farmers in Sub-Saharan Africa are related to households' basic needs, such as lack of drinking water, food shortage and human disease (e.g**.** Eenhoorn and Beck, 2009; German and Taye, 2008; Amede et al., 2007; Baro and Deubel, 2006). Maslow (1970) suggests that all human beings have five needs that can be arranged by hierarchy. The five levels of the hierarchy of needs are: (i) biological and physiological needs (e.g. food, water, energy, shelter), (ii) safety needs (e.g. security, stability and prevention of from aggression), (iii) belongingness and love needs (e.g. family, affection, relationship), (iv) esteem needs (e.g. responsibility, reputation, respect), and (v) self-actualization needs (e.g. realizing personal potential, self-fulfillment, seeking personal growth).

This concept of hierarchy of needs is useful to understand why farmers or farmer groups are not investing in long-term investments in land management. For example, Pieri (1997**)** adapted the concept of hierarchy of needs to the concept of decision making in sustainable land management. The key point made by Pieri (1997) is that any individual, or human group, can only move to a higher level (e.g. environmental concerns) when they have satisfied their basic needs (food, water, shelter). It is therefore not logical to talk about investments in land management to a farmer who has not fulfilled these basic needs. This indicates that investments in satisfying basic needs are a precondition for investing in land management. The case study in Galessa watershed supports the idea that farmers can be motivated through co-investments in satisfying their top priorities (need for drinking water). Nevertheless, most of the activities that satisfy farmers' basic needs are very costly and cannot be executed by farmers alone. This underlines the necessity of co-investments by other stakeholders. The co-investment in three springs in the Galessa watershed ensures access to adequate water supply for the community, builds trust between the community and external actors (research and extension), and catalyzes community interests in other land management activities (Amede et al., 2009; Ayele et al., 2007).

7.5.2 Co-investments in farmers' asset accumulation

One of the key factors that affect farmers' decisions how much to invest in land management is the households' resource endowment, mainly land and livestock holding. This study shows that farmers who have more livestock invest more in land management (Chapter 4). This factor is directly related to the farmers' financial capacity to make investments in land management, given that livestock is the main source of cash for farmers in the CRV. Moreover, livestock plays a crucial role in short-term coping strategies during abrupt food shortage for most households in the Central Rift Valley of Ethiopia (Chapter 2).

Livestock is the most important asset for most households in Ethiopia, both as a source of savings and as a source of draft power (in the case of cattle). Although Ethiopia is well known in Africa by its large livestock population (Solomon et al., 2003), the productivity of livestock is very low and susceptible to drought and disease (Desta and Coppock, 2002). Like the other parts of the country, grazing land in the CRV is subject to increased degradation, and there is a high mortality of livestock due to limited veterinary service (Biffa et al., 2007). Therefore, co-investments in technology generation, animal health, water, feed, marketing and value addition are crucial to improve the productivity of livestock in Ethiopia. Furthermore, co-investments are required to reduce the environmental problems related to livestock production, such as land degradation (due to over grazing) and greenhouse gas emission.

7.6 Towards co-investments in land management

Based on the previous chapters, this section highlights the plea for a new approach: fostering co-investments in land management. In recent years, there has been a growing consensus that promoting integrated approaches is an effective way for sustainable land management and rural development in general (Biswas et al., 2012; Qi and Altinakar, 2011; Kessler, 2007). Although the integrated approach is effective, it cannot be realized by smallholder farmers alone, given the severe shortage of financial resources (Stroosnijder, 2012; Kessler, 2007).

Of all the identified factors, farmers' lack of financial resources (liquefiable assets, such as livestock) is one of the most important factors that determine investments in land management (Chapter 4; Pender and Gebremedhin, 2007). Furthermore, initial investments in some land management practices (e.g. soil/stone bunds) require relatively heavy investment costs beyond the capacity of farmers (Shiferaw and Holden, 2001). Given farmers' resource limitations and high initial investment costs in land management, delivering tangible impact on land management by farmers is unlikely, unless more support is obtained from other relevant stakeholders.

In addition to farmers' own benefits, investments in land management provide public benefits also (Hajkowicz, 2009). These public benefits (or environmental services) include services such as provision of clean water, climate regulation, and maintaining biodiversity. Given that investments in land management by smallholder farmers contribute to these benefits, several questions can be raised: Who should pay for these public benefits? Why do only farmers pay the bill for land management practices that provide environmental services? So, is it fair to blame farmers for the low success of land management in Ethiopia? Given farmers' financial constraints to invest in land management and the contribution of farmers' investments for public benefits, it is logical that all stakeholders would co-invest in land management in Ethiopia.

Currently, there are several opportunities to promote co-investments in land management in Ethiopia. Firstly, sustainable land management is becoming a global concern and there is growing interest to finance such projects in Ethiopia (MoARD, 2011; World Bank, 2008). Secondly, there is increasing interest in developing payments for environmental services programs (beyond those that generate food and fiber) to encourage investments in agricultural lands for environmental services (Bohlen et al., 2009; Kosoy et al., 2008; World Bank, 2004). Thirdly, the lessons and experiences from Galessa watershed can be used as an opportunity to scale-out co-investments in land management in Ethiopia.

7.7 Further research recommendations

Chapter 6 provides a practical example regarding the prospects of co-investments in land management based on the case study in the Galessa watershed. Most physical land management measures, such as soil and stone bunds, take a relatively long-time for crop productivity and livelihood impacts (Bodnar, 2005). Moreover, assessing the impact of these practices on soil fertility improvement will take a long time span (Scanlon et al., 2005; Harbor, 1994). This all warrants the importance of further evaluation of the co-investment initiative in the Galessa watershed with reference to land productivity, livelihood improvement and soil fertility improvement.

Moreover, there are also concerns that the case study is mainly successful because it was led by research institutions with a relative advantage in financial and human resources. Some researchers argue that the result may be different if such a co-investment initiative is led by extension institutions. This emanates the research question of what will happen in that case? Fortunately, however, there are two initiatives (projects) under implementation that can be used for further research to answer this question. The first initiative is focusing on the out-scaling of best practices from the Galessa case study to two "baby" watersheds: *Borodo* watershed in Dendi wereda and *Mekentuta* watershed in Were-Jarso wereda (both in Oromiya Region in Ethiopia). In these two watersheds, unlike the Galessa experience, the coordination role is already given to the micro-level institutions, mainly to the wereda council and the extension service. The second initiative is related to a country wide SLM project in 35 weredas funded by the World Bank and GTZ (the Deutsche Gesellschaft für Technische Zusammenarbeit) (World Bank. 2008; MoARD, 2011). These weredas are found in the "potential areas" of the country and have been coordinated by the Ministry of Agriculture and Rural Development at the *micro* level (weredas).

The main opportunity for these two initiatives is to learn from the co-investment experiences in the Galessa watershed and apply the most successful lessons (Chapter 6).Moreover, given that these two initiatives have been coordinated by micro level institutions, it is an opportunity for researchers to test if the micro-level institutions (mainly extension) are capable and effective in implementing co-investment activities.

7.8 Limitations of the study

This section points out the limitations of this PhD research. Data for Chapters 2, 3 and 4 were generated using a survey of 240 randomly selected households, however, two-third of the sampled households (4 kebeles) was located in Meskan so as to capture both the cereal and enset based farming systems in Meskan. In AJK only the cereal based farming system was considered.

Chapter 2 explains farmers' coping and adaptation strategies to the ''decreasing'' trends of rainfall and crop productivity. The identification of coping strategies would probably have been richer if ethnographic data collection methods (e.g. participant observation) had been used to supplement the survey data for such type of study. The advantage of using an ethnographic method is to uncover farmers' hidden coping strategies during food shortage. However, such data collection techniques require living with the community for a long period of time (years) and furthermore that an actual food shortage occurs in order to observe coping strategies.

In Chapter 3, land degradation (soil erosion and nutrient depletion) and investments in land management were assessed from farmers' perspectives. Farmers' perception of land degradation as a problem and its severity would have been better assessed if alternative methods (e.g. measurements of soil erosion and nutrient depletion) had been used to estimate actual severity of land degradation. Similarly, the total investment made in land management practices by households were obtained by asking farmers how much they had invested for each plot in terms of soil/stone bunds, fertilizer and/or manure. Since most of households do not keep records of resources spent on different land management measures, it was difficult to gather reliable information on actual expenditure for different land management measures. Also, given the fact that farmers own several scattered plots, it was not possible to come up with the actual level of investment for each individual household using survey data.

Chapter 5 explores the potential of co-investments in land management by analyzing bottlenecks and requirements of public and private sectors. Various purposive sampling methods were used to select respondents from public and private sectors. Purposive sampling of 165 professionals was employed to identify bottlenecks and requirements of *public institutions* for co-investments in land management. In this chapter, purposive sampling technique was employed to capture experienced employees who have been working at least for three years in a given institute. This was due to the fact that newly recruited employees lack information in most of the issues in the questionnaire. However, respondents were not drawn randomly and study results may be biased. Moreover, in order to analyze bottlenecks and requirements of *private sector* stakeholders for co-investments in land management, 42 private sector partners were identified by using snowball sampling method. This method is useful for studying hard-to-reach populations (when the population is so widely dispersed that cluster sampling would be inefficient) that are not accessible through conventional methods. However, there is a possibility that due to the sample size (n=42) larger social networks will be oversampled and respondents in smaller social networks will not be identified and accessed. Validity and reliability are therefore more difficult to evaluate with this method, which might limit the generalization of the results to whole Ethiopia.

Furthermore, the research is limited to the Oromia and Southern Nations, Nationalities and People regions mainly due to time and logistic constraints. Other regions, especially Amhara and Tigray where land degradation is relatively serious and land management efforts are very active, were not included in the study. It is therefore not possible to extrapolate the results of this study to these two major regional states. Thus, it would be worthwhile to carry out a large-scale study in different regions in in Ethiopia order to get wider insights regarding the potential of co-investments in land management at national level.

7.9 Extension and policy recommendations

The findings of this research and previous literature (e.g. Amsalu and De Graaff, 2007; Shiferaw and Holden, 2000) show that the factors affecting farmers' investments in land management are site specific and highly diverse. The current land management strategy in Ethiopia however, is a blueprint (one-size fits all) approach, and does not take into account this diversity. Land management strategies designed at macro level should be adapted to the local circumstances in the specific areas, based on their local situation. This implies that wereda level experts and kebele level development agents should be trained and empowered to plan and implement land management at local level - under macro strategic frameworks.

The result of this study confirmed that implementing land management alone cannot be effective without being firmly integrated into farmers' livelihoods; particularly investing in farmers' basic needs (e.g. drinking water) and diversifying their income is crucial for triggering (later) investments in sustainable land management. Similarly, investments in asset accumulation activities are crucial as confirmed by this study as well as others in Northern Ethiopia (Riley et al., 2009). Hence, integrating rural development strategies with land management activities is fundamental. However, for this to happen, a strong and supportive policy that links all stakeholders to collaborate in integrated rural development is crucial. Furthermore, institutional and human resource capacity is vital for these stakeholders to plan and implement integrated rural development activities.

Several authors argue that there is weak human resources capacity to plan and execute agricultural development activities at different levels in Ethiopia (e.g. Gebremedhin and Swinton, 2003; Shiferaw and Holden, 2000). In particular, the shortage of skilled professionals in research and development institutions has been frequently mentioned as one of the reasons for the limited success of agricultural development in Ethiopia (Chapter 5; Tettey, 2006). Shortage of professionals has resulted from low educational attainment, and brain-drain due to low salary and political persecution (Semela, 2011; Papadopoulos et al., 2004). In addition to this shortage, professionals who are working in research and extension institution at different levels are often not effective to bring change in rural development in general and in SLM in particular. Three major reasons have been mentioned as the root causes for the limited developmental impact of professionals. *Firstly*, there is lack of collaboration between policy makers and professionals in Ethiopia mainly due to divergent political views (Fransen and Kuschminder, 2009; Zeleza, 2004). *Secondly*, development strategies are top-down and professional advice and consultation are neglected (Bati, 2009). *Thirdly*, dissatisfaction with salaries and lack of a conducive working environment undermine the commitment of professionals to their organizations and careers.

Without the active involvement of professionals at all levels, achieving sustainable results in land management and rural development remains difficult. Therefore, first of all, professionals and policy makers must be committed to work together towards common goals. Ensuring a favorable institutional environment that fosters shared organizational values and a sense of ownership among its professionals can motivate professionals to be committed to perform needed tasks and work collaboratively. Moreover, there should be a continuous capacity building strategy to strengthen the skilled man power of the country.

Agriculture is the main economic base of the Ethiopian population **(**CSA, 2010; Shiferaw and Holden, 1998; 2001). The statement "Agriculture is the mainstay of the Ethiopian economy" has almost become a formula for professionals in Ethiopia. Those who went to school 50 years ago, read it; and later on wrote about it. So has the present generation. As things stand, our children and grandchildren will be repeating this for generations to come. Yet, the sector has been unable to realize its potential and contribute significantly to economic development. Therefore, besides improving agricultural productivity, there is an urgent need for policy-led interventions that create jobs outside the agricultural sector. These include provision of credit to initiate non-farm activities, skill training for non-agricultural employment and focusing on small-scale industries that absorb labor.

Furthermore, attention should be given to the Ethiopian land policy and the current large-scale investments in land as a development strategy. In Ethiopia, land has been under the control of state since 1974 (Rahmato, 1994; Yigremew, 1999). Several researchers (e.g. Rahmato, 1994; Yigremew, 1999; Admassie, 2000; Gebremedhin and Swinton, 2003; Asrat et al., 2004; Deininger and Jin, 2006) confirm that this state ownership of land has been a source of insecurity for farmers and has made them hesitant to invest in long-term land management practices. As a matter of fact, foreign investors have increasingly become interested in acquiring land in Ethiopia, and more than 3.5 million hectares of land has already been transferred to these investors (Rahmato, 2011; Human Rights Watch, 2012). The Government of Ethiopia claims that these land transfers are a means of addressing the food crisis, creating employment, transferring technology, developing infrastructure and earning foreign exchange (Lavers, 2012; Stebek, 2011). Nevertheless, these expectations are rarely met (Lavers, 2012; Human Rights Watch, 2012; Deininger et al., 2011; Rahmato, 2011; Stebek, 2011). Furthermore, authors criticize that such investments in land are unsustainable, and that they over-exploit, degrade and deplete resources needed for future generations and the ecosystem at large (Rahmato, 2011; Stebek, 2011; Human Rights Watch, 2012). Re-thinking these new investments in land in Ethiopia is definitely needed, and the co-investment lessons from this PhD study offer a very useful alternative. More than enough money is available to be invested in land, but in order to attain the expected outcomes of these investments, it is crucial to establish co-investment agreements that clarify benefit-sharing, as well as the rights and responsibilities of relevant stakeholders (local groups, the Government, investors, etc.). Moreover, instead of focusing only on large-scale farms, these investors should co-invest with smallholder farmers on degraded lands. This would entail commitment of the government to bring about radical changes in their land policy and the willingness of these investors to co-invest with smallholder farmers.

The final recommendation focuses on the central theme of this thesis: co-investments in land management and their potential applicability in Ethiopia. This study spells out this can only be realized when all stakeholders and the government at large are convinced and committed towards the concept of co-investments. Currently however there is a mismatch between macro-level institutions (policy makers) and micro level institutions in Ethiopia regarding the requirements for co-investments in Ethiopia. Although scientific publications have significant effect to communicate the research findings, policy makers and the public at large may not access the research findings, and publications may not be appropriate due to academic jargons. Therefore, national dialogues should be organized for debating how to narrow the current macro-micro gap; as a very first step towards co-investments and more sustainable impact.

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Summary

Like in any other part of the country, land degradation resulting from water erosion and nutrient depletion is one of the most challenging problems for farmers in the Central Rift Valley (CRV) of Ethiopia. Nevertheless, investments in land management to reduce land degradation and increase agricultural production by smallholder farmers have been limited. In addition, public and private sector organizations have never collaborated to stimulate (investments in) land improvement. This study focuses on co-investments, which are conceived as the collaboration of different stakeholders in land management in the form of material, labour, finance, technology, knowledge and governance. The overall aim of this study was to explore the potential of co-investments to foster land management and increase land productivity in the CRV of Ethiopia.

Chapter 2 presents ***farmers' perceptions of crop productivity*** and their strategies to cope with perceived changes in the CRV of |Ethiopia. It reveals that farmers perceive a decrease in crop productivity and food production over the last decades and that they blame a decline in rainfall for this. As a consequence, farmers apply different strategies to cope with, and adapt to perceived rainfall shortages and related expected yield losses. However, an analysis of rainfall data in the CRV shows that rainfall characteristics have not changed over the last three decades. Moreover, according to analysis of official data, crop productivity per hectare in the CRV even shows a slight increase over the last decade. Therefore, farmers' perception of a decline in crop productivity and rainfall can be explained by i) the increased demand to grow more crops to feed the rapidly growing population, and ii) the lower moisture availability for plant growth as a consequence of more intensive farming (often on less suitable fields) and land degradation. The root causes of frequent food shortages are thus not only related to rainfall, but also to soil fertility decline, soil erosion and lack of rainwater storage in the soil. Current farmers' strategies are, therefore, not adequate to cope with the increased food demand. There is an urgent need to invest in sustainable land management (SLM) practices that enhance local food production.

Chapter 3 focuses on the ***farmers' perception of land degradation*** (especially soil erosion and nutrient depletion) and their investments in land management. If farmers perceive land degradation as a problem, the chance that they invest in land management measures will be enhanced. Results reveal that land degradation in the form of water erosion and fertility depletion is a problem and has increased over the last decade in the CRV. Farmers are aware of it and consider it as a problem. Nevertheless, farmers' investments to control water erosion and soil fertility depletion are very limited. Results also show that farmers' awareness of both water erosion and soil fertility decline as a problem is not significantly associated with their investments in land management. Hence, even farmers who perceive land degradation on their fields and are concerned about its increase over the last decade, do not significantly invest more in water erosion and soil fertility control measures than farmers who do not perceive these phenomena.

Chapter 4 is devoted to ***exploring the determents of farmers' decisions*** how much and where to invest in land management. The study identified five major factors that influence farmers' decisions *how much* to invest in land management. These include households' resource endowments, farming experience and knowledge, access to information, social capital and availability of family labour. This result implies that extension strategies aiming at sustainable land management should try to enhance households' resources endowments, improve their access to information and stimulate collective action in land management. Similarly, the study revealed the decisions of farmers' *where* to invest in land management is influenced by the vulnerability, accessibility and fertility condition of their plots. Farmers were more willing to invest in plots that are vulnerable to water erosion, have better soil fertility and are larger. However, the influence of all these factors on farmers' investments in land management was highly variable across the different

study sites within the CRV. Hence, the diversity in social, economic, cultural and biophysical conditions must be taken into account by rural extension programmes. This calls for site-specific land management strategies that can be planned and implemented at micro-level with active participation of farmers.

Chapter 5 deals with ***co-investments in land management.*** Lack of collaboration is a growing concern for the success of SLM in Ethiopia. In Ethiopia, not only farmers but also public institutions and private sectors are hesitant to collaborate and invest in SLM. This study identified several major bottlenecks and requirements for co-investments by public institutions and private sectors. Nevertheless, the results varied across the administrative levels. As a result, macro level institutions did not acknowledge most of the bottlenecks and requirements reported by meso and micro level institutions. Therefore, a micro-meso-macro consensus is required to improve co-investments. Furthermore, most bottlenecks and requirements for public institutions were related to governance issues. This suggests the need to establish good governance at all levels in Ethiopia in order to improve co-investments in SLM. In addition to public institutions, private sectors identified major bottlenecks and requirements which are mostly related to economic issues. However, given the current socio-economic and political situation in Ethiopia, it is a long way to fulfilling the requirements proposed by public institutions and private sectors. This indicates that requirements should be fulfilled gradually and systematically for successful co-investments in SLM.

Chapter 6 explores ***the potential of co-investments in land management*** for bringing change at the grassroot level in Ethiopia. First, this study explores the most important co-investment activities that trigger farmers to invest in land management based on a co-investment initiative in the Galessa watershed. Second, it assesses the impact of these co-investment activities on farmers' investments in land management by comparing experimental (participant) and control (non-participant) groups of farmers using survey data. The case study revealed that the most important co-investment activities that triggered farmers to invest in land management include co-investments in awareness creation, water provision, technology and governance. Of these activities, co-investing in water provision is the most successful activity, because it directly solves one of the basic needs of farmers in the watershed. Results reveal that the experimental group of farmers invested more in land management practices, such as soil bunds, compost and tree planting, than the control group of farmers. The article concludes that multiple level co-investment activities are crucial to trigger farmers to invest in land management in Ethiopia.

Chapter 7 is a ***synthesis of previous chapters***. It briefly summarizes answers to the research questions, describes the added value of the thesis in terms of knowledge generation and provides suggestions for further research and policy making. The synthesis indicates that although farmers are well aware of the land degradation problem, their investments in land management are not sufficient to reverse the situation. It also reveals that farmers' investments are affected by highly diverse socio-economic and biophysical constraints. Moreover, public and private sectors are constrained by financial and governance factors and require several preconditions before actually investing in land management. Despite these constraints at *micro, meso* and *macro* institutional levels, this thesis shows that there is potential for co-investments in SLM in Ethiopia. Exploiting this potential principally requires commitment of all stakeholders to co-invest in land management.

Samenvatting

Net als in andere delen van Ethiopië is landdegradatie als gevolg van watererosie en een afname van de bodemvruchtbaarheid één van de meest uitdagende problemen voor boeren in de Central Rift Valley (CRV) van Ethiopië. Niettemin zijn investeringen door boeren in bodembeheer om landdegradatie te verminderen en de agrarische productie te verhogen beperkt. Ook hebben publieke en private sectoren nooit samengewerkt m.b.t. investeringen in bodembeheer. Deze studie richt zich op co-investeringen, d.w.z. op de bijdragen van verschillende belanghebbenden aan beter bodembeheer in de vorm van materiaal, arbeid, geld, technologie, kennis en bestuur. Het doel van deze studie was om de mogelijkheden van co-investeringen in het tegengaan van landdegradatie en het verhogen van de productiviteit in de CRV van Ethiopië te verkennen.

Hoofdstuk 2 beschrijft de perceptie van de boeren m.b.t. gewasproductie en hun strategieën om waargenomen veranderingen in de CRV van Ethiopië te compenseren. Het blijkt dat de boeren een daling van de gewasproductie en voedselzekerheid in de afgelopen decennia waarnemen. Ze geven een daling van de neerslag hiervan de schuld. Als gevolg hiervan hanteren boeren diverse strategieën om neerslagtekorten en de daarmee verband houdende opbrengstdaling te compenseren. Uit een analyse van neerslaggegevens in de CRV blijkt echter dat de belangrijkste neerslagkenmerken niet zijn veranderd in de afgelopen drie decennia. Bovendien laat de gewasproductie per hectare in de CRV, volgens een analyse van officiële gegevens, zelfs een lichte stijging in het laatste decennium zien. De boerenperceptie van een daling van de gewasproductie en regenval kan worden verklaard door: (1) de toegenomen vraag naar meer voedsel om de snel groeiende bevolking te voeden, en (2) de lagere beschikbaarheid van bodemvocht voor plantengroei als gevolg van meer intensieve landbouw (vaak op minder geschikt gronden) en als gevolg van landdegradatie. De onderliggende oorzaken van frequente voedseltekorten hebben dus niet alleen betrekking op neerslag, maar ook op een dalende bodemvruchtbaarheid, en op bodemerosie met een gebrek aan beschikbaar water in de bodem tot gevolg. De strategieën welke de boeren op dit moment gebruiken zijn derhalve niet voldoende om aan de toenemende vraag naar voedsel te kunne voldoen. Er is dringend behoefte aan investeringen in duurzaam landbeheer (SLM: Sustainable Land Management) om de lokale voedselproductie te verbeteren.

Hoofdstuk 3 richt zich op de boerenperceptie van landdegradatie (in het bijzonder die van bodemerosie en een tekort aan nutriënten) en hun investeringen om die degradatie tegen te gaan. Als boeren landdegradatie als een probleem zien, zal de kans dat ze investeren in maatregelen voor beter landbeheer groter zijn. Onze resultaten laten zien dat landdegradatie in de vorm van watererosie en uitputting van de bodemvruchtbaarheid zijn toegenomen in de laatste tien jaar in de CRV. Boeren zijn zich hiervan terdege bewust en beschouwen het als een probleem. Toch zijn hun investeringen om watererosie en uitputting van de bodem te beheersen zeer beperkt. De resultaten tonen ook aan dat het bewust zijn van zowel watererosie als een tekort aan bodemvruchtbaarheid niet significant is gecorreleerd met hun investeringen. Vandaar dat zelfs boeren die de aantasting van de bodem op hun velden waarnemen en zich zorgen maken over de toename hiervan in de laatste tien jaar, niet significant meer investeren in controlemaatregelen tegen watererosie en de bodemvruchtbaarheidsafname dan boeren die deze verschijnselen niet duidelijk zien.

Hoofdstuk 4 is gewijd aan het verkennen van de factoren welke de beslissingen van boeren beïnvloeden m.b.t. hoeveel en waar te investeren in bodembeheer. De studie identificeerde vijf belangrijke factoren: (1) de bezittingen (basisvoorzieningen) waarover een huishouden beschikt, (2) landbouwervaring en -kennis, (3) toegang tot informatie, (4) sociaal kapitaal en (5) de beschikbaarheid van gezinsarbeid. Dit impliceert dat voorlichtingsstrategieën gericht moeten zijn op het vergroten van basisvoorzieningen, op het verbeteren van de toegang tot informatie en op het stimuleren van collectieve actie t.b.v. het

bodembeheer. Ook is gebleken dat de beslissing van boeren waar te investeren wordt beïnvloed door de kwetsbaarheid, de toegankelijkheid en de vruchtbaarheid van hun percelen. Boeren zijn meer bereid om te investeren in percelen die gevoelig zijn voor erosie, een betere vruchtbaarheid hebben en die groter zijn. De invloed van al deze factoren op boereninvesteringen varieert echter sterk over de verschillende studiegebieden binnen de CRV. Daarom moet de diversiteit in sociale, economische, culturele en biofysische omstandigheden in aanmerking worden genomen bij landelijke voorlichtingsprogramma's. Dit vraagt om locatie-specifieke strategieën voor bodembeheer waarvan de planning en uitvoering op lokaal niveau plaats kan vinden met actieve deelname van de boeren.

Hoofdstuk 5 behandelt co-investeringen bij het bodembeheer. Gebrek aan samenwerking tussen belanghebbenden is een groeiende zorg voor het succes van SLM in Ethiopië. In Ethiopië, zijn niet alleen de boeren, maar ook openbare instellingen en de particuliere sector huiverig om samen te werken en in SLM te investeren. In deze studie zijn een aantal belangrijke knelpunten en eisen voor co-investeringen geïdentificeerd m.b.t. publieke en de private sector. De resultaten variëren tussen de bestuursniveaus. Instellingen op het macro-niveau erkennen de meeste van de knelpunten en eisen gerapporteerd door meso-en microniveau instellingen niet. Daarom is een micro-meso-macro consensus vereist om de kans op co-investeringen te verbeteren. De meeste knelpunten en eisen m.b.t. openbare instellingen hebben betrekking op bestuurlijke (governance) kwesties. Dit suggereert de noodzaak van een goed bestuur op alle niveaus in Ethiopië teneinde co-investeringen in SLM te verbeteren. In de particuliere sector hebben de belangrijke knelpunten en eisen betrekking op economische vraagstukken. Gezien de huidige sociaal-economische en politieke situatie in Ethiopië, is er een lange weg te gaan om aan de eisen van publieke instellingen en de private sector te voldoen. Dit geeft aan dat verbeteringen van de omstandigheden voor succesvolle co-investeringen in SLM geleidelijk zullen moeten verlopen.

Hoofdstuk 6 onderzoekt welke veranderingen co-investeringen in bodembeheer hebben op het lokale niveau in Ethiopië. Als eerste verkent deze studie de belangrijkste co-investeringsactiviteiten die boeren er toe brachten om in bodembeheer te investeren. De basis voor onze studie was een bestaand co-investering initiatief in het Galessa stroomgebied. De impact van deze co-investeringsactiviteiten werd bepaald door het vergelijken van een experimentele groep boeren (deelnemers) en een controle groep van niet-deelnemende boeren en aan de hand van enquêtegegevens. De belangrijkste co-investeringsactiviteiten die boeren er toe brachten om te investeren in landbeheer waren: (1) co-investeringen in bewustmaking, (2) in watervoorziening, (3) in technologie en (4) in bestuur. Van deze activiteiten is co-investeren in watervoorziening de meest succesvolle activiteit gebleken. Dit, omdat het één van de meest urgente basisbehoeften van de boeren in het stroomgebied vervulde. De experimentele groep boeren heeft meer geïnvesteerd in methoden voor landbeheer, zoals de aanleg van aarden dijkjes, het maken en gebruiken van compost en het planten van bomen, dan de controlegroep van de boeren. Dit hoofdstuk concludeert dat co-investeringen op meerdere niveaus nodig zijn boeren zover te krijgen dat zij in landbeheer investeren.

Hoofdstuk 7 is een synthese van voorgaande hoofdstukken. Het geeft in het kort antwoord op de onderzoeksvragen, beschrijft de toegevoegde waarde van de scriptie m.b.t. kennisontwikkeling en biedt suggesties voor verder onderzoek en beleidsvorming. De synthese geeft aan dat, hoewel de boeren zich terdege bewust zijn van het bodemprobleem, hun investeringen in bodembeheer niet voldoende zijn om de verslechterende situatie te keren. Het toont ook aan dat de boereninvesteringen worden beïnvloed door zeer uiteenlopende sociaal-economische en biofysische omstandigheden. Bovendien wordt deelname van de publieke en private sector beperkt door financiële en bestuurlijke factoren. Verbetering van deze situatie vereist een aantal randvoorwaarden alvorens daadwerkelijk te investeren in bodembeheer. Ondanks al deze beperkingen op micro-, meso-en macro-institutionele niveaus, toont dit proefschrift aan dat er ruimte is voor co-investeringen in SLM in Ethiopië. Benutting van dit potentieel vereist inzet van alle betrokkenen om mee te investeren in bodembeheer.

PE&RC PhD Education Certificate

With the educational activities listed below the PhD candidate has complied with the educational requirements set by the C.T. de Wit Graduate School for Production Ecology and Resource Conservation (PE&RC) which comprises of a minimum total of 32 ECTS (= 22 weeks of activities)

Review of literature (6 ECTS)

- Factors affecting farmers 'investments in sustainable land management in sub-Saharan Africa (2008-2009)

Writing of project proposal (4.5 ECTS)

- Towards sustainable land management in the Central Rift Valley of Ethiopia: exploring the potential of co-investments (2008)

Post-graduate courses (4.1 ECTS)

- Integrated assessment of agriculture and sustainable development; PE&RC (2008)
- Experimental methods in social science and interdisciplinary research; CERES (2009)
- Introduction to R for statistical analysis; PE&RC (2010)

Invited review of (unpublished) journal manuscripts (1 ECTS)

- Invited review of (unpublished) journal manuscript (1 ECTS)
- Food security: food insecurity and copping strategies: experience from Kersa district, East Hararghe, Ethiopia (2012)

Deficiency, refresh, brush-up courses (2.7 ECTS)

- Environmental policy: analysis and evaluation; WUR-ENP (2008)
- Basic statistics (2008)

Competence strengthening / skills courses (3.3 ECTS)

- Information literacy for PhD including to EndNote; WGS (2009)
- Project and time management; WGS (2010)
- Techniques for writing and presenting a scientific paper; WGS (2012)

PE&RC Annual meetings, seminars and the PE&RC weekend (1.5 ECTS)

- PE&RC Weekend (2008)
- PE&RC Weekend (2012)

Discussion groups / local seminars / other scientific meetings (9.7 ECTS)

- Symposium on the role of long-term landscape reconstruction; WUR (2008)
- Going to scale for SLM in the highlands of Eastern Africa; Addis Ababa, Ethiopia (2009)
- Biannual meeting on soil science society of Ethiopia (2009)
- Annual research review meetings at Ethiopian Institute of Agricultural Research (2010)
- Paper presentation in the national conference on Eucalyptus species management, history, status and trends in Ethiopia; Addis Ababa (2010)
- Paper presentation in the conference : from emergency aid food security in Ethiopia; Bahir Dar (2010)
- Oral presentation, inauguration workshop "Ethiopian Journal of Applied Sciences & Technology (EJAST); Jimma University, Ethiopia (2010)
- Poster presentation, Ethiopia-WUR collaboration programme on science for impact; Holeta Agricultural Research Centre, Ethiopia (2010)
- Annual research review meetings at Holeta Agricultural Research Centre (2011)

International symposia, workshops and conferences (6.9 ECTS)

- 2^{nd} World Congress of Agroforestry; Nairobi, Kenya (2009)
- International conference Ecosystem Conservation and Sustainable Development; Ambo University, Ethiopia (2011)
- The 8^{th} International Symposium Agro Environ; Wageningen (2012)

Supervision of 2 MSc student (3 ECTS)

- Dynamics in people-tree interactions in farm fields: farmers' perspectives in Meskan District, Ethiopia
- The effect of land certification on sustainable land management in the Central Rift Valley of Ethiopia

Curriculum vitae and author's publications

Zenebe Adimassu Teferi was born on August 31, 1974 in Wollo, Ethiopia. He has obtained his BSc degree in Soil and Water Conservation from Mekelle University with distinction in July, 1999. Right after his graduation, he has employed by the Ethiopian Institute of Agricultural Research (EIAR) as junior researcher in the department of soil and water management research based at Holeta Agricultural Research Centre (HARC). In September 2003, Zenebe joined the Erosion & Soil and Water Conservation group (later named Land Degradation and Development) of Wageningen University and Research Center (WUR) for his second degree (Master of Sciences, MSc) sponsored by the Netherlands organization for international cooperation for higher education (NUFFIC). In May 2005, Zenebe completed his MSc and returned to Ethiopia. In his stay at HARC, he designed and led integrated action and empirical research projects on land management at plot and watershed scales, including both biophysical and socio-economic aspects. He had also a privilege to coordinate the African Highlands Initiative (AHI) programme (at Galessa watershed in Ethiopia). AHI is one of the programmes of the World Agroforestry Centre (ICRAF) in Eastern Africa region with the aim of "Developing methodologies for integrated natural resources management and their institutionalization in partner NARS in the humid highlands of East and central Africa (ECA). While coordinating AHI, he led an interdisciplinary team in the development and implementation of participatory action and empirical researches to improve livelihoods through the intensification of under-utilized and degraded outfield areas in Galessa watershed.

In September 2008, he admitted to the PhD program of Land Degradation and Development Group (currently named as Soil Physics and Land Management) of WUR. His PhD study was funded by WUR as part of the project ''Improving livelihoods and resource management in the Central Rift Valley of Ethiopia''. He co-supervised two MSc students from Wageningen University which were attached to his PhD project. He has published peer reviewed articles, book chapters, policy briefs, proceedings, and made a number of oral and poster presentations in several national and international meetings. He would like to continue in research and teaching regarding land degradation and sustainable land management. E-mail: zenebeteferi@yahoo.com

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