# Financial institutions and trends in sustainable agriculture:

# Synergy in rural sub-Saharan Africa

Emmanuel Olatunbosun Benjamin

**Thesis**

Submitted in fulfilment of the requirement for the doctoral degree at the Bergische
University of Wuppertal (BUW) by the authority of
Prof. Dr. Paul J.J. Welfens in the presence of the
Thesis committee appointed by the Academic Board

Die Dissertation kann wie folgt zitiert werden:

urn:nbn:de:hbz:468-20150209-121129-4

[http://nbn-resolving.de/urn/resolver.pl?urn=urn%3Anbn%3Ade%3Ahbz%3A468-20150209-121129-4]

*“In loving memory +Mr. Heinz Lohrey and +Dr. Adeyemi Kalejaiye”*

**Table of Content**

“What we are doing to the forests of the world is but a mirror reflection of what we are doing to ourselves and to one another.”

Mahatma Gandhi
Environmentalist and civil activist

**List of Tables**

## List of Figures

**Acknowledgements**

This doctoral dissertation conducted with the European Institute for International Economic Relations (EIIW) and the Bergische University of Wuppertal (BUW) would not have been possible without the academic, moral and financial support of a number of individuals as well as institutions.

First and foremost, I would like to thank God for the inspiration and wisdom in carrying out this research project. I would also like to use this opportunity to express my gratitude to Gabriele Lohrey-Benjamin and Joyvita Benjamin, the Lohrey family, my siblings and parents, especially my mother Mrs. Abiola Caulcrick-Benjamin, for their support. Furthermore, I would like to appreciate the Ausgleichsstiftung Landwirtschaft und Umwelt which supported my dissertation with a research grant under the German Gesellschaft für Internationale Zusammenarbeit (GIZ) program.

The dynamic support from the European Institute for International Economic Relations (EIIW) shaped this idea into the academic work it came to be. I would therefore like to thank my colleagues at the institute for their constructive feedbacks during our numerous doctoral seminars. I shall be ever grateful to Dr. Matthias Blum and Dr. Maarten Punt of the Department of food and Agricultural at the Technical University of Munich (TUM). These scholars not only help improve my initial dissertation draft but also encouraged me through their wealth of knowledge in environmental and developmental economics. Methodologically I also profited from both Dr. Matthias Blum and Dr. Maarten Punt of the TUM.

The successful field study conducted during this research project in Kenya was due to the enormous support of The International Small Group Tree Planting Programme (TIST). I would therefore like to thank Mr. Charles Ibeere and Mr. Gillbert of the TIST group in Meru. In addition, I would like to express my appreciation to Mr. Alphaxard Kimani and his colleagues of the TIST group Nanyuki. These gentlemen not only traveled with me through the rural areas in Nanyuki were TIST projects were located but also helped in coordinating the interview with smallholder farmers. The cooperation with this TIST staff gave me the opportunity to experience first-hand the challenges of extension services in rural areas.

I also feel obliged to express my appreciation to the smallholder farmers, both TIST and non-TIST members, who at different locations and point in time participated in the survey. I have come to appreciate not only their means of livelihood but the fruits and the cup of teas offered to me during field visitation as well as the hospitality bestow upon me.

Finally, I am indebted to my supervisors and advisors Prof. Dr. Paul J.J. Welfens and Prof. Dr. Andre Betzer who have supported and motivated me all through the duration of this project. These scholars have also used their networks and influence to contribute to the realization and successful completion of this Thesis.

# Chapter 1: Introduction

## 1.1 Background

Small scale agriculture in developing countries, especially sub-Saharan Africa (SSA), is confronted with a number of challenges—such as low productivity—compounded by the adverse effect of climate change. The low productivity in smallholder agriculture in SSA is, in part, due to degradation of soil using poor and unsustainable farming systems, low human capital and climatic conditions. These factors are also largely responsible for the low level of agricultural investment and financing (Zepeda, 2001; Thorp et al., 2005; Tenywa et al., 2011).

Sustainable agriculture and rural development (SARD), as defined by the food and agriculture organization, FAO (1989) is *"the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.*" It is argued that sustainable agricultural growth amongst smallholders to overcome inefficiencies and natural resource degradation can be achieved by an innovation systems approach (Tenywa et al., 2011). Upscaling of sustainable productivity in agriculture is suggested to involve substantial investment and innovative institutional arrangements (Jama and Pizarro, 2008; Conning and Morduch, 2011). Structured institutions are required to facilitate access to and use of inputs such as physical capital and fertilizer necessary to attain food security and adequate levels of financing for agriculture, particularly in SSA (Wiebe et al., 2001). Organizations which act as intermediaries in the coordination of different sectors necessary to the attainment of social and environmental sustainability facilitate access to information and markets (Hall et al., 2006). As such, existing local structures and national pro-poor schemes could be vital to the promotion of rural agriculture and institutional innovation. Innovation by smallholder farmers that results in community empowerment is also suggested to increase market access via strong interactions and flow of knowledge within institutional networks (Kaaria et al., 2009; Biggs, 2007).

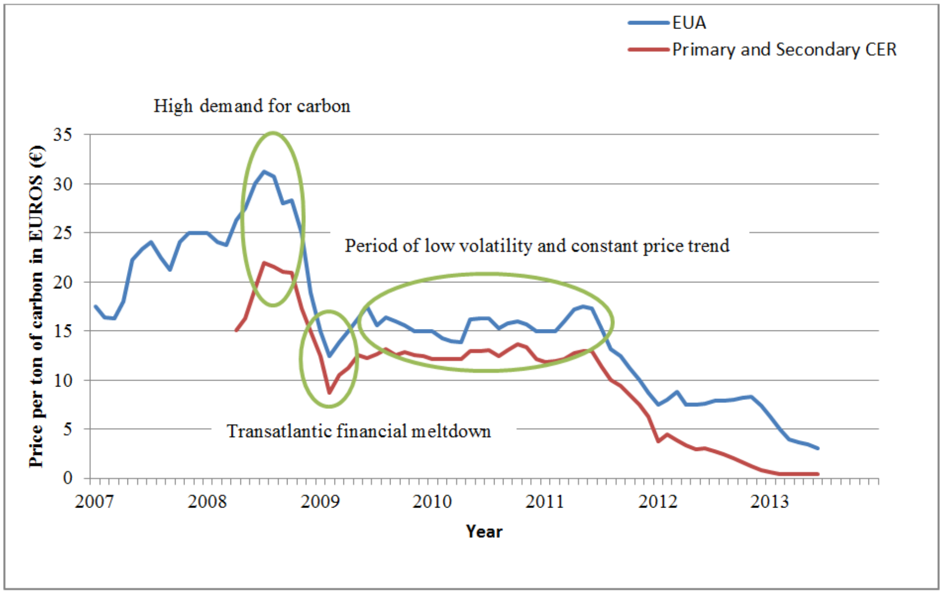
When farmers are linked to new (international) markets attaining higher bargaining power may improve their livelihoods (Sanginga et al., 2006). This is in line with a study by Dorward et al. (2003), who argue that the absence of markets, institutions and technology may be detrimental to the development of sustainable livelihoods and poverty reduction.

Carbon emission markets such as the clean development mechanism (CDM) and voluntary carbon standards (VCS) are examples of the emergence of new markets driven by institutional innovation. These markets have the potential to achieve the millennium and sustainable development goals (M/SDG) of climate resilience agriculture and poverty reduction if properly designed and implemented. The afforestation and reforestation (A/R) or agroforestry emission trading scheme under the CDM and VCS which offer payments for ecosystem services (PES) are becoming successful in SSA especially amongst the least developed countries (LDC) (Kreibich et al., 2013). Agroforestry with PES projects accounts for 30 percent and 19 percent, respectively, of total A/R registered projects represents largest share of SSA registered project (Kreibich et al., 2013). PES are designed to provide socio- economic benefit to various groups by reward those providing ecosystem services accordingly (Ghazoul et al., 2011). PES, an indicator for sustainable agriculture, may also impact rural agricultural credits accessibility beyond current levels as a result of the increase in business investment as well as participation of various institutions in sustainable rural development. Efforts to promote agroforestry in rural SSA in recent years has had moderate success due to low rate of adoption estimated to be less than one percent of the continents land mass (Thiombiano and Meshack, 2009). Another hurdle to agroforestry with PES is transaction costs, e.g., input maintenance, monitor reporting and validation (MRV), and low output prices (Ghazoul et al., 2011; Tschakert, 2007; Locatelli and Pedroni, 2006). It is argued that weak infrastructure in education, business and information hinders the adoption of innovation in developing countries (Aubert, 2005). Adoption of innovation such as agroforestry with PES in rural areas may not require well-developed infrastructure. It is suggested that strong partnerships between public and private parties involved in sustainable agriculture activities, especially in LDCs, may result in strong bargaining power in future climate policy agreements with respect to market regulations and PES prices (Tubiello, 2011). For instance, agriculture and climate policy on agroforestry in Northeast Thailand led to the establishment of Inpang Carbon Bank and the reduction of transaction costs through the application of a new methodology (Samek et al., 2011). The PES from small-scale agroforestry has the ability to engage institutions which were previously not adequately linked to rural agriculture production, eventually increase financing (Ottaviani, 2011).

PES prices are usually negotiated between buyers and sellers and take into consideration a number of factors, such as market prices and also the contribution of a project to the overall livelihood of smallholders. The historical prices of each unit of carbon, i.e., certified emissions reductions – CER and European Union allowances - EUA sold on the CDM and the European Union emissions trading system (EU ETS), respectively, are depicted in figure 1 below. Both guaranteed and non-guaranteed forms of credit corresponding to secondary and primary CER assumes certain co-integration to the EUA which is a source of concern. This co-integrated has been argued not to exist as such, so that both EUA and CER are more independent (Mizrach, 2010). Nevertheless high volatility and low carbon price due to exogenous shocks may have certain negative impact on climate mitigation efforts as well as investment in low carbon technologies in developing countries (Ares, 2013). Celebi and Graves (2009) suggest that CO2 price volatility could delay investment in mitigation technologies by more than 10 years; therefore, they propose a floor and ceiling price on CO2 to safeguard low-carbon investments. Internationally traded emission credits can be assumed to be a main driver of sustainable investment and low-carbon innovation in developing countries. However, the restriction of trading of agroforestry related certain carbon on the EU ETS due to fear of non-permanent risk could impair efforts to promote rural sustainable because of market entry barrier (Dutschke et al., 2005; Shames and Scherr, 2010).

Depending on a number of socio-economic factors, agroforestry with PES schemes in rural areas could promote inclusiveness, i.e., participation of the poorest of the poor. Certain schools of thought have, however, argued that there may be cases where PES schemes lead to the exclusion of the poorest of the poor (Tschakert, 2007). It is suggested that for pro-poor environmental service provisions to be successful, demand and supply have to be linked to adequate levels of payment and supported by equity mechanisms (Tschakert, 2007). The equity mechanism stipulated above is expected to ease the low level of investment prevalent in rural areas (Tschakert, 2007). Financial institutions can bridge the gap left by low investments. These institutions can participate in the value chain of agroforestry through direct investments in projects or providing lending and saving facilities targeting smallholder farmers participating in agroforestry with PES schemes. The latter may improve the credit environment in rural agriculture areas which has been described by substantial number of studies as incredibly poor. The ability of small scale agriculture practitioners to signal of business quality to financial institutions has being problematic due to lack of adequate instruments. The self-financing of a portion of agroforestry costs within a PES scheme, e.g., purchase input by smallholders and contractual agreements, could serve as an adequate signaling mechanism. This could be a novel approach to changing the perception widely held by financial institutions that small-scale agriculture activities are *"risky"*. The development of rural agriculture can be attained not just by increased access to credit but also more favorable credit terms for rural agricultural clients. PES schemes could improve the probability of financial institutions (microfinance) lending to small-scale agroforestry projects at favorable interest rates. This could potentially lessen one of the major hurdles to sustainable agriculture development in rural SSA.

The potential benefits of small-scale agroforestry with PES schemes in rural SSA appear to include more than the conventional direct benefits, such as climate mitigation, nutritional supplementation, soil improvement and higher productivity. This thesis establishes a framework for institutional innovation in the agroforestry emission certification process and explores the possible poverty alleviation effect of this innovation through improved agriculture financing and also evaluates the socio-economic condition of participating smallholders. Furthermore, the study seeks to shed light on the emergence of a low-risk sustainable agriculture system in parts of rural SSA. This study contributes to existing literature on sustainable agriculture and institutional innovation by adopting a pragmatic approach.




*Source: Author´s modification (Greenresources, 2014; World Bank, 2012)*

**Figure 1: Carbon emission reduction price trend 2007 – 2013**

## 1.2 Objective and research question

A conceptual framework on how to integrate local institutions into the smallholder agroforestry PES value chain is proposed in this study. A comprehensive overview of the agroforestry carbon certification procedure and carbon accounting is introduced in later sections of this chapter. The impact of international emission trading mechanisms related to agriculture emission reduction (similar to that of the Kyoto protocol) on agricultural financing is evaluated. The inclusion of projects aimed at sequestering carbon via Land Use, Land Use Change and Forestry (LULUCF) in international agreements is a way of promoting and rewarding '*climate friendly'* land use, particularly in developing countries (Thomas et al., 2009). Climate change mitigation through agroforestry (carbon capture and storage) and soil carbon offset emissions may potentially offset approximately 84 percent of current emissions due to agricultural activities (Smith et al., 2008). The total annual a global carbon ($CO_2$) emission from agriculture is estimated between 5.1 Giga tons of carbon equivalent - Gt $CO_2$-eq and 6.1 Gt $CO_2$-eq (Smith et al., 2007). Over the last decade there has been a growing interest in agroforestry, particularly its provision of environmental services, impact on household welfare, and promotion of biological diversity conservation

(McNeely and Scherr, 2006). Agroforestry with PES also offers financial and non-financial incentives such as carbon revenues and improved yield due to soil fertility, both of which can help promote the adoption of sustainable agriculture in rural SSA (Wollenberg et al., 2012; Streck et al., 2012). In order to effectively tap into the aforementioned benefits, certain constraints such as credit, investment and knowledge that confront smallholder farmers in rural SSA need to be addressed. This is in line with studies which argue that the success of small-scale agroforestry in developing countries depends on financing, including access to credit, available to project participants (Udo de Haes et al., 2008; Valdivia et al., 2009; Streck et al., 2012). Therefore a financing mechanism capable of dealing with smallholder farmers' diverse risks can encourage sustainable practices on a large scale (Foster et al., 2013; Morton, 2007). Sustainable or conservation farming in the form of agroforestry can potentially increase rural agriculture investment by harnessing the opportunity provided by climate change, e.g., international climate agreements and sustainable poverty alleviation programs. Furthermore the capital accumulation of participating smallholders can lead to other benefits such as access to formal credit. Bumpus and Liverman (2008) argue that, although carbon offset is a capital-accumulation strategy for reducing atmospheric carbon, its policy design primarily benefits industrial countries and may be disadvantageous to agroforestry due to relative low prices for agroforestry carbon offset. A number of international and local institutions as well as Non-profit and for-profit organizations are involved in agroforestry with PES leading to a comprehensive value chain. This value chain interaction is suggested to have led to a positive and significant relationship between agricultural carbon finance, institutional structure, and smallholders (Shames and Scherr, 2010). Researchers in agricultural and developmental economics have been urged to conduct studies on how to strengthen this value chain linkage in order to improve technical efficiency and the welfare of smallholder farmers in SSA (Oduol et al., 2011). The value chain of agroforestry with PES can be utilized by financial institutions as a risk management strategy that has lower transaction costs and information asymmetries than strategies solely based on a borrower's creditworthiness.

This thesis analyzes smallholder *sustainable* agriculture (agroforestry with PES) in connection to credit financing. The opportunities provided by international climate agreements and emission trading schemes as well as corresponding value chains are evaluated. More specifically the following questions are addressed in this thesis:

1. Who are the *sustainable* smallholder farmers practicing agroforestry with PES, and what has influenced their decision to do so?
2. What possible value chain framework can promote business partnerships between sustainable smallholders and financial institutions in rural SSA?
3. Can the self-financing aspect of agroforestry with PES signal the quality of a farm business to financial institutions?
4. How does payment for ecosystem services (PES) influence a borrower's credit risk indictor?
5. Are sustainable smallholders credit constrained and/or have favorable interest rate compared to conventional smallholders

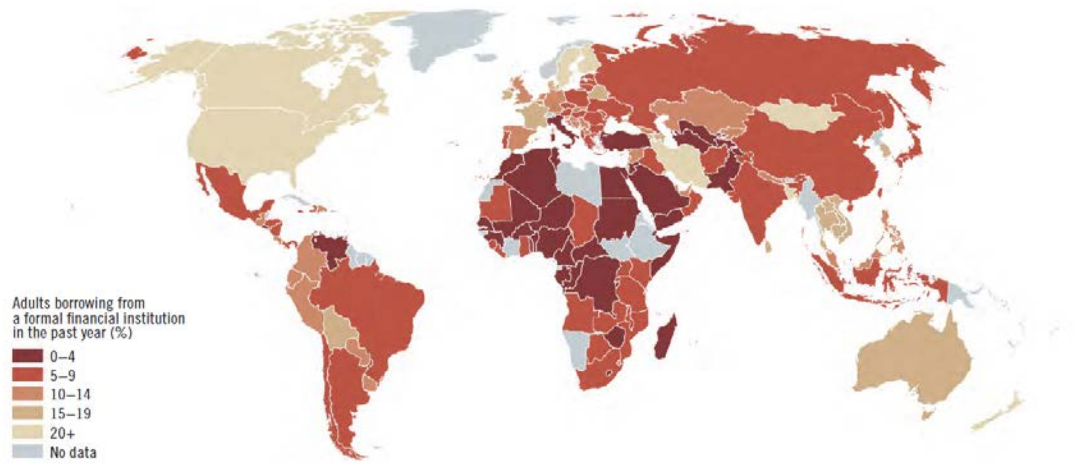
## 1.3 Climate, productivity and sub-Saharan Africa agriculture

Agriculture is the main source of livelihood for a large share of the rural population in SSA. The smallholder farming system, i.e., farm size less than three hectares (ha), is one of the largest employers within the informal sector, employing over 60 percent of the continent's labor force (Prakash and Stigler, 2012). Smallholder farmers are responsible for approximately 90 percent of food and cash crop production in developing countries, while the sector accounts for between 18 and 35 percent of SSA gross domestic product (GDP) (Morton, 2007; Prakash and Stigler, 2012; Mucavele, 2009). Despite the sector´s substantial contribution to economic growth in SSA, it continues to experience a moderate level of productivity. For instance, SSA agriculture productivity remains relatively low, estimated at 1.1 to1.5 metric tons per hectare compared to the world average of 3.2 metric tons per hectare (Oluoch- Kosura, and Sikei, 2013). Amongst the factors that have contributed to the low productivity observed in SSA are climate and environmental effects and financial constraints (Challinor et al., 2007; Dercon, 2008; Dercon, 2000; Morton, 2007). This section reviews the effects of the former on agriculture while the latter is addressed in the subsequent section. Climate change, either natural or human-induced, influences the productivity of agriculture systems due to the release of greenhouse gases (GHGs) which changes rainfall patterns and temperatures (Challinor et al., 2007). A substantial number (89 percent) of cereal production farming systems in rural SSA agriculture as well as other developing countries are dependent on rainfall (Challinor et al., 2007). The effect of climate change across various ecological zones within SSA varies. Decline in annual rainfall for parts of Western African over the last 60 years is estimated to be between 20 and 40 percent while certain parts of the region, e.g., the Guinean coast, have witnessed a 10 percent increase in annual rainfall (Boko et al., 2007). It has also been argued that while East Africa observed increased rainfall in the north and reduced rainfall in the south, Southern African has been experiencing extreme climatic conditions (Boko et al., 2007). Simulation models suggest that the agriculture system in western Africa may see an increase in crop yield in the early part of the 21st century due to increases in temperature and precipitation; however, a decline in crop yield is projected for the latter part of the century (Adewojun, 2006). Grain crop yields in lower latitudes, i.e., most of SSA, may decrease compared to yields in higher latitude regions if average temperature increases by one to three degrees Celsius (Schneider et al., 2007). The low productivity of smallholder farming in SSA is also attributed to poor and unsustainable farming practices which have led to erosive cultivation and declining soil fertility (Mazvimavi and Twomlow, 2009; Hartemink, 2006). Approximately 10 to 12 percent of total global greenhouse gas (GHG) emissions in 2005 were due to unsustainable agricultural activities (Smith, 2007). Over the last 40 years, 500 million hectares of land globally have been converted to agricultural land, this corresponds to an average six million hectares of forest land and seven million hectares of other land annually (Smith, 2007). The reasons for this massive trend in land use change, which is expected to continue, are growing populations and an increased demand for food and energy (Smith, 2007; Benjamin, 2012). Certain agriculture activities such as clearing of land and fertilizer application serve as a source of $CO_2$ emissions. SSA estimates that emissions from the aforementioned agricultural activities from 1990 – 2020 will be approximately 1000 Mt $CO_2$eq (Smith, 2007). The $CO_2$ emission due to land clearing and expansion of agricultural land accounts for 43 percent of Africa's total $CO_2$ emissions (Shames and Scherr, 2010). The area of land in SSA that will have been deforested for agriculture expansion purposes over the last decade (2005 – 2015) is estimated at five million hectares which will emit 13 percent (two billion tons of $CO_2$eq) of annual global $CO_2$ (Shames and Scherr, 2010). Certain agriculture practices have been shown to be major contributors to the production of/release of GHGs; however, other practices mitigate atmospheric GHGs, offsetting adverse effects. The mitigation potential of agriculture practices such as crop and organic soil management is approximately 5500–6000 Mt $CO_2$-eq $yr^{-1}$ which is 20 percent of total annual emissions of 29 Gt $CO_2$-eq in the 1990s (Smith, 2008). Smallholder agroforestry intercropping systems may help reduce the effect of GHGs by mitigating between40 and 147 $CO_2$eq $yr^{-1}$ (Shames and Scherr, 2010; Benjamin, 2012). Perennial crops, apart from improving soil conditions and increasing soil carbon content, may also protect against soil erosion (Benjamin, 2012). Therefore adoption of conservation agriculture is seen as a means of increasing crop productivity despite the presence of climate change and environmental degradation. An estimated 65.7 percent of Zambian smallholder farmers have adopted conservation farming practices such as minimum tillage and nitrogen-fixing crop rotation (Kabamba and Muimba-Kankolongo, 2009; Manzeke et al., 2012; Jama and Pizarro, 2008). This form of agricultural practices has led to an average maize yield of approximately 2 tons/ha, which is three times the yield from conventional farming observed in Zambia and across parts of SSA (Kabamba and Muimba-Kankolongo 2009; Manzeke et al., 2012; Jama and Pizarro, 2008). Adoption of conservation farming moves smallholder farmers away from production inefficiency and closer to their production frontier and technical efficiency (Musara et al., 2012; Feder et al., 1982). This may also increase human capital through access to extension services. However, the adoption rate of sustainable farming practices in SSA is low and suggested to be restricted to South Africa, Ghana and Zambia (Giller et al., 2009). The adoption of sustainable agriculture practices to mitigate GHGs in the future will depend on the price of carbon dioxide equivalents. The incentives that come with the adoption of sustainable agriculture practices must be higher than the opportunity cost; in other words, the net benefit of agroforestry with PES must be substantially greater than zero. This is in line with a study by Smith et al. (2008) where it was argued that the potential of agriculture to mitigate GHGs can be effectively tapped into if future prices of carbon are between

US$20 and US$100 t $CO_2$-eq$^{-1}$. The low carbon prices currently observed on the market may therefore be a barrier to the adoption of sustainable practices as the opportunity costs of these practices may be higher. However, if the other benefits that come with agroforestry with PES are considered, the opportunity cost may be lower.

## 1.4 Agricultural credit and investment in sub-Saharan Africa

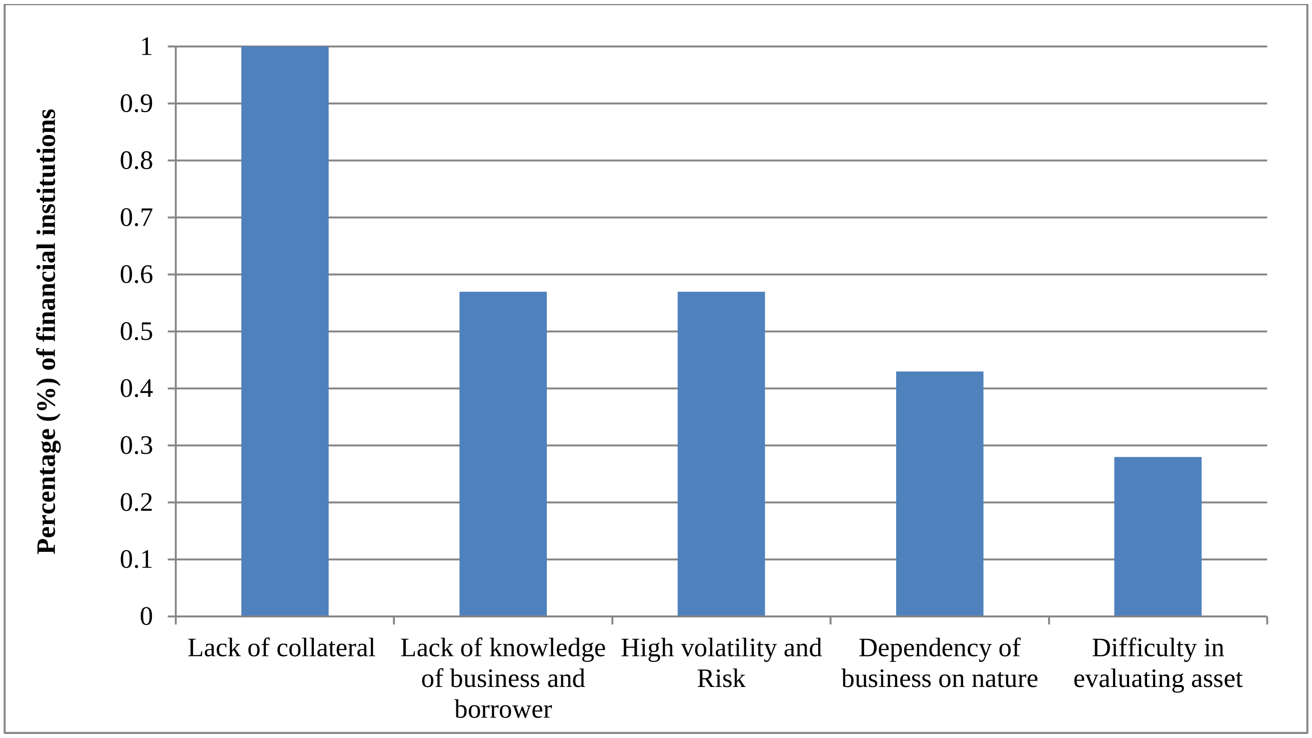
Lending by formal institutions to the agricultural sector in rural areas in developing countries, especially SSA, is low. It is difficult to estimate if the unbanked are omitted because they own profitable businesses, are not creditworthy, or are creditworthy but not interested in credit (Johnston and Morduch, 2007*;* Beck and Demirguc-Kunt, 2008*;* Sahan and Mikhail, 2012). In Africa, lack of access to credit (see figure 2) generally affects agriculture inputs in particular (Jama and Pizarro, 2008). Smallholders in SSA are argued to be in need of seasonal credit to buy inputs for reviving cash crop production; this credit may be achieved by involving intermediary such as traders in formal lending process of banks to ensure low default rates (Poulton et al., 1998). The mechanism as proposed by Poulton et al. (1998) may be controversial as smallholders are locked-out of the financial system, with the intermediary taking advantage of the system design. Although smallholder farmers in parts of rural SSA have devised means of accessing credit by forming informal savings groups such as *Chama* and *tontines*, this has not lessened the constraints on credit due to low lending volume (Kiptot and Franzel, 2012). Risk management strategy as well as lack of agriculture sector evaluation by a number of financial institutions may have shifted lending to low-risk borrowers (Hughes and Mester, 1998; Skees and Barnett, 2006).




*Source: Demirguc-Kunt, A., and L. Klapper. 2012*

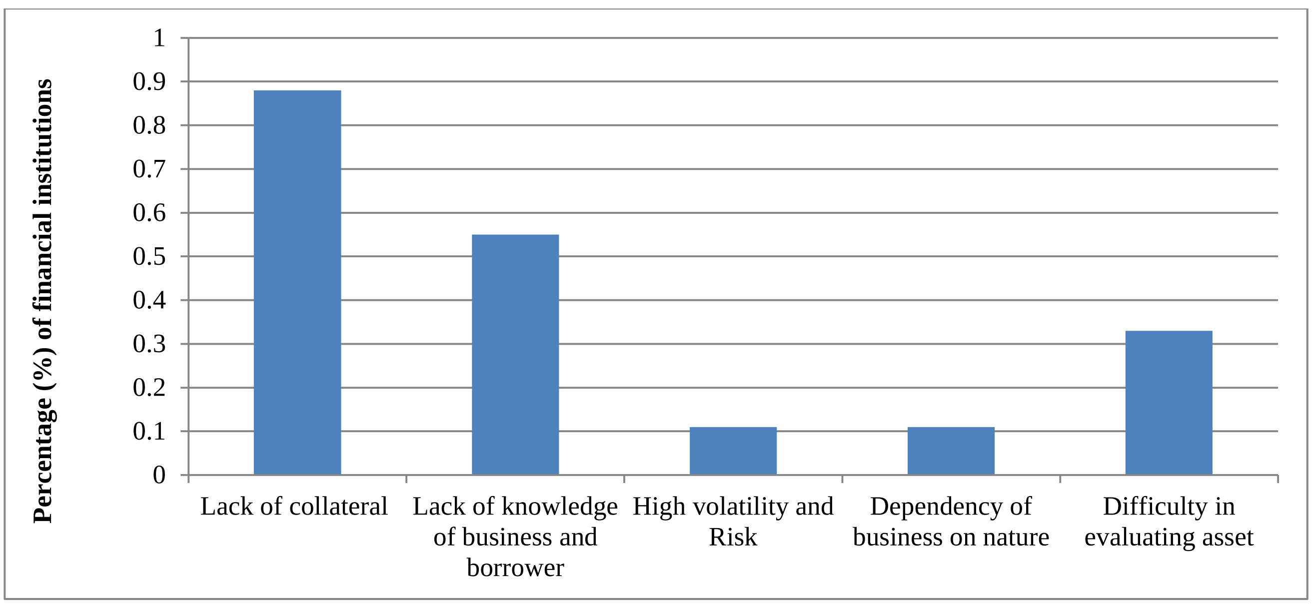
**Figure 2: Lending around the World (2012)**

Rural smallholder farmers are often regarded by financial institutions as high-risk borrowers due to lack of collateral and inadequate instrumentation for signaling business quality (Johnston and Morduch, 2007; Armendariz and Morduch, 2005; Dercon, 2004; Jama and Pizarro, 2008; Lubwama, 1999). The vulnerability of smallholders to climate change as well as lack of business knowledge, land tenure and information asymmetry may further limit loan availability to the rural agriculture sector (Rodrigues de Aquino, 2011). Besley (1994) and Stiglitz and Weiss (1981) have argued that credit rationing always occurs when lenders lack information on borrowers and incur high costs due to contract enforcement which leads to institutional inefficiency. This is in line with the results of the survey conducted by this study on commercial and microfinance bank lending to agriculture small and medium enterprise (SME) in the rural Mount Kenyan region (see figures 3 and 4). This may be one of the reasons for the observed decline in investment in rural agriculture in SSA. Another reason for the decline in agriculture investment is the fall in bilateral aid from the Organization for Economic Cooperation and Development (OECD) from 13.2 percent in 1987 to 7.3 percent in 1998, along with a decrease in national government funding (Tschirley and Benfica, 2001). For instance, total investment in agriculture for SSA in 2007 stood at one percent, compared to the 2001 level of between 1.5 and 7.9 percent (Prakash and Stigler, 2012; Zepeda, 2001). In the last 40 years, agricultural economists have argued that investment in the agricultural sector is vital to both poverty alleviation and economic transformation (Tschirley and Benfica, 2001).




*Source: Author*

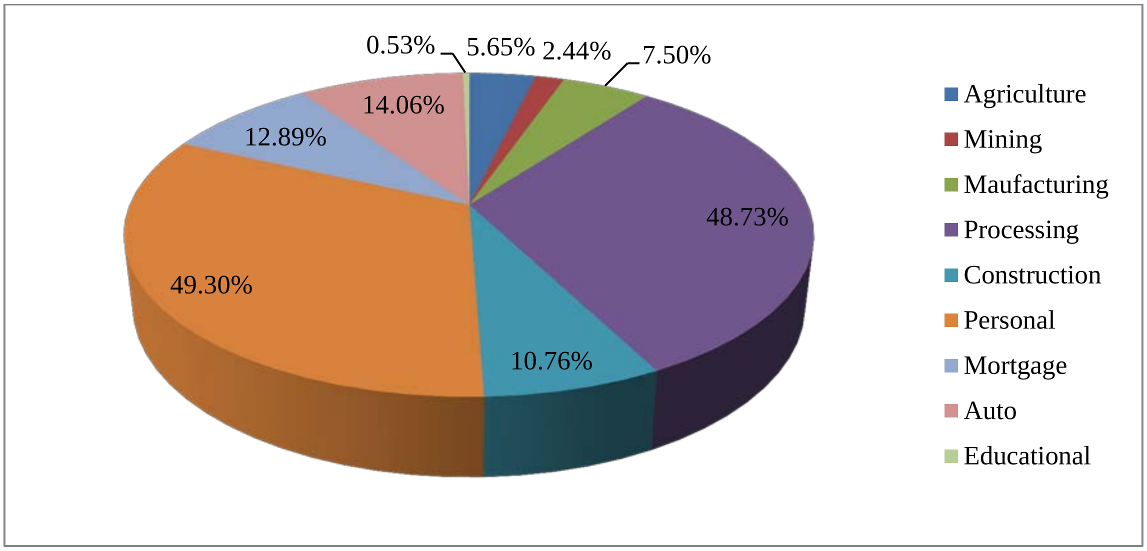
**Figure 3: Reasons for low level commercial bank lending in Meru, Embu and Nanyuki Kenya (2013)**




*Source: Author*

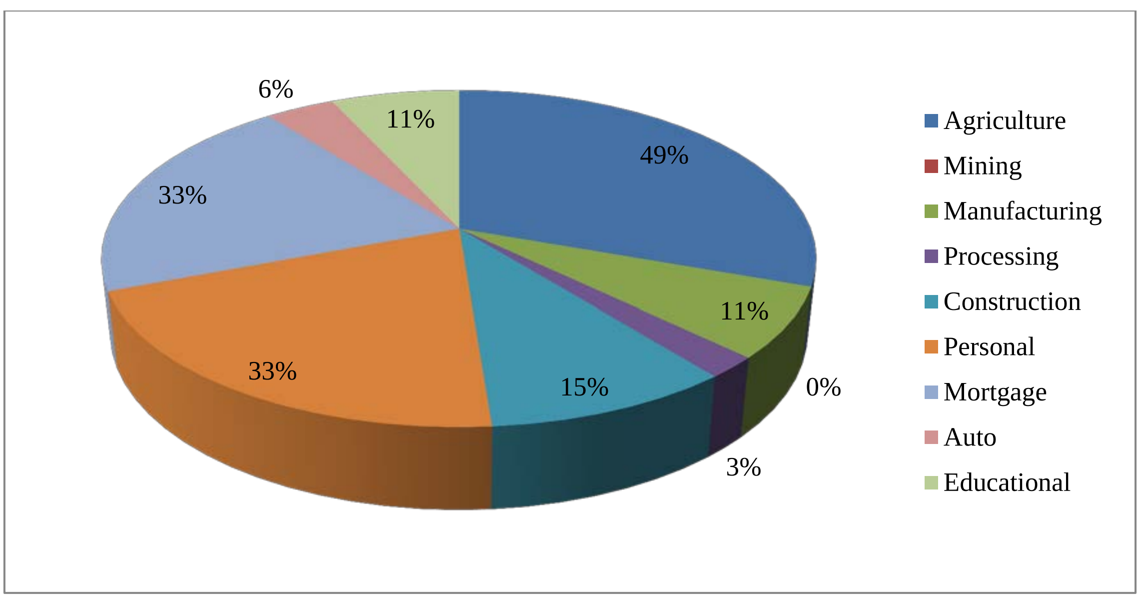
**Figure 4: Reasons for low level microfinance bank lending in Meru, Embu and Nanyuki Kenya (2013)**

In contrast to developed countries, where private funding is a common option available to agriculture, developing countries have limited accessibility to private funding combined with uncertain returns and low private-led research institutions (Prakash and Stigler, 2012). Funding in the form of credit or loans is suggested to be connected to social capital and common pool resources and more recently has been linked to environmental resource management (Anderson et al., 2002). This may imply that smallholder farmers' limited access to formal credit might correspond to a high rate of environmental resource depletion or degradation. This is in line with the study by Tamazian et al. (2008) in which it is argued that development of the financial (banking) sector and financial openness are important for the reduction of $CO_2$ in developing countries. It may not be appropriate to assume a strict positive and significant correlation between environmental degradation and credit. Degradation of the environment may also correlate with other traditional and socio-economic factors as well as nature which should not be excluded from consideration. Farm-level measures to control environmental degradation usually provide diverse long-term benefits. But these practices involve upfront costs and credit market imperfections and failures in rural areas of developing economies impair long-term lending to conservation endeavors (Winters et al., 2004). The low level of lending to smallholder farms may continue to encourage *unsustainable* farming systems, leading to continued soil degradation. Lending by sector amongst commercial banks around the Mount Kenya region indicates that SME agriculture may be underserved. The total lending of commercial banks to small and medium agriculture was 5.65 percent of total portfolio (see figure 5). Prakash and Stigler (2012) argue that commercial bank lending to agriculture in developing countries is less than 10 percent. The percentage of total credit portfolio allocated to agriculture by microfinance and co-operative banks in the Mount Kenya region was high at 49 percent (see figure 6). Commercial banks and an increasing number of microfinance institutions are focusing on individual lending in agricultural financing. Commercial banks prefer the conventional form of collateralization, namely land and physical capital i.e. savings deposit (see figure 7). The same is observed amongst microfinance and co-operative banks (see figure 8) due to a risk management strategy that involves a collateral requirement. This in line with a study by Kodongo and Kendi (2013) that suggests that microfinance institutions in Kenya are shifting from group to individual lending.




*Source: Author*

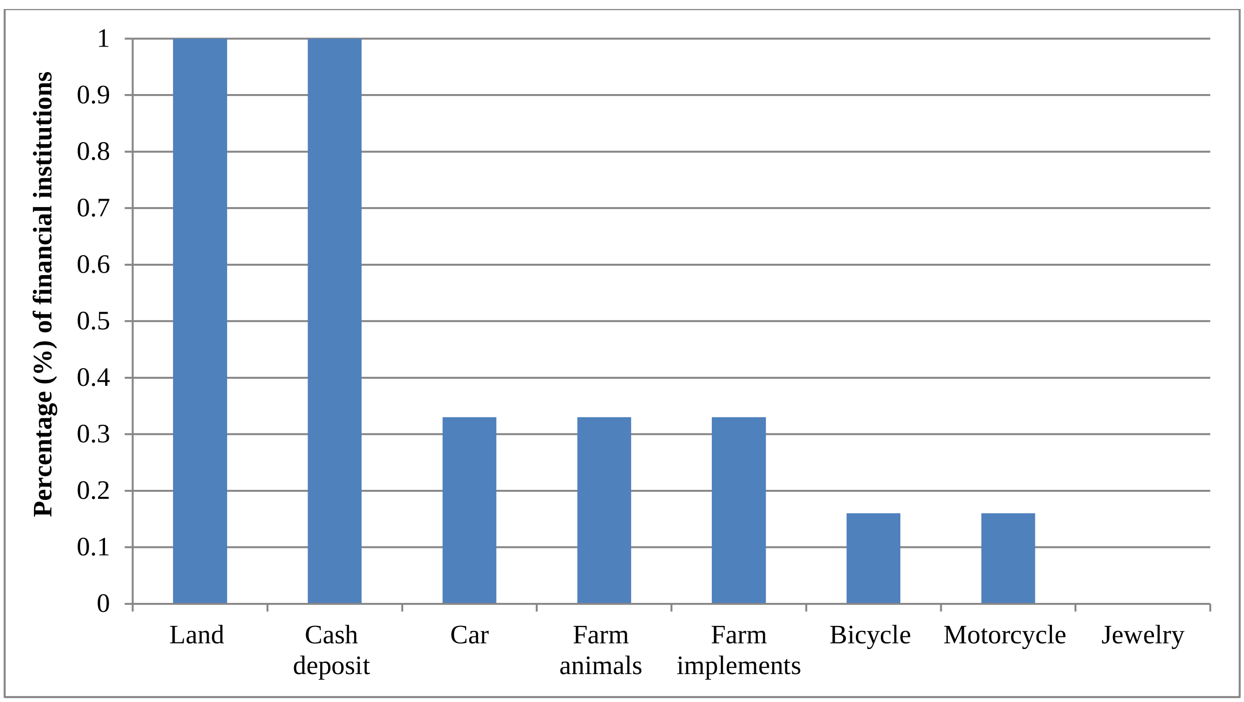
**Figure 5: Average commercial bank lending by sector in Meru, Embu and Nanyuki. Kenya (2013)**




*Source: Author*

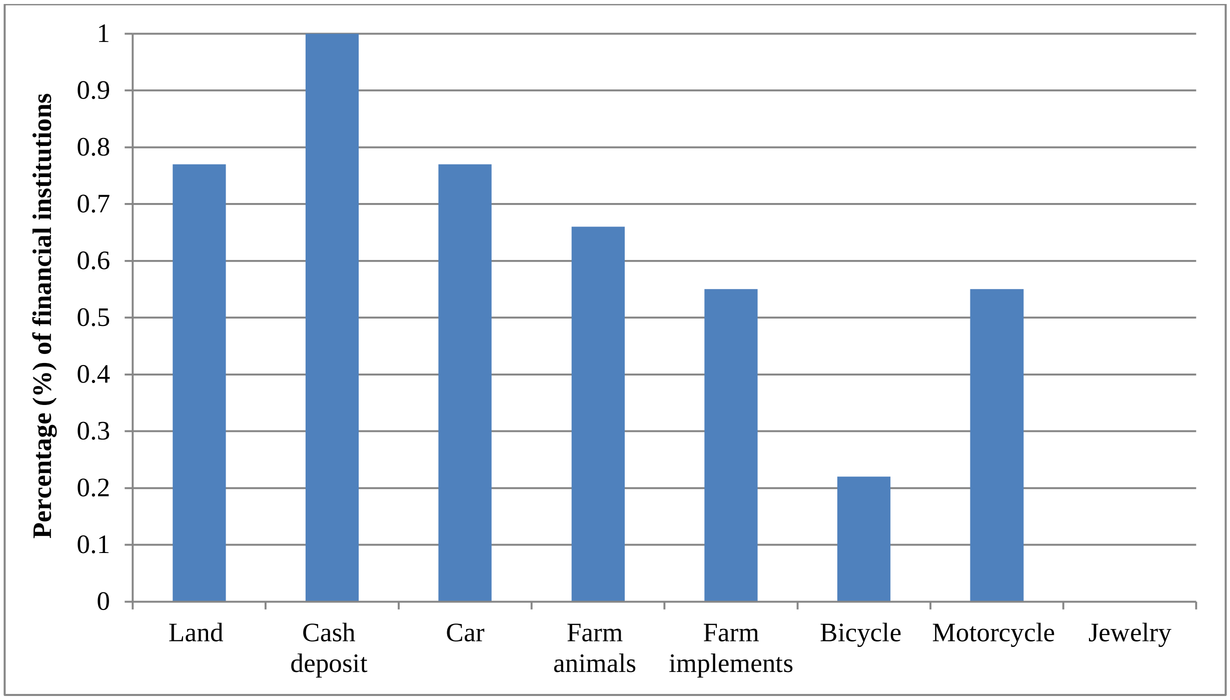
**Figure 6: Average microfinance lending by sector in Meru, Embu and Nanyuki. Kenya (2013)**

When credit is available to smallholder farmers in certain parts of SSA, high interest rates, usually between 22 and 27 percent, make it unaffordable for potential borrowers (Lubwama, 1999). The interest rate charged on agricultural credit by commercial banks in the sampled area is between 18.5 and 19 percent.  This is similar to that charged by microfinance institutions which range between 10 and 24 percent. The high interest rates charged by financial institutions may be due to the aforementioned lack of adequate collateral by smallholders in the agricultural sector. Certain risk-management strategies and national banking legislations may limit agricultural financing of SME agriculture thus favoring large-scale farms which can put up conventional collateral (Jessop et al., 2012; Kloeppinger-Todd and Sharma 2010). Risk management strategies for individual lending that solely focus on conventional collateral in agriculture may not be able to evaluate other eligible forms of collateral. This may be a reason why all the microfinance and commercial institutions sampled in the eastern province of the Mount Kenya region were not aware of Payment for Ecosystem Services (PES) programs taking place within the various local communities.




*Source: Author*

**Figure 7: Preferred collateral of commercial banks in Meru, Embu and Nanyuki Kenya (2013)**




*Source: Author*

**gure 8: Preferred collateral of microfinance banks in Meru, Embu and Nanyuki Kenya (2013)**

Smallholders "*conventional collateral*" due to exposure to exogenous and endogenous shocks may negative influence borrowers credit evaluation by financial institutions. The financial institutions interviewed stated that farmland evaluation is a challenge due to size and ownership structure. Moreover, the high transaction cost accruable to the financial institution in case of default and inability to sell the acquired land is also an issue. Physical capital such as savings deposits—which were not available to rural populations in the past but can now be accessed via Information and communication technology-ICT such as *mobile money*–is perceived to present an opportunity to financial institutions. However, in Kenya, of the 68 percent of adults using mobile phones on an annual basis for sending or receiving money, only 43 percent had an account with a financial institution (Demirguc-Kunt and Klapper, 2012). The total percentage of adults in rural SSA with accounts with a financial institution was estimated at 21 percent compared to 88percent in high-income countries (Demirguc-Kunt and Klapper, 2012). This massive difference in the percentage of savings account holders has been attributed to low national income and high gender inequality in SSA.

The issue surrounding consideration of conventional collateral in smallholder credit evaluation may lead to a pooling system for agriculture loans. Charging a uniform interest rate (pooling) is another measure by financial institutions to reduce the risk of default by borrowers, at the same time this strategy limits lending to a specific thus, exposure to correlated shocks (Skees and Barnett, 2006). This may explain the reason microfinance banks are shifting from group to individual lending, which is a more collateralized form of banking (Goldberg and Palladini, 2010; Lehner, 2009). There is need to provide some form of support to *sustainable* farmers in developing countries to enable them to access formal financial credit (Winters et al., 2004). Credit with favorable interest rates helps smallholder farmers to invest in fertilizers, improved seeds, and conservation which impacts livelihood despite the poor marketing conditions present in most rural areas (Jama and Pizarro, 2008; Solís et al., 2007).

## 1.5 Methodology

To address the research questions in section 1.2, theoretical and empirical analysis was conducted based on game theory, random utility model, logistic regression and ordinary least squares (OLS). Models were proposed for the integration of financial institutions into agroforestry with PES value chain. The game theory model used to address some of the research questions reverts to mathematical methodology in analyzing the strategy of agents (farmers and financial institutions). The strategy chosen by an agent is expected to maximize payoffs in the presence of competitors with other strategies. In such situations the game theory and random utility models are appropriate analytical tools. Question 1 is closely related to the adoption of innovation in a rural context. Question 2 prompts analysis of the mode of interaction between a principal and an agent and information asymmetry. Question 3 revolves around signaling as a mechanism. Question 4 is based on the impact of sustainability on credit risk management. Question 5 is related to the assessment of sustainability on credit accessibility and terms.

Chapter 2 aims to address the first research question. The adoption of an innovation, agroforestry with PES, is treated as a utility problem. A random utility discrete choice model for the adoption of agriculture conservation practices with PES in Costa Rica is applied to agroforestry in Kenya. The model is based on utility maximization of the adopters as well as investigating factors that are likely to influence the adoption of agroforestry with PES in the rural Mount Kenyan region. Apart from the utility derived from agroforestry, aforementioned factors may turn participation in a PES scheme into a sort of “club” which may lead to exclusion of poorer smallholders. Factors that generally characterize smallholder farmers such as farm size, age, and education are analyzed against the backdrop of participation in agroforestry with PES.

Research question 2 is the center of focus of chapter 3. This chapter investigates rural agricultural financing and investment given opportunities provided by international agreement on sustainable development and climate change mitigation. A model based on the current linkage of sustainable smallholder farmers to international emission markets as a value chain process is designed to integrate formal financial institution. This model sheds new insight on diversification of agricultural risk and sustainable investments opportunities for formal financial institutions and international investors.

Chapter 4 seeks to address research question 3. In this chapter, game theory signaling, given incomplete information, is used to assess the first-mover advantage of certain types of borrowers, i.e., smallholder farmers. From the perspective of the financial institution, borrowers are divided into two groups: sustainable and non-sustainable. The former are assumed to have self-financed part of their agroforestry project. This study therefore investigates if partial self-financing can signal to potential lenders a form of business quality, eventually leading to a separation rather than pooling equilibrium amongst agriculture borrowers.

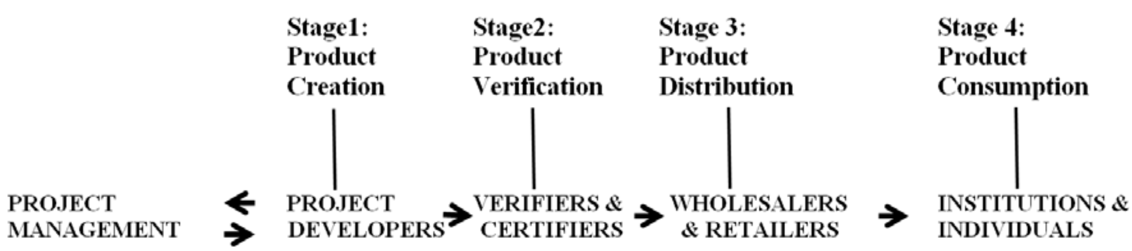
Chapter 5 deals with the fourth research question. Evaluation of credit performance based on sustainable and conventional agricultural practices are simulated using credit risk instruments. The effects of PES from agroforestry on variables including probability of default (PD), loss given default (LGD), and profitability of credit portfolio are quantified. The current low price for carbon per ton and falling prices of conventional collateral was simulated to determine what impact, if any, PES has on risk variables.

Chapter 6 provides answers to the fifth research question. This chapter investigates the credit terms and constraints amongst *sustainable* (agroforestry with PES) and conventional smallholder farmers in Kenya. The impact of PES as an eligible collateral substitute on the interest rate charged by financial institutions is also investigated.

## 1.6 Institutional setting and scale

Environmental degradation, poverty and climate change have called on international and national policy-makers and institutions to establish a framework for sustainable development, including improved smallholder productivity (Winter et al., 2004). Lybbert and Sumner (2010) argue that institutions are important links between agriculture and ecosystem services; through the accounting of GHGs, PES or emission credits are introduced within the sector. The rights to carbon credits are also linked to land rights and therefore the lack of land tenure may present challenges (Shames and Scherr, 2010). Successful PES programs in developing countries require collaboration between organizations (predominantly NGOs) working as intermediaries and local trustworthy networks (Bekessy and Cooke, 2011). Involvement of governmental organizations may delay the adoption of agriculture innovation, since lack of knowledge and proper program design inhibit opportunities to access new markets (Salami et al., 2010). The lack of local institutions to enforce agroforestry regulations may lead to a collapse of the PES project (Rodrigues de Aquino et al., 2011; Perez et al., 2007). Multi-layered institutional structure can address the hurdles in the provision of ecosystem services in areas with high levels of poverty and can also promote pro-poor adoption of agroforestry (Tschakert, 2007). For instance, the value chain of smallholder agroforestry with PES usually involves non-government extension services (project management), carbon developers, third party verifiers and buyers (see Figure 9) (Bayon et al., 2009; Shames et al., 2012; Shames and Scherr, 2010; Peskett et al., 2010). This structure is observed across almost all emission trading markets. The two markets for agroforestry emission trading comprise the compliance and voluntary markets which shall be discussed in detail in the next section. The United Nations' Clean Development

Mechanism (CDM) which is the compliance market, between 2001 and 2003, accepted (A/R) activities as a $CO_2$ emission reduction strategy (Dutschke et al., 2005; Smith, 2002). The voluntary carbon market recognized agroforestry as a mitigation strategy in 1989 and has continuously upgraded its quality of agroforestry emission with standards (Bayon et al., 2009). Lower prices coupled with the limited recognition of forestry's additional social and environmental benefits are two reasons for the low level of transactions on the CDM (Peskett et al., 2010; Kreibich et al., 2013). This study does not differentiate between PES traded on the VCS or CDM market, as the procedures are similar. It is important to analyze the value chain of smallholders' agroforestry with PES from an organizational perspective. Project management entities with the PES project provide extension services and technical assistance (Shames et al., 2012). The extension services provided by the project management differs from the conventional extension services as the focus is on sustainable practices targeted at overcoming climate and environmental challenges. This core competence "*climate smart agriculture*" may therefore lead to resilient and profitable rural agriculture. Project managers are pro-active in the day-to-day operations and outreach of the project, including tree monitoring and PES sharing supervision. The International Small Group Tree Planting Programme (TIST) provides project management of the agroforestry with PES analyzed in this study. TIST is located in the city of Meru in the Eastern province of Kenya.




*Source: Author´s modification* (*Bayon et al., 2009)*

**Figure 9: Supply chain of the voluntary carbon markets**

Carbon project developers are vital for the establishment of carbon projects given their know-how and expertise in emission registration. Carbon project developers range from for- and non-profit organizations to public institutions, each with different motives connected in one way or another to climate change mitigation/adaptation and sustainable development (Hamilton et al., 2008). The carbon developer for the smallholder agroforestry with PES project in the Mount Kenya region is the Clean Air Action Corporation (CAAC). Project developers have to perform a number of tasks which include the monitoring of the cost of project implementation (Shames et al., 2012). Carbon developers have the capability and resources to conduct proper carbon accounting and project design; they usually make decisions regarding project implementation and benefit-sharing (Atela, 2012). Furthermore, it is the responsibility of the carbon developer to provide evidence of a positive socio-economic effect of the project's activities on smallholders, as well as choose appropriate emission methodology (Shames et al., 2012). The overall objective of a carbon developer is to authenticate carbon mitigation, certifying smallholders' farming activities as sustainable. Apart from appointing verifiers, carbon developers—depending on level of involvement in the project—also link smallholders to markets by either acting as carbon credit buyers or finding potential buyers (Seeberg-Elverfeldt, 2010). The verifiers or auditors of emissions within a project are known as the designated operation entity (DOE). The auditing costs of the DOE makes up a substantial portion of the project cost, as DOEs are typically international corporations. This cost is perceived as a hurdle to the registration of projects on the VCS in South Africa, where the focus has shifted to capacity building of local verifiers and auditors (Peters-Stanley and Hamilton, 2012). Retailers and wholesalers supply emission offsets to the market in different volumes using different transaction channels. Retailers provide small amounts of emission credits to individuals and organizations, mostly using online transaction tools (Hamilton et al., 2008; Bellassen and Leguet, 2007). Wholesalers sell emission credits in large quantities to specialized organizations using over-the-counter (OTC) transactions (Hamilton et al., 2008; Bellassen and Leguet, 2007). Organizations buy into the carbon market to offset their emissions for various reasons. Some organizations offset emissions because they are consumer-based, perceive investment opportunities or see it as a form of corporate social responsibility (CSR) (Peters-Stanley and Hamilton, 2012; Gössling et al., 2007; Rondinelli and Berry, 2000; Butzengeiger, 2005). Individuals participate directly or indirectly in carbon trading by paying additional fees on services or products to compensate for emissions generated during production (Bellassen and Leguet, 2007).

The share of organizations and individuals purchasing emission offsets depends on their individual visions and objectives (Butzengeiger, 2005).

### 1.6.1 Climate mitigation mechanism

The carbon emission reduction and corresponding PES of the project analyzed in this section, although traded on the voluntary carbon market, uses the framework of the compliance market. The voluntary and compliance carbon markets are quite similar in the registration and certification issuance processes. The standards of the compliance market are applicable and generally acceptable under the voluntary carbon standards. CDM methodology approved by the Intergovernmental Panel on Climate Change (IPCC) is one of the options available to voluntary carbon for emission calculation from Agriculture, Forestry and Other Land Use (AFOLU) (Kollmuss et al., 2008). There has been a considerable surge in sub-Saharan African forest emission reduction transactions on the compliance and voluntary markets compared to 2010 levels (Shames and Scher, 2010; Kreibich et al., 2013). Carbon credits generated from land-based or terrestrial projects are relevant in voluntary carbon market accounting for 45 and 23 percent of the total credit transactions in 2010 and 2011, respectively (Seeberg-Elverfeldt and Gordes, 2013). The compliance market transacted a total of 10.2 billion tons of $CO_2$ in 2011 compared to 8.7 billion tons of $CO_2$ in 2010 (Peters-Stanley and Hamilton, 2012). On the contrary, the voluntary carbon market transaction decreased from 128 million tons of $CO_2$ in 2010 to 95 million tons of $CO_2$ in 2011 (Peters-Stanley and Hamilton, 2012). The transacted volumes and values of the compliance and voluntary market are depicted in table 1.

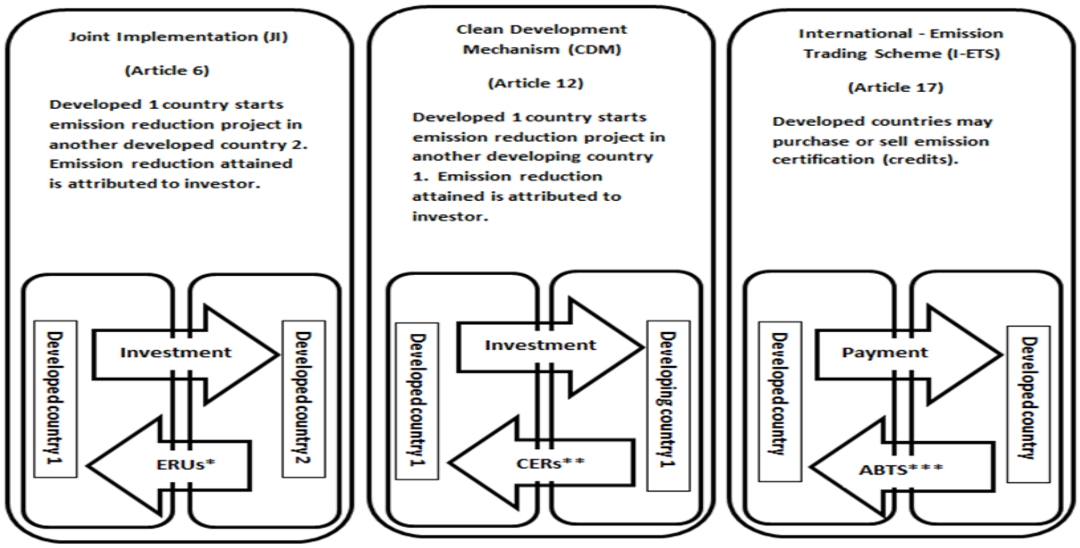
**Table 1: Transaction Volumes and Values, Global Carbon Market, 2010 and 2011**

| | Volume (MtCO2e) | | Value (US$ million) | |
|---|---|---|---|---|
| **Markets** | **2010** | **2011** | **2010** | **2011** |
| **Voluntary OTC-traded** | 128 | 93 | 422 | 572 |
| **CCX (exchange -traded)** | 2 | - | 0.2 | - |
| **Other Exchanges** | 2 | 2 | 11 | 4 |
| **Total Voluntary Markets** | **132** | **95** | **433.2** | **576** |
| **EU ETS [EUA]** | 6789 | 7853 | 133598 | 147848 |
| **Primary CDM**[1] | 265 | 291 | 3206 | 3320 |
| **Secondary CDM**[1] | 1275 | 1822 | 20637 | 23250 |
| **Kyoto** | 62 | 47 | 626 | 318 |
| **RGGI (Regional Greenhouse Gas Initiative)** | 210 | 120 | 458 | 249 |
| **RMU (Removal unit - Land Use, Land-Use Change and Forestry (LULUCF))**[2] | - | 4 | - | 12 |
| **NZU (New Zealand Units)** | 7 | 27 | 101 | 351 |
| **CCA (California Carbon Allowance)** | - | 4 | - | 63 |
| **Other Allowances** | 94 | 26 | 151 | 40 |
| **Total Regulated or compliance Markets** | **8702** | **10194** | **158777** | **175451** |
| **Total Global Markets** | **8834** | **10289** | **159210.2** | **176027** |

*Source: Peters-Stanley and Hamilton, 2012*

The seventh session of the United Nations convention on climate change in 2001 in Marrakesh restricted the maximum amount of forestry mitigation investment by developed countries to developing countries under the Kyoto protocol. The maximum permissible investment from a developed country in generating carbon credits through forestry in developing countries is one percent of its 1990 emission level multiplied by five (Smith, 2002). The articles 6, 12, and 17 of the Kyoto protocol stipulate three transaction or trading channels of emission reduction by developed or annex 1 country (see figure 10). The article 12 is an important transaction avenue for forestry i.e. A/R emission project from developing countries under the compliance market. A/R has a rather broad definition which comprises the conversion of non-forest land to forest through conversation farming system or protection of forest and should support sustainable development (Smith, 2002).

[1] Clean Development Mechanism
[2] Land Use, Land Use Change and Forestry




*= Emission Reduction Units

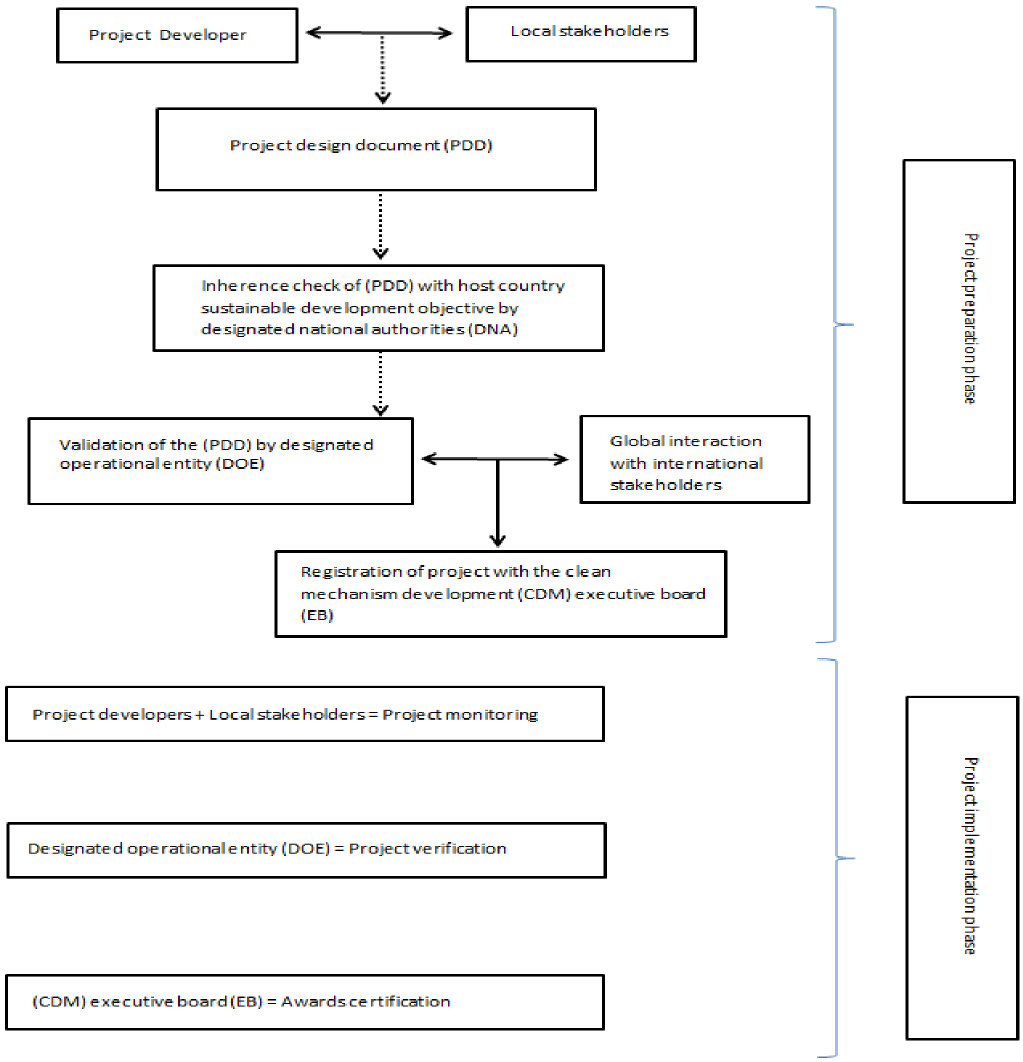
**= Certified Emission Reductions

***= Allowance-Based Transaction System

*Source: Author*

**Figure 10: Framework of climate mitigation mechanism of the Kyoto protocol**

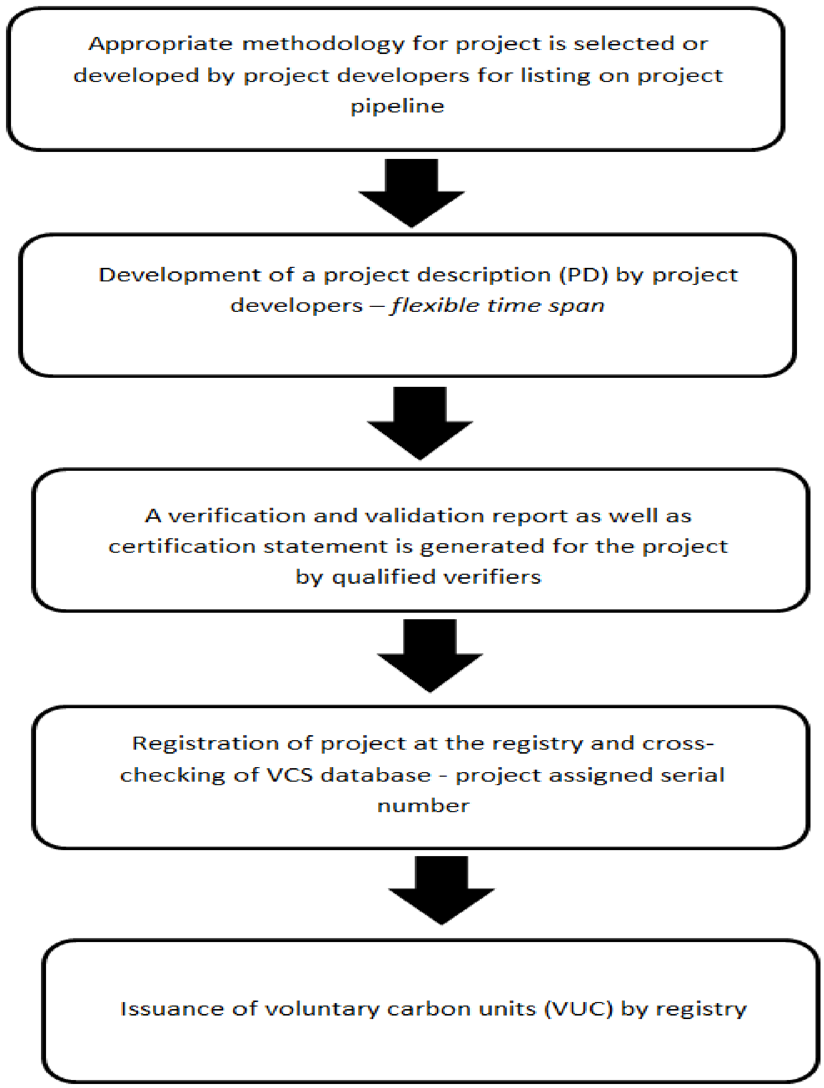
An important step at the beginning of any carbon project is the formulation of a project idea note (PIN), which helps developers structure their project objectives. The PIN lays the foundation for the project design document (PDD) which is the formal documentation that determines the approval of the projects. The PDD communicates the main reason for engaging in an emission mitigation project, e.g., for financial or environmental purposes, to the registration authority. The document also stipulates the baseline, appropriate methodology for carbon accounting and leakage as well as monitoring and verification. The compilation of forestry PDD involves a large number of stakeholders which include individual farmers, local authorities and host communities. This broad consultation with different stakeholders and the corresponding protocols are Important for meeting the additionality criteria of the CDM as well as baseline calculation. Countries that rectified the Kyoto protocol, apart from pledging to implement mitigation action plans, also established designated national authorities (DNAs) to monitor self-determined threshold levels. The DNAs undertake the evaluation of the PDD on behalf of the host country and also approve the host country's submission to the CDM executive board after it is reviewed by the DOE. After validation of emissions reduced by the project, it is then registered with the CDM executive board. The registration procedure of emissions as described above is termed the project preparatory phase for all emission mitigation projects including agroforestry with PES (see figure 11). The next phase of the project is implementation which includes active participation of all stakeholders along the agroforestry with PES value chain. At the start of the agroforestry with PES project, stakeholders work vigorously to predefine timelines for monitoring emission reductions and extension service offerings. Extension services include farm and financial management training, demonstrations, and regular meetings to promote sustainable farming through forest cover. The project verification by the DOE is done on a continuous basis, i.e., throughout the life span of the project, typically every five years for a small-scale agroforestry with PES project. Only after additional validation by a third DOE of the claimed emissions reduction from the project is certification possible. The CDM executive board will then issue the credit for the subsequent commitment period.




*Source: Author*

**Figure 11: Registration processes under the Kyoto protocol´s Clean Development Mechanism (CDM) afforestation / reforestation (A/R)**

The methodology for accounting for carbon sequestrated, discussed in the next section, is an important component of all emission projects, particularly in the preparation phase. However, the PDD for carbon credits designated for the voluntary market project can be formulated before, during or after the project implementation phase. This is one area where the VCS requirement is flexible compared to the CDM. While project developers choose the appropriate methodology, DOE ensures that methodologies and baselines chosen are suitable and comply with VCS or other approved standards (VCS, 2007). Only after the conditions of the VCS are met, and validation and verification reports as well as certification of statements are issued by at least two DOEs, can carbon credits be expected (VCS, 2007). The multi-evaluation of voluntary market traded carbon credit is required to allow for transparency and reduce conflict of interest which has made external, rather than in-house, verifiers or auditors increasingly important (Kollmuss et al., 2008). The registration of the project with the registry after thorough examination of submitted documents and VCS screening leads to issuance and depositing of emission certification to a custodial service.




*Source: Author*

**Figure 12: Registration processes under the voluntary carbon standard (VCS)**

### 1.6.2 Carbon measurement in agroforestry

This section reviews forestry carbon accounting and important conditions for forest carbon registration under the CDM, which is also applicable to all other carbon markets. The United Nations Framework Convention on Climate Change (UNFCCC) (2005) defines forest as "*a minimum area of land of 0.05-1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 meters at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10-30 per cent or tree height of 2-5 meters are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest*". The applicability condition states that crop and settlement land can be converted into forest cover, irrespective of size, and earn PES. If a number of plots belong to one project, it is possible to bundle these plots of farmland into a single entity as long as the total amount of carbon sequestrated does not exceed to 8000 tons or eight kilotons of $CO_2$ per year (UNFCC, 2003). Non-bundled small-scale agroforestry sequestrates a maximum of 16,000 tons of $CO_2$ equivalent (tCO2e) annually (Thomas et al., 2009). To keep opportunity costs low, a maximum of 20 percent of total land may be allocated to tree crown covered for cropland, while tree cover on the project site prior to the project should be less than 20 percent (UNFCC, 2003). It is suggested by a number of studies that more flexibility and simplification of the methodology and documentation procedures will lead to increased forestry participation on the carbon market (Thomas et al., 2009; Locatelli and Pedroni, 2006). Although the challenges of implementing agroforestry with PES may be daunting due to applicable methodology, approved methodology seeks to simplify this procedure. Other important variables such as additionality, greenhouse gas removal by sinks (based on baseline calculation), leakage, non-permanence and environmental and socioeconomic impacts have to be estimated.

The additionality condition stipulates that actual carbon removal by sink due to a project should increase beyond the baseline scenario, i.e., a case where the project was non-existent. This condition also states certain barriers which would make the implementation of the project less likely in developing countries, thus, qualifying for investment from annex 1 countries. Some examples of these barriers are lack of funds, credit constraints, inconsistent forestry legislation and lack of know-how (UNFCC, 2003). Other barriers are the ecological condition of the region as well as social factors such as conflict of interest and illegal tree harvesting.

To calculate the AFOLU greenhouse gas removals by sinks, the baseline condition needs to be determined. The baseline, also termed a "reference scenario", is defined as the projection of the changes to carbon stock at the project site in the absence of the project. Existing stock of carbon such as tree biomass, litter and deadwood, shrubs and vegetation, soil organic carbon (SOC) are called carbon pools in baseline. In selecting a baseline, it is important to know if the carbon pool is significant. If there are no significant carbon pools in a baseline, then a simplified baseline, which is constant throughout the credit period, can be used otherwise revert to a baseline method proposed by executive board of the CDM. The simplified baseline standard as stated in the UNFCCC (2014) guidelines may therefore apply to the on-going project in rural Kenya since portions of cropland are converted to forest. This Simplified baseline of land-use prior to a project in a given year t is denoted as:

$$\Delta C_{BSL,t} = 0 \tag{1}$$

This means changes in the carbon baseline without the project, annually measured as $t\,CO_2eYr^{-1}$, shall be equal to zero.

The actual net carbon removal by sink per year $(t\,CO_2eYr^{-1})$ is equivalent to the project's carbon removed by sink given stratification by tree species, tree age classes, soil, and agroforestry practices calculated as:

$$\Delta C_{Actual,t} = \Delta C_{PJ,t} \tag{2}$$

Stratification by tree species, tree age classes, soil, and agroforestry practices is estimated as:

$$\Delta C_{PJ,t} = \sum_{i=1}^{I} \Delta C_{\mathrm{Pr}oject,i,t} \cdot \frac{44}{12} \tag{3}$$

The equation (3) above can be simplified to consist of the difference in carbon stock (ton of Carbon -tC) in living trees for a given stratum, *i*, at a given time *t*, the number of years between carbon stock evaluation, $T$ , and average yearly carbon change in the soil for a given stratum, *i*, at a given time *t*, denoted as:

$$\Delta C_{\Pr oject,i,t} = \frac{C_{tree,i,t_2} - C_{tree,i,t_1}}{T} + \Delta C_{soil,t} \quad (4)$$

The estimation of carbon stock, $C_{tree,i,t}$ , can be done using the biomass expansion factor (BEF) or the allometric equation method.

The BEF method to calculate carbon stock $C_{tree,i,t}$ above and below ground, *AB/BB*, for individual tress, *l*, by species, *j*, plot, *sp*, stratum, *i*, and year, *t*, ($C_{AB,i,sp,j,l,t}$ and $C_{BB,i,sp,j,l,t}$ ) involves certain steps. The first step is an *ex ante* estimate at 1.3 meters above ground level of the diameter at breast height (DBH) and height using a data table, or an *ex post* estimation by actual measurement. The next step is to estimate the volume of the commercial component, $V_{AB,i,sp,j,l,t}$ , of the trees using the available equation, default value or yield table. A relascope or tele-relascope measurement may provide a combined value for step one and two. The third step is to choose a value for BEF and a carbon fraction, $CF$ , of dry matter for specific species (IPCC default value for CF is 0.5 t C). The fourth step would be to calculate the basic wood density D, which is:

$$D = \frac{M}{V} \quad (5)$$

Where *M* is equal to mass and V is the volume of the tree.

The conversion of the commercial component of the tree, $V_{AB,i,sp,j,l,t}$ , to above-ground carbon stock is as follows:

$$C_{AB,i,sp,j,l,t} = V_{i,sp,j,l,t} * D_j * BEF_{2,j} * CF_j \quad (6)$$

The above-ground $C_{AB,i,sp,j,l,t}$ carbon stock can be converted to below-ground biomass $C_{BB,i,sp,j,l,t}$ by multiplying by a root-shoot ratio, *R*, (default value for all trees = 0.3kg d.m t C):

$$C_{BB,i,sp,j,l,t} = C_{AB,i,sp,j,l,t} * R_j \quad (7)$$

Total above and below ground carbon stock of all trees, *l*, in sample plot *sp*, stratum *i*, at given time, *t*, can be estimated by summing all trees, *l*, by species, *j*, in the plot, *sp*, and time *t*:

$$C_{tree,i,sp,t} = \sum_{j=1}^{S_{PS}} \sum_{l=1}^{N_{,i,,j,sp,t}} \left( C_{AB,i,sp,j,l,t} + C_{BB,i,sp,j,l,t} \right) \quad (8)$$

To estimate the mean carbon stock, $C_{tree,i,t}$, in trees biomass for each stratum, $i$, divide the area of stratum of corresponding plots, $A_i$, by the total area of sample plots in stratum (ha), $Asp_i$, and multiply by carbon stock of all trees, *l*, in sample plot *sp*, stratum *i*, at given time, *t* :

$$C_{tree,i,t} = \frac{A_i}{Asp_i} \sum_{sp=1}^{Pi} C_{tree,i,sp,t} \quad (9)$$

The allometric equation method to estimate the carbon stock, $C_{tree,i,t}$ is similar to the BEF method. The DBH and Height calculation are identical to that of the BEF. The total above-ground biomass (TAGB) for respective tree species, *j*, at time, *t* , for any given *DBH* and *H* referred to as $f_j$ (DBH, H) can be solved using different estimation models (Basuki et al., 2009). The TAGB for (tropical) trees with a diameter of between 5cm to 156cm can be estimated as (Basuki et al., 2009):

$$TABG = \exp(-2.134 + 2.53\ln(\text{DBH})) \quad (10)$$

$$TABG = p\exp(-1.499 + 2.148\ln(\text{DBH}) + 0.207(\ln(\text{DBH})^2 - 0.0281(\ln(\text{DBH})^3) \quad (11)$$

Where *P* is species-specific wood density (g/cm3)

$$TABG = r\, p^{avg}((\text{DBH})^{2+c} \quad (12)$$

Where *r* is a parameter constant over a wide range of geographical areas, $p^{avg}$ is the average wood density for the study areas, and c is a parameter estimated from the relationship between tree height and DBH.

The above-ground carbon stock $C_{AB,i,sp,j,t}$ for each individual tree, *l*, and species, *j*, on sample plot, *sp*, for stratum, *i*, can be evaluated as:

$$C_{AB,i,sp,j,t} = \sum_{l=1}^{Nl,sp} CF_j * f_j(DBH, H) \tag{13}$$

The conversion of above-ground carbon stock $C_{AB,i,sp,j,l,t}$ to below-ground biomass $C_{BB,i,sp,j,l,t}$ follows earlier calculation:

$$C_{BB,i,sp,j,t} = C_{AB,i,sp,j,t} .R_j \tag{14}$$

The resulting carbon stock in living tress, by species, plot, stratum and year, is calculated as:

$$C_{tree,i,sp,t} = \sum_{j=1}^{S_{PS}} \left( C_{AB,i,sp,j,t} + C_{BB,i,sp,j,t} \right) \tag{15}$$

The mean carbon stock in trees biomass for each stratum **(**$C_{tree,i,t}$) also follows earlier estimations:

$$C_{tree,i,t} = \frac{A_i}{Asp_i} \sum_{sp=1}^{Pi} C_{tree,i,sp,t} \tag{16}$$

The *ex-ante* and *ex-post* estimations of the difference in annual soil organic carbon (SOC), $\Delta C_{soi\acute{i},i,t}$, for strata, *i*, in year, *t*, without organic soil is calculated as:

$$\Delta C_{soi\acute{i},i,t} = A_i * \Delta C_{agroforestry,i} \qquad for\ \ t \le t_{equilibrium,i} \tag{17}$$

$$\Delta C_{soi\acute{i},i,t} = 0 \qquad for\ t > t_{equilibrium,i} \tag{18}$$

Where $A_i$ is the area earlier defined, $\Delta C_{agroforestry,i}$ is the average increase in carbon stock for SOC pool in agroforestry in stratum *i*, and $t_{equilibrium,i}$ is the time a new equilibrium is attained in carbon stock for SOC pool for agroforestry in stratum *i*, from the project commencement period. The default value of $\Delta C_{agroforestry,i}$ and $t_{equilibrium,i}$ are given as 0.5 t C $ha^{-1}$ $yr^{-1}$ and 20 years respectively (UNFCC, 2014).

Leakage is the occurrence of unintended and unwanted activities due to implementation of an emission reduction project. An example of leakage is the increase in GHG emissions due to the deforestation of a different location as a result of implementing a forestry emission mitigation project (Seeberg-Elverfeldt, 2010). For the simplified methodology, leakage, $LK_t$, will not occur at any given time, and therefore for the carbon developer and project participant this value is equal to zero:

$$LK_t = 0 \tag{19}$$

The net anthropogenic gas removal by sinks for each year $(C_{AR-CDM,t})$ is therefore estimated as:

$$C_{AR-CDM,t} = \Delta C_{Actual,t} - \Delta C_{BSL,t} - \mathrm{LK_t} \tag{20}$$

The units of temporary certified emission reduction, $tCER_{tv}$, at year of verification, *tv*, in $tCO_2e$ is estimated as:

$$tCER_{TV} = \sum_{t=0}^{tv} C_{AR-CDM,t} * \Delta t \tag{21}$$

Where Δt is a time increment of typically 1 year.

The units of long-term certified emission reduction, $lCER_{tv}$, at year of verification, *tv*, in $tCO_2e$ is calculated as:

$$lCER_{TV} = \sum_{t=0}^{tv} C_{AR-CDM,t} * \Delta t - lCER_{TV-K} \tag{22}$$

Where $lCER_{TV-K}$ are the units of *l*CER issued in the current verification deducted from those issued in the previous verification period. The *l*CER and tCER from small scale forestry expires at the end of the crediting period, i.e., a period where emission reduction from the baseline is verified and certified by DOE. The crediting period for small scale forestry commences at the implementation, rather than registration, phase. The typical crediting period for small scale forestry project is between 30 to 40 years (CDM rulebook, 2014).

The non-permanence (loss in carbon stock due to fire, drought) risk of AFOLU emission reduction requires setting aside carbon credit from the project as insurance (VCS, 2012b). The tCER calculation of forestry carbon is used to account for the risk of non-permanence, i.e., duration of storage and probability of loss of a project (Seeberg-

Elverfeldt, 2010). The *l*CER may also address the risk of non-permanence of credit from forestry.

Environmental and socio-economic analyses include the direct and indirect impacts of the project. The analyses also consider the impact of the project on biodiversity and natural ecosystems beyond the project site (CDM rulebook, 2014). The socio-economic analysis of the impact of agroforestry with PES on a smallholder's livelihood, apart from suggesting a positive and significant direct effect, also indicates a similar effect on credit accessibility and interest rates (Benjamin 2014; Benjamin et al., 2014).

The variables discussed above, to a large extent, constitute the PDD for the program of activities (PoA) and may explain the high transaction costs associated with forestry carbon programs. The cost of developing a small-scale agroforestry with PES project sequestrating < 5000 ton $CO_2yr^{-1}$ is estimated to range between US$25,000 and US$65,000 (Benjamin, 2012). This is in line with estimates by Thomas et al. (2009), where application costs of CDM forestry projects were between US$50,000 and US$200,000. The total cost of a forestry carbon project registration under VCS in Thailand was US$75,000 (Samek et al., 2011). The estimated cost of verifying and certifying the project which sequestrated 45,125 Mg $CO_2$ over the next 15 years, was US$45,000 (Samek et al., 2011). This is somewhat in line with estimates given by Bayon et al. (2009) for the cost of carbon verification under VCS, which ranged between US$5,000 and US$23,100. The transaction costs due to measurement, reporting and verification are argued to exceed the PES per hectare per year which is estimated to be far less than US$30 $ha^{-1}$ $yr^{-1}$ (Luedeling et al., 2011).

## 1.7 Reading Guide

The subsequent chapters of this thesis address the research questions formulated in section 1.2, while the last chapter draws some overall conclusions. The research questions analyzed in this thesis are a result of the multiple challenges confronting rural agriculture financing in parts of sub-Saharan Africa as described by the status quo in sections 1.4 and 1.5. Moreover the research questions are related to the institutionalization of international climate and sustainable development agreements as well as certification value chain in section 1.6.

Chapter 2 analyzes the participation of smallholders in the TIST program in rural Kenya. This small-scale agroforestry project is linked to the international emission market and generates PES. The analysis is carried out to explore the determinants of adoption and the inclusiveness (i.e., non-formation of privileged participation or club) of small-scale agroforestry with PES projects in rural areas.

Chapter 3 assesses the potential linkage of PES value chain to the credit evaluation of financial institutions. A model which savors business relationships between sustainable smallholder farmers and financial institutions is developed. Two scenarios of the proposed model are explored.

Chapter 4 explores partial self-financing of business as a strategic business decision and its influence on financial institution credit allocation. The signaling theory is used to show if and how such a strategy may lead to a separation rather than pooling equilibrium in agricultural lending.

Chapter 5 analyzes the impact of PES on the credit default potential of farmers with conventional collateral (farmland) given an exogenous shock. Financial mathematical methodology for risk assessment is used to compute the credit default probability of South African farmers with and without PES.

Chapter 6 reviews the impact of PES on credit accessibility and the interest rate of sustainable smallholder farmers. A theoretical assumption based on sorting and screening is used to model collateral and interest rate interaction. The data collected in rural Kenya is used in the empirical analysis.

Chapter 7 concludes with important policy recommendations for stakeholders. These stakeholders include national and international agencies and organizations as well as farmers.

## Chapter 2[*]: Participation of smallholders in carbon-certified small-scale agroforestry: A lesson from the rural Mount Kenyan region

### 2.1 Introduction

Agriculture is central to ensuring food security; it provides jobs and livelihoods for large shares of the populations in developing and emerging economies, and it offers a channel for smallholder farmers to escape poverty and increases incomes above subsistence-levels. In the future, agriculture will be crucial in the move towards achieving sustainable economic production by providing food and feed as well as eventually producing the crops for bioenergy that can replace fossil fuels. Agriculture also plays a major role in mitigating the effect of climate change (Garnett et al., 2013; Smith et al., 2007); using diverse technologies and adopting them to local circumstances is an effective way to achieve these goals. Medium- and high income farmers have means to adopt new technologies since their farm infrastructures often include modern communications, education, a skilled labor force, and access to financial markets. For example, it has been observed that in Costa Rica and Senegal, forestry programs that enable farmers to obtain payments for ecosystem services (PES) may be adopted predominantly by larger farms with highly-skilled staff and off-farm income (Zbinden and Lee, 2005; Tschakert, 2007). Smallholders often face little asset endowment due to small farm size and insecure property rights, thus they have limited opportunities to enter credit markets and adopt sustainable or modern technologies. Research has shown that networks of smallholders may help foster information flows and induce spillover effects among them, helping to achieve the aforementioned goals, despite substantial disadvantages (Benjamin et al. 2014).

This paper contributes to our understanding of how networks, farm characteristics and farmers' individual characteristics function with respect to the adoption of innovative production methods. We focus on smallholders' participation in

---

[*] The definitive, peer-reviewed and edited version of this article is published in [World Bank Land and poverty conference 2015 proceedings, March 23 – 27, Washington D.C, U.S], or [https://www.conftool.com/landandpoverty2015/index.php/Benjamin-108-108.pdf?page=downloadPaper&filename=Benjamin-108-108.pdf&form_id=108.].

agroforestry with PES, a means to generate additional revenue through the acquisition of pollution rights (carbon storage through agroforestry) and the sale of these pollution rights on the compliance market (clean development mechanism (CDM)) or voluntary carbon market (voluntary carbon standards (VCS)).

PES from land use programs benefits poor smallholder farmers in developing countries, depending on the distribution of land quality, through productivity compensation and increases in output prices and labor demand (Zilberman et al., 2008). Empirical evidence suggests that participation in emissions trading and corresponding PES may ease smallholder farmers' financial credit constraints and lower interest rates of borrowers over the long term (Benjamin et al., 2014). Easier access to credit markets in turn is associated with more investment in agriculture, health and education, and subsequently, higher incomes. Agroforestry projects with PES may promote poverty alleviation amongst poor smallholders by increasing incomes, contributing to soil fertility, and reducing soil erosion, all of which can lead to increased food security. It is argued that participation by the poorest smallholders in agroforestry with PES may help in the attainment of international poverty alleviation objectives such as the Millennium Development Goals (Pagiola et al., 2005; Saliu et al., 2010; Shames, 2012; Garrity, 2004; Miyazawa, 2012).

The rationale behind this study is to understand motives and determinants of smallholders' participation (or non-participation) in PES. We use data from The International Small Group Tree Planting Programme (TIST) around the Mount Kenya region in Kenya. Participation in TIST is voluntary and unrestricted. TIST contributes to the local agricultural sector through the provision of credit and savings infrastructure, farm management training, as well as training in agricultural techniques and technologies. TIST encourages participation in the carbon markets and ensures collaboration with carbon developers who serve as intermediaries, helping to link Kenyan smallholders and carbon markets. This empirical study uses information about smallholders to assess their reasons and incentives to participate in TIST, as well as the barriers for doing so. This paper may serve as a manual to the investigation of country-specific effects, leading to a more comprehensive picture. In the Kenyan case, we find evidence that the spread of information, existing networks and peer involvement in the

TIST program are forces that drive participation in TIST. Conversely, smallholders' participation in TIST does not seem to be influenced by education levels, land ownership or asset endowment. Contrary to some sources, we found weak evidence that the adoption of agroforestry with PES in the Mount Kenyan region increases with a smallholder's age.

The remainder of this article is structured as follows. In section 2.2 we discuss materials and methods used in this study. In section 2.3 we provide a selective review of the literature and discuss potential determinants for participation in agroforestry with PES. In sections 2.4 and 2.5 we present our data and discuss empirical results, respectively, and Section 2.6 outlines our conclusion.

## 2.2 Material and methods

Conservation farming, depending on level of investment, has greater benefits, e.g. higher productivity, when compared to conventional farming (Byiringiro and Reardon, 1996). It is therefore assumed that there are two types (conservation and conventional) of farming practices, $Y_{F,}$ available to farmers, *i*, in sub-Saharan Africa. These farmers choose the practice that gives the highest utility given resource constraints. Smallholder farmers maximize not only profit but also welfare, with multiple objectives ranging from food and social security to reduction in diverse consumption risks (Scherr, 1995). Wunscher et al. (2011) analyzed the effect of non-monetary variables of the opportunity cost of agroforestry with PES on adoption using a utility function. The utility function of agroforestry with PES, $U_c$, was defined as $U_c = U_c(P_{\exp}(C_{payment}, C_{t+p,} R, I), N_c)$. $U_c$ is a function of expected net payment ($P_{exp}$) which is a function of offered payment $C_{payment}$, transaction and protection cost $C_{t + p}$, perceived risk and risk behavior *R*, information attributes *I*, as well as non-monetary costs and benefits of forest conservation through PES enrollment which are unknown parameters $N_c$. The utility of alternative agricultural land use, $U_a$, is defined as $U_{a.} = U_{a.}(B_{\exp}(C_{opp}, R, I), N_{a.})$. $U_a$ is a function of expected net payment ($B_{exp}$) which is a function of the opportunity cost, $C_{opp}$, as well as $R$, *I*, *N* (as defined above).

The random utility model similar to that of Wunscher et al. (2011) is also used in this analysis by concentrating on the effects of non-monetary variables of agroforestry with PES on its adoption. The PES from agroforestry is an economic incentive which may influence the adoption decisions of smallholders (Pattanayak et al., 2003). However, low carbon market prices and revenues accruable to smallholder farmers may be a setback to agroforestry projects. The PES from agroforestry to smallholders around the Mount Kenyan region is approximately US$10 per hectare per year or US$0.02 per tree per year (Shames et al., 2012). This is similar to payments observed in Bolivia, where forest conservation generates US$7 per hectare per year, whereby in some instances PES are lower than the opportunity cost (Wunder, 2007; Landell-Mills and Porras, 2002). Despite current low PES, smallholder farmers in developing countries continue to voluntarily participate in agroforestry programs, in part due to long contract phases or awareness of non-PES-related benefits. The effect of soil and natural resource conservation, an important part of sustainable agroforestry, on the livelihood of smallholders cannot be overemphasized (Nicoll et al., 2005; Sanchez et al., 1997; Benjamin, 2012). Franzel (1999) argues that factors that influence the adoption of agroforestry practice as a conservation method in Africa may be classified into feasibility, profitability, and acceptability. If the utility of agroforestry with PES, $(U_{A/R})$, is greater than alternative use of land $(U_{Alter.})$ $U_{A/R} > U_{Alter.}$ then smallholders will opt for Afforestation or reforestation-A/R participation (Ogada, 2012; Wunscher et al., 2011).

Our model focuses on the utility of agroforestry with PES as it is modified to give the spread of information through social interaction a more central role. The importance of social capital on the adoption of sustainable agricultural conservation in communities has been illustrated by diffusion in innovation theory (Wejnert, 2002; Knowler and Bradshaw, 2007). The flow of information is essential to the adoption of agricultural innovation; the more complex the innovation, the more information that will be sought. The innovation-decision process has been described as an information-seeking and information-processing activity which in the long run reduces uncertainty amongst adapters through proper communication channels (Rogers 2003). Social capital and consultative norms were observed to positively influence the adoption of agriculture technology in Tanzania (Isham, 2000). The model by Foster and Rozenweig (1995) on the effect of knowledge on innovation adoption by rural households in India suggests that low levels of knowledge are a major barrier. The model also gives evidence of learning spillover from experienced neighbors. It is argued that social information channels and farmer-to-framer communication amongst smallholder can increase the adoption of conservation practices with PES (Garbach et al., 2012).

Households producing ecosystem services at or below the fixed set of PES will accept current market prices, while those producing above the fixed set may decide not to enroll in PES schemes (Jack et al., 2008). However, non-monetary benefits from agroforestry with PES may motivate households in the latter category to stay in the program[3]. In other words, households may be quite aware of the future earnings of PES as well as the non-monetary benefits via information received from extension services and informal meetings (Zbinden and Lee, 2005).

The information disparity level amongst family members is argued to be minimal (Pollak, 1985). This may lead to a high monitoring of projects whereas household members themselves serve as a kind of insurance mechanism that can impact levels of transaction and protection costs (Pollak, 1985)

The spread of information through interpersonal exchange (*I*), word of mouth *(WOM)* and media (*M*) also reduces perceived risk and risk behavior of individuals (Mitra et al., 1999). Thus, membership in community agroforestry organizations, to which more than one member of a family often belongs, not only provides infrastructural support but also an adequate channel for communication of relevant information, reducing uncertainty and improving payoffs (Mercer and Pattanayak, 2003; Caveness and Kurtz, 1993; Kabwe et al., 2009). It can therefore be argued that all variables are a function of some form of information flow, i.e.:

$$C_{payment} = C_{payment}(I_M);\ C_{t+p,} = C_{t+p,}(I_{HH});\ \ R = R(I_{I,WOM,M});N_{A/R}) .$$

$I_M$ denotes the information flow on monetary benefits of PES, $I_{HH}$ information sharing amongst households on transaction and protection cost, $I_{I,WOM,M}$ is the interactive information and communications link within formal or informal programs. The conditional utility function of agroforestry with PES therefore can be re-written as:

[3] However, this aspect was largely ignored in this analysis as it is beyond the scope of this article.

$$U_{A/R} = (P_{\exp}(I_{M,WOM,M,HH}), N_{A/R}) + \varepsilon_{A/R} \quad (1)$$

The utility function of not participation in agroforestry with PES is denoted as

$$U_{Alter} = (B_{\exp}(C_{opp}, R, I),\ N_{Alter.}) + \varepsilon_{Alter} \quad (2)$$

Where $\varepsilon$ is the error term for adopting and non-adopting smallholders.

The reduced form of the choice probability of participating in agroforestry with PES, $Y_{Fi}$, is therefore denoted as:

$$Y_{Fi} = \begin{cases} 1, if\ (P_{\exp}(I_{M,WOM,M,HH}), N_{A/R}) + \varepsilon_{A/R} > (B_{\exp}(C_{opp}, R, I),\ N_{Alter.}) + \varepsilon_{Alter} \\ 0, if\ (P_{\exp}(I_{M,WOM,M,HH}), N_{A/R}) + \varepsilon_{A/R} + \varepsilon_{A/R} < (B_{\exp}(C_{opp}, R, I),\ N_{Alter.}) + \varepsilon_{Alter} \end{cases} \quad (3)$$

Equation 3 defines the general condition under which decision to adopt conservation may occur.

Smallholders also generate additional utility, $y_i$*, which are unobservable, if they choose either conservation or conventional farming. This additional utility is however conditional on certain features of these farmers. Additional utility, $y_i$*, is denoted as;

$$y_i * = \beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + u_i \quad (4)$$

$$y_i * = \beta_1 + \beta_2 Farm\ characteristics_i + \beta_3 Bu\sin ess\ \mathrm{mod} el_i + \beta_4 Personal\ characteristics_i + u_i$$

The unobservable additional utility if greater than zero will increase the likely of adoption of agroforestry with PES

$$Y_{Fi} = \begin{cases} 1, if\ \ y_i * > 0 \\ 0, if\ \ y_i * < 0 \end{cases} \quad (5)$$

## 2.3 Potential determinants for participation in agroforestry with PES

a) Farm size

Smallholder farmers may decide against certain types of conservation agriculture especially if confronted with land constraints and if adopting a new agricultural technology requires substantial land allocation. This trend was observed in certain parts of sub-Saharan Africa and other developing countries (Thangata et al., 2008; Current et al., 1995). Marenya and Barrett (2007) and Scherr (1995b) argued that for smallholders in western Kenya, farm size had a significant positive effect on agroforestry adoption. While farm size is an appropriate indicator for wealth in a rural economy context is highly contested (Pattanayak et al., 2003; Scherr, 1995b), farmers with larger farms typically are not the poorest of the poor, and often the poorest of the poor lease or rent land under different tenure systems. This implies that only farmers with a certain level of asset endowments participate in agroforestry projects, leading to a selection issue amongst adopters of agroforestry with PES and possible exclusion of the poorest of the poor smallholders from PES schemes. The adoption of agroforestry in Kenya was found to be affected by the security of land ownership/rental agreement rather than the size of farm land cultivated (Mercer and Pattanayak, 2003). Therefore, the tenure system of the rented or leased land may be vital to inclusion in PES schemes. Because of the length of time involved in the agroforestry adoption process compared to other agricultural practices, property rights are an important consideration (Place et al., 2012). Not only are clear definition of asset rights and consent of the parties involved key issues surrounding property rights but also the right to a level of expected income and compensation (Coase, 1960). Coase (1960) also suggested that property rights at the initial stage should be allocated to parties with the lowest externality costs. The lack of security of tenure was one of the major constraints of agroforestry adoption and conservation farming, confronting the most vulnerable groups of smallholder farmers (especially women), in the Katete district of Zambia and provinces in Kenya (Kabwe et al., 2009; Nyangena, 2008). It is also argued that conservation farming and Corresponding PES may allow for securing property rights in the absence of secured frameworks (FAO, 2007; Nyangena, 2008;, 2004). Even in developed countries, Land tenure is suggested to be important factors which influence the decision to adopt medium-term conservation practices (Soule et al., 2000; Fraser, 2004; Zbinden and Lee, 2005). In the case of developing countries there is no definite result for the correlation between the area-based farm size and conservation adoption amongst farmers (FAO, 2011a). This is in line with the study of Pattanayak et al. (2003) which argued that the sign of the correlation between farm size and agroforestry adoption in 68 per cent of the existing literature was inconsistent, with approximately 50 per cent positive and 28 per cent negative. The adoption of agroforestry with PES by smallholders in rural Kenya, who on average have one hectare, may not be influenced by farm size but rather land tenure security.

b) Farm elevation

Cultivating sloping land is generally cumbersome given the risk of soil erosion and degradation. In the case of the sloping farmland, lack of conservation practices such as agroforestry may lead to soil erosion and land degradation (Young, 1989). The difference in elevation of farmland, i.e. the grade of the slope, is suggested to be a significant determinant in the adoption of conservation practices, and therefore more adoption should take place in areas of steeply sloping land (Nyangena, 2008; Mercer and Pattanayak, 2003). Keeping erosion to a minimum and replenishing soil nutrients through agroforestry can improve the livelihoods of smallholders. In as much, practicing conservation agriculture such as agroforestry, can convert formerly marginal agricultural land into healthier, more productive land and ease the susceptibility of rural areas to deforestation. The clearing of forests for the purpose of agriculture may be reduced if cultivation of sloping land is viable. Agroforestry in sloping areas is also identified as a measure to alleviate poverty. The continuous expansion of trees on diverse landscapes cultivated by smallholders has been identified as the driving force behind the reforestation observed in the tropics (Sanchez et al., 1997). There is a higher probability that farmers with gently sloping land will adopt agroforestry to control run-offs and erosion as compared to farms on steeply sloping land which makes the practice challenging. In Ethiopia the degree of slope influences the adoption of conservation farming, however, a very steep slope may also lead to non-adoption (Gebremedhin and Swinton, 2003). The adoption level of agroforestry on hillside landscape in southern Malawi was suggested to be due to secondary benefits, e.g., food security, rather than soil improvement (Sirrine and Shennan, 2010). Mugagga and Buyinza (2013) argue that adoption of soil conservation on the slopes of Mount Elgon National Park in eastern Uganda is not widespread. The effect of a farm's physical characteristics on adoption of conservation is not easily estimated due to the availability of a range of inexpensive conservation activities for sloping plains aside agroforestry. The adoption of agroforestry around the Mount Kenya region, despite the fact that 45 per cent of cultivated land was observed to be located on a slope, may therefore be moderate.

c) Distance to market

Distance and access to market may promote adoption of agricultural conservation technologies as well as reduce transaction costs in accessing funds and workforce.

Markets are usually located in areas with modest infrastructure, e.g., semi-urban, and institutions are also more likely to cluster in these areas rather than rural settlement thus opportunities may abound in agriculture financing. The excess supply of labor which may prevail on the labor market in urban and semi-urban areas in developing countries may also present employment opportunities for the unemployed. Smallholder farmers adopting agroforestry, which is labor-intensive especially during the early stages, may profit from this surplus of manpower as well as investments from nearby urban and semi-urban areas were markets are situated (Akinnifesi et al., 2008). On the contrary, the proximity to market may also increases opportunity cost of labor and lead to low levels of adoption of agriculture conservation technologies such as agroforestry. The demand for food due to proximity to market may be high such that the opportunity cost of alternative land use, in this case agroforestry, could be quite large. Gebremedhin and Swinton (2003) argued that for conservation adoption in Ethiopia, the further farms were from local markets, the more likely that **(**adoption would take place due in part to the lower opportunity cost of labor. Winter et al. (2004) argue that for Ecuador, the further away the urban centers, i.e., the greater the lack of market access, the more likely it is that smallholders will embrace agricultural innovations and participate in conservation programs. The effect of proximity to markets on conservation agriculture adoption by smallholders in sub-Saharan Africa is suggested to be obscure (Yesuf and Kohlin, 2006). In the case of Kenya, where there appears to be a structured labor market around urban and semi-urban areas and proximity to large urban markets is great (more the 250 kilometers on average, the opportunity cost of agricultural labor may be low. This may lead to high levels of adoption of agroforestry with PES.

d) Labor supply

The magnitude of the effect of labor on the adoption of conservation practices such as agroforestry depends on the relative labor intensity of the particular agricultural innovation (Mercer, 2004). Adoption of agroforestry by smallholders in sub-Saharan Africa is argued to be positively correlated with household labor supply (Marenya and Barrett, 2007; Franzel, 1999; Mugwe et al., 2009). Apart from the household endowment of labor, the level of development of the labor market plays a crucial role (Gebremedhin and Swinton 2003; Barrios et al., 2006; Silici, 2010). The higher level of economic growth in urban areas as compared to rural areas implies that rural-urban migration in developing countries, especially sub-Saharan Africa, may be quiet high. The growth rate of urbanization for sub-Saharan Africa is notoriously high and ranked amongst the highest in the world, this increase in urbanization observed has been linked to climate change effect i.e. shortage in rainfall (Barrios et al., 2006). The dependence of rural agriculture production areas on rainfall compounds the livelihood challenges of those at margin of subsistence (Barrios et al., 2006). This shortage of rain does not only affect the agricultural sector, which is a major employer in rural areas, but also contributes to rural–urban migration patterns (Barrios et al., 2006). Employment opportunities in urban areas may not be plentiful enough to support the volume of labor supply, resulting in high levels of unemployment. Even though unemployment is persistent in urban areas, the high productivity of other sectors outside agriculture and their level of compensation do not create room for urban-rural migration (Barrios et al., 2006). One of the reasons why the adoption of certain types of agroforestry in Malawi and other parts of sub-Saharan Africa was constrained was the amount of labor required (Current et al., 1995; Adesina and Chianu, 2002). The constraints of an insufficient labor supply in rural sub-Saharan Africa are driving the adoption of agroforestry practices that are less labor-intensive. The effect of household labor supply on the adoption of agroforestry with PES in Kenya may be positive despite the presence of a structured labor market.

e) Access to credit

Access to credit may be significantly and positively correlated to the adoption of agroforestry (Pattanayak et al., 2003). Kiptot and Franzel (2011) and Gladwin et al. (2002) argue that the lack of access to resources such as credit resulted in limited agricultural input and led to low adoption of agroforestry especially amongst women in sub-Saharan Africa. Credit constraint plays a crucial role in early-stage decisions regarding innovation adoption in developing countries (Feder et al., 1985; Mercer, 2004). In Kenya, the adoption of improved tree fallow by smallholders was positively correlated with the availability of credit as well as other economic benefits (Kiptot et al., 2007). In Senegal, certain constraints to agroforestry adoption may be eased with policies effectively designed to promote credit accessibility (Caveness and Kurtz, 1993). This is in line with the study of Place et al. (2012) which points out that the exclusion of agroforestry as a means to access credit and favorable credit terms in parts of sub-Saharan Africa has led to low adoption of the practice. The impact of credit accessibility on agroforestry adoption in Latin America has been observed to be insignificant (Current et al., 1995). The regeneration project which implemented agroforestry with PES in Ethiopia and The International Small Group Tree Planting Programme (TIST) in Kenya provide credit and savings facilities to participating smallholder farmers (Shames et al., 2012). Therefore smallholder farmers facing credit constraints are more likely to participate in agroforestry with PES, due in part to the certain financial incentives involved.

f) Interest rate

If a high interest rate is imposed on agroforestry credit, this may lead to low adoption levels amongst smallholder farmers. Loans provided at market rates in parts of Imo state, Nigeria, are argued to be vital for the adoption of agroforestry by regional farmers with limited financial possibilities (Lambert and Ozioma, 2011). In India, cases where credit for agroforestry comes with a higher interest rate than that for other agricultural activities have been observed (Place et al., 2012). For agroforestry adopters in rural Kenya, the opposite has been observed, and the lower interest rates can be attributed in part to the diverse benefits derived from carbon certification (Benjamin et al., 2014; Roshetko et al., 2005). Certain agroforestry schemes with PES provide financial support through a low-interest-rate loan scheme intended to ease credit constraints and facilitate the purchase of inputs such as tree seedlings, fertilizer and pest control. Smallholder farmers charged low interest rate are more likely to adopt in agroforestry with PES and vice versa.

g) Age of famer

Age is one of the socioeconomic factors perceived to significantly influence the adoption of agroforestry in rural sub-Saharan Africa. The age of  smallholder farmer i.e. older farmers, which may serve as a proxy for experience, is argued to positively influence the management decision to use tress on farmland (Adesina and Chianu, 2002; Asafu-Adjaye, 2008). Aging smallholders may benefit from and adopt non-labor-intensive types of agroforestry and the associated technologies In the Mount Kenyan region, where the average age of smallholder farmers is approximately 48 years, and a certain level of rural-urban migration has restricted household labor supply, adoption of certain types of agroforestry technologies may be unlikely. Mercer and Pattanayak (2003) and Ndayambaje et al. (2013) emphasize the positive correlation between age and the probability of agroforestry adoption. Mercer (2004) argued that 64 percent of all agroforestry adoption studies include age as a determinant and of those 64 percent, 29 percent conclude age is not significant, however, when significant it was mostly positively correlated. The effect of farmers' age on the likelihood of agroforestry adoption is not consistent, as probability of adoption may either increase or decrease with age (Mugwe et al., 2009). The lack of adoption by older farmers may be due to shorter planning horizons. Younger farmers are more likely to adopt innovative farming practices as they tend to be better informed and are typically less risk-averse than older famers (Asafu-Adjaye, 2008). A number of studies have also indicated that adoption of conservation practices amongst older farmers was less likely as these farmers reduce investment required to improve farm productivity (Mugwe et al., 2009; Marenya and Barrett, 2007). The influence of age on the adoption of conservation practices may depend on the type of these practices and the asset endowment (including labor) of individual farmers.

h) Education

Education is used as an approximation for human capital. Education can lead to a decrease in the knowledge gap, promoting higher labor productivity and incomes by increasing the likelihood of adopting innovative and lucrative farming practices. The growth rate of total factor productivity in agriculture is considered to be positively correlated to human capital stock which determines the speed of technology adoption and level of home-grown technological innovation (Foster and Rosenzweig, 1995). The ability to process information relating to agricultural innovation may therefore depend on years of early schooling or informal training. Low-income countries investments in primary school have a high rate of return on most sectors, while the low rate of return to agriculture may be due to climatic and environmental conditions (Huffman, 2001). Human capital has been argued to significantly influence decisions to adapt and modify technology in agriculture (Adesina and Chianu, 2002). Human capital and technological adoption is arguably of high significance when access to other resources is limited (Solís et al., 2007; Silici, 2010). The resulting improvement due to adoption of a specific technology may be sustained if a certain level of human capital is available. Rahm and Huffman (1984) argue that human capital was one of the variables which led to the effectiveness of reduced tillage practices Feder and Umali (1993) suggest no defined effect of education on the adoption of conservation agriculture. Education was not found to significantly influence the conservation adoption decisions of smallholder farmers in countries such as Kenya, Zambia and Fiji Island (Mugwe et al., 2009; Kabwe et al., 2009; Asafu-Adjaye, 2008; Mercer and Pattanayak, 2003). Pilot demonstration and extension services and learning-by-doing could make level of education insignificant in the case of agroforestry.

i) Information and communication technology (ICT)

The use of ICT in sub-Saharan Africa agriculture to spread information to smallholder has being receiving considerable attention in the last 13 years. The use of television, radio and most especially mobile phones in rural areas in sub-Saharan Africa is one of the success stories of the rapid adoption of ICT (Aker and Mbiti 2010). Radio and television in developing countries, is argued to positively and negatively influence social capital and conduct, in some instance leading to adoption of new type of life style and values (Jensen and Oster, 2009). Television in rural Kenya is not as widely spread as radio which is present in almost all household. The adoption rate of mobile phone in Kenya as of 2009 was estimated at 47%, while one-third of the population shared mobile phones relatives and friends (Aker and Mbiti 2010). Mobile phone option has being introduced to agriculture extension services in Kenya for farmers to dial in or send text messages for agricultural support and information (Aker and Mbiti 2010). However, the use of mobile phones on the in rural areas to access information is rather moderate. Approximately 33% of total smallholders farmers interviewed in this study stated that they have at point in time in the last 2 years use mobile phone to access market information while most smallholder have not used mobile phone to request for agriculture extension service information . Some of the reasons for the limited use of ICT in agricultural extension service may range from lack information on agricultural practices and data exchange to cost (Aker, 2010). Aker (2010) argued that ICT-based agricultural extension may become redundant and limit adoption of agriculture innovation and spread of knowledge amongst smallholders if current programs are not adequately evaluated.

**Table 2: The effect of non-monetary variables on the adoption of agroforestry in Kenya**

| Variable | Measurement | Expected effect on adoption decision |
|---|---|---|
| **TIST membership** | Discrete | + |
| **Neighbor is TIST member** | Discrete | + |
| **Co-operative member** | Discrete | + |
| **Farm size** | In hectares | +/- |
| **Farm elevation** | Dummies | +/- |
| **Distance to market** | In km | +/- |
| **Labor supply** | Discrete | + |
| **Access to credit (yes/ no)** | Discrete | + |
| **Interest rate (in %)** | In % | - |
| **Age** | In years | +/- |
| **Education** | In years | +/- |
| **Information and communication technology** | Discrete | +/- |

## 2.4 Data

We collected original micro data on Kenyan smallholders who participate in TIST, a non-government-run agroforestry mitigation program with PES in the Mount Kenya region. Descriptive statistics presented in table 3 indicate that 58 percent of all farmers are members of the TIST program, while 82 percent of interviewees reported to have at least one neighbor who cooperates with TIST. Sixty-seven percent of interviewees state to be a member of a co-operative. We observe considerable variation in market integration: average distance to the nearest market is on average 2.1 kilometers with a standard deviation of 2.8 kilometers. We also obtained information on farm and the farmer's household: on average two to three household members participate in farm activities; average years of schooling completed by the farmers is 8.78; exactly 50 per cent of the farmers report that they possess land located on hillsides; and average age of the interviewee is approximately 48 years. We know that 16 per cent of smallholders are unable to access credit markets and that for the 59 individuals who do have credit; the average interest rate is 14.92 per cent. Variations in the interest rate for loans are quite substantial with a minimum of four per cent and a maximum of 50 per cent, and a standard deviation of approximately eight per cent.

**Table 3: Descriptive statistics (refer to model 1 in table 4)**

| Variable | N | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| **TIST membership (yes/ no)** | 142 | 0.55 | 0.5 | 0 | 1 |
| **Neighbor is TIST member (yes/ no)** | 142 | 0.8 | 0.4 | 0 | 1 |
| **Co-operative member (yes/ no)** | 142 | 0.7 | 0.46 | 0 | 1 |
| **Distance to market (in km)** | 142 | 2.03 | 2.45 | 0 | 15 |
| **Age** | 142 | 47.6 | 13.53 | 25 | 80 |
| **Size of farm** | 142 | 0.54 | 0.42 | 0.1 | 2.4 |
| **Land on slope (yes/ no)** | 142 | 0.51 | 0.5 | 0 | 1 |
| **Number of workers in household** | 142 | 2.62 | 1.51 | 1 | 10 |
| **Years of education** | 142 | 8.63 | 3.56 | 0 | 16 |
| **Own a TV** | 142 | 0.61 | 0.49 | 0 | 1 |
| **Interest rate (in %)** | 55 | 15.1 | 8.26 | 4 | 50 |
| **Credit constraint (yes/ no)** | 116 | 0.16 | 0.37 | 0 | 1 |

## 2.5 Empirical results

Results of a set of logistic regressions are presented in table 4. Based on these results we can identify two potential explanations for the variation in TIST membership: neighbors' participation in the TIST program and the farmer's membership in a cooperative. To a lesser extent, age and labor abundance, measured by the number of household members active on the farm, are positively correlated but with low levels of statistical significance. We find that having a neighbor who is a TIST member increases the probability that the interviewee is also a participant by the factor three to four. Unfortunately, we do not know if the neighbor or the interviewee joined the TIST program first. Therefore, we cannot precisely identify who convinced whom to join the program, but we can clearly observe information spillovers between neighbors. Our results are similar to those of Scholz (2009) who argued social capital is an important variable in the adoption of small-scale agroforestry in Tanzania. Therefore, we are not able to identify whether our interviewee was motivated by or the motivator for the neighbor to join TIST. The correlation, however, indicates an information flow between neighbors, suggesting that word of mouth is an important channel for the exchange of experiences and opportunities. Conversely, we do not find possession of television or mobile phones (the latter is not shown in regression tables) to be correlated with TIST participation, indicating that spillover effects occur mainly through word-of-mouth.

**Table 4: Determinants of small-scale forestry adoption among smallholder farmers (farmland < 3 hectares) in the Mount Kenyan region**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Neighbor is TIST participant** | 3.11*** | 3.66*** | 3.11*** | 2.36*** | 3.06*** |
| **(yes/no)** | (3.81) | (4.67) | (3.85) | (2.77) | (3.66) |
| **Cooperative member (yes/no)** | 1.39** | 1.40*** | 1.41** | 1.69 | 2.58*** |
| | (2.39) | (3.11) | (2.44) | (1.25) | (3.40) |
| **Distance to market (km)** | 0.07 | | 0.08 | 0.24 | 0.14 |
| | (0.77) | | (0.82) | (0.60) | (0.99) |
| **Size of farm (hectares)** | 0.69 | 0.71 | 0.71 | 0.84 | 0.92 |
| | (1.41) | (1.62) | (1.42) | (0.63) | (1.26) |
| **Age of farmer** | 0.02 | 0.03** | 0.02 | 0.05 | 0.04 |
| | (1.09) | (2.40) | (1.08) | (1.22) | (1.60) |
| **Slope on farm (yes/no)** | -0.10 | -0.06 | -0.09 | 0.07 | 0.22 |
| | (-0.25) | (-0.15) | (-0.21) | (0.08) | (0.44) |
| **Workers from own household** | 0.11 | 0.09 | 0.12 | 0.94** | 0.00 |
| | (0.66) | (0.68) | (0.70) | (2.21) | (0.00) |
| **Years of education** | -0.11* | | -0.10 | 0.08 | -0.07 |
| | (-1.76) | | (-1.50) | (0.50) | (-0.97) |
| **Own a TV** | | -0.33 | -0.32 | -0.99 | -0.32 |
| | | (-0.82) | (-0.73) | (-1.30) | (-0.59) |
| **Credit interest rate (in %)** | | | | -0.05 | |
| | | | | (-0.87) | |
| **Credit constraint (yes/no)** | | | | | 1.25* |
| | | | | | (1.69) |
| **Constant** | -4.18*** | -5.84*** | -4.14*** | -8.30** | -6.24*** |
| | (-3.39) | (-5.30) | (-3.33) | (-2.08) | (-3.50) |
| **Observations** | 142 | 165 | 142 | 55 | 116 |

*Note: Robust z-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Cooperative membership is associated with an increased likelihood of joining TIST. This coefficient is statistically significant in four out of five models; only in model four, where the number of observations drops substantially due to the inclusion of a new variable, statistical significance cannot be observed. We also cannot identify an unambiguous causal direction going from co-operative membership and TIST participation, but we know that co-operatives have existed in Kenya for many decades while TIST activities started only in 2005, suggesting that preexisting co-operative structures fostered information flow about TIST. Our control variable ‘age of farmer’ suggests a higher likelihood of participation among elderly smallholders, even though this coefficient is not consistently statistically significant. Similarly, coefficients reflecting the effects of farm size and distance to market indicate a positive relationship between these variables and TIST participation. As for farm size, we may hypothesize that this coefficient possibly indicates a benefit from economies of scale. Remote farms may face high transaction costs with conventional farming; in these cases, agroforestry is an attractive alternative since revenues may be generated without the necessity of bringing crops to local markets. Also, remoteness to markets seems to reduce the opportunity cost of potential laborers and reduce the necessity to use land primarily for food exports to urban markets. Interestingly, school education seems to have a negative effect on TIST participation; we abstain from interpreting this coefficient in the light of inconsistent expectations suggested by aforementioned literature, but use this variable as a control to avoid omitted variable bias. We also tested whether an individual’s experience with formal credit markets is an incentive for participation. In model 4, we investigated determinants of TIST membership among clients of a formal credit institution and found no correlation between paid interest rates and TIST membership. Model 5 extends the analysis performed in model 4 and investigates all potential clients of a credit institution. We use the information on credit constraints as another proxy for the incentive to participate in TIST. The corresponding coefficient indicates that credit constraints serve as an incentive to participate in TIST. This confirms the considerations discussed above: smallholders with limited credit market access may join TIST in order to benefit from credit and savings infrastructure. This seems to be an important finding since participation in TIST and the accompanying income from ecosystem services have been found to be a successful business strategy for smallholders, granting them favorable credit contract terms and providing a collateral substitute (Benjamin et al., 2014).

## 2.6 Conclusion

We investigate a strategy which may help poor smallholder farmers overcoming impaired possibilities of adopting agricultural technologies and credit constraints. A deeper understanding of the forces withholding smallholders' productivity may help addressing challenges related to ensuring food security, provision of jobs and livelihoods in developing and emerging economies, and rural poverty. There are concerns that adoption of agricultural technologies may be restricted to a specific set of smallholder farmers that are characterized by above-average socio-economic status, thus, excluding poorer social strata from access to innovations and credit markets. We do so by investigating Kenyan smallholders' participation in The International Small Group Tree Planting Program (TIST) around the Mount Kenya region. Participation in TIST is voluntary and open to anyone interested, including poor smallholders. TIST contributes to the local agricultural sector through provision of credit and savings infrastructure, farm and forestry management training, as well as training in agricultural techniques and technologies. TIST encourages participation of farmers in emission trading by linking agroforestry stored carbon to the carbon markets and ensures collaboration with carbon developers who serve as intermediates. This also increases smallholders' incomes through payments for ecosystem services (PES).

We use a random utility model and a logistic regression approach to investigate factors that influence agroforestry adoption. We collected original data from non-government-run agroforestry mitigation programs with PES that have been implemented in the Mount Kenya region, allowing us to investigate non-monetary factors, such as information spillover, that influence the decision to adopt such conservation strategies. Smallholders' socio-economic variables examined are farm characteristics e.g. farm size and topography, farm organization, labor supply and access to credit as well as personal characteristics e.g. age and education. Our findings indicate that the spread of information, existing networks and peer involvement in such programs drive participation. Conversely, participation by smallholders does not seem to be influenced by education, land or asset endowment. Contrary to some existing literature, we found weak evidence for a positive correlation between the adoption of agroforestry with PES and age of smallholder, e.g., one increases with the other, in the Mount Kenyan region.

## Chapter 3*: Financial Lending and Investment in Sustainable Small-Scale Agribusiness in Sub-Saharan Africa: A Review of Carbon Sequestration and welfare Benefits

### 3.1 Introduction

Agricultural growth plays a critical role in eradicating poverty**,** especially in low-income countries. In developing countries, especially sub-Saharan Africa, apart from generating a substantial level of revenue, the sector contributes ca. 32 per cent to Gross Domestic Product (GDP) (Christiaensen and Demery, 2007). 75 per cent of the work-force in low income countries in sub-Saharan Africa is engaged in agriculture with largely small-scale farming of between 0.5 and 2 hectares of land (The World Bank, 2007b). In promoting agricultural growth, it is essential to increase factors of production and productivity (labor **–** L, capital **–** K and total factor productivity **–** A) in a sustainable manner as this ensures food and energy security. The ability to alleviate poverty depends**,** to a large extent**,** on the availability of finance to both urban and rural business activities. These entrepreneurs must have access to regular and adequate capital as well as resource management knowledge to function (Balkenhol, 1991)**.** Finance and capital to rural small-scale agribusiness requires well-defined and stable financial institutions as the investment and individual wealth or asset of rural smallholders are quite digress and the absence of these institutions may lead to a plunge in capital stock during economic downturn (Gonzalez-Vega & Graham, 1995).

The composition of rural financial institutions has evolved from microfinance institutions (MFIs), money lenders and Non-Governmental Organizations (NGOs) to include commercial banks due to the gap in the access to wide range of credit (Randhawa & Gallardo, 2003; Cull, Demirgüç-Kunt, & Morduch, 2008). The prime objective of micro finance remains the ability to providing financial services to low-income households, micro, small and medium size firms at an affordable rate to support

---

economic growth while utilizing appropriate methodology that guarantees financial soundness and enhance consumer livelihood. Sub-Saharan pre-regulatory eras of micro finance in the 1980s were characterized by structural disorganization, high default rate and lack of financial discipline. In order to foster a stable financial environment**,** international and national prudential organs have stipulated guidelines or regulations which financial institutions specifically deposit-taking organizations have to abide by (Amha, 2001). As financial and non-financial institutions in the sub-Saharan Africa regions are increasing regional operations, it is important that these institutions also adhere to international standards such as the Basel accord. Stakeholders and depositors protection as well as monitoring and measuring of risk is a vital component these guidelines (Lafourcade et al., 2005). Loans to off-farm enterprise have shown remarkable success due to reduced vulnerability, stable income and group guarantee. However, micro financing of agriculture is not as profitable as conventional lending with collateral or collateral substitute (Cull, Demirgüç-Kunt, & Morduch, 2008).

An array of literatures identifies credit constraints as one of the major problems confronting development of agriculture not only in developing countries but on a global scale. Factors ranging from information asymmetry, moral hazard, contract enforcement, high rate of interest and farm debt, under-developed financial institution to high transaction cost may be responsible for limited credit allocation. In the 1970s, 15 per cent of farmers had access to institutional credit in Latin America and 5 per cent Africa (Gonzalez-Vega, 1993; Gonzalez-Vega & Graham, 1995). The issue of land tenure system has compounded to the woes of agricultural financing because lack of proper definition of right to land deprives usage as collateral while the absence of stable income arising from risk associate with agriculture (weather, price volatility, poor infrastructure) means no physical collateral. The direct effect of climate change on the banking operations can be due to severe weather threat or indirectly due to regulatory compliance or change in societal preference. Financial institutions in rural areas can, however, seize business opportunities to provide services and develop financial techniques that foster climate mitigation and adaptation through emission trading and advisory services (Furrer et al., 2009).

Africa will be one of the most vulnerable regions to climate change, due to projected decrease in precipitation and increase in temperature and population as well as decline in GDP (Schneider at el., 2007). Therefore there is a need to shift attention to what can be done not only to adapt but also to mitigate its negative in order to ensure food security for the growing population. Investment in adaptation and mitigation of harmful climate change (including agriculture – carbon sink) requires an estimated investment of over US$1 trillion per annum with 86 per cent anticipated to come from the private sector, such as financial institutions, directed to developing countries. Although the private sector seems discouraged by carbon market situation, there are certain investments that are starting to emerge (Jones & Hiller, 2010). Climate smart agriculture can be propelled by smallholders and may provide sustainable investment potential of ca. US$1 trillion over the next 4 decades which has been projected for sub-Saharan Africa (Branca, 2011). There are signs of strong interest in investing in sustainability amongst financial investors on a global scale. A study by the Rockefeller foundation found that 69 per cent of financial advisory perceived sustainable investment as an avenue for growth. However, only 38 per cent actively participated in international micro-finance engaged in sustainable development while over 80 per cent were not engaged and 43 per cent were either doubtful or uninterested (Conway & Stevens, 2012).

This paper seeks to establish how financial institutions engaged in microfinance can benefit directly from agricultural sustainability through climate investment or indirectly through a targeted lending with climate-backed- security, which may lead to rural development and solid financial environment. There are indications that there is need to emerge with new innovative approaches to be countered the old problems relating to credit constraint experienced by the poor at the hands of financial institutions. Specifically, this study aims to establish a benchmark that can be used for further research into climate financing.

This paper proceeds by investigating the financial sector servicing the rural low-income farmers and changes in operations and compliance in order to facilitate a stable financial environment. Section 3.3 reviews the lending by financial and non-financial organisations towards smallholders and their participation in investments relating to environmental protection and development. Section 3.4 outlines possible benefits of sustainability to credit institutions and how this can be an integral part of their operation in line with international standards. The formulation of policies which may help prompt sustainable lending and investment are the focus of section 3.5. The paper then draws a conclusion from the relevant research materials and information gathered on the topic.

### 3.2 Trends in sub-Saharan rural credit institutions

Some authors have questioned if the existence of banks in the conventional definition, in this modern times, are relevant as banks continue to engage in off-balance sheet rather than deposit taking and loan disbursement. Banks have become less dependent on core business thus exploring other form of business activities. It is also argued on one hand that the involvement of other non-banking organization in banking activities is undermining the traditional banks which are causing banks to shrink (Llewellyn, 1999). On the other hand financial service provided to rural smallholders in sub-Saharan African by institutions is not wide-spread as the market it is both limited and under-served thus the financial sector has continued to see growth in size and operations. A substantial number of microfinance institutions in Africa have been able to post impressive growth without compromising portfolio quality, even as competition intensifies (Fernando, 2008). There are several changes that have taken place in the financing of rural poor. However, this paper would rather focus on 4 of these namely:

(a) Institutional expansion and profitability
(b) Deposit
(c) Regulation (Risk Management)
(d) Technology

#### 3.2.1 Institutional expansion and profitability

The low entry requirement for the establishment of financial institution in Sub-Saharan Africa in the 1970s and 1980s propelled the growth of local banks and non-bank financial institutions (NBFI). This period also witnessed the setting-up of government backed developmental banks, intended for the urban and rural entrepreneurs. Although this government incentive to increase financing to local business increased the number of financial institutions, they were mostly inefficient. There was a decline in the number of financial institutions in the 1990s due to bank failures; however, commercial as well as other financial and non- financial institutions witnessed a revival in a more stable financial environment (Brownbridge, 1998; Steel & Andah, 2003). There has been an increase in the number of sub-Saharan financial institutions in Africa operating beyond national borders in accordance to international standards (Verhoef, 2005). However, the profit efficiency of banks in Africa is argued to be in smaller size banks than in big financial institution, therefore**,** casting doubt over the development of the continent´s financial sector through the establishment of mega banks (Kiyota, 2009). This may be in line with studies which show that more unconventional financial institutions, especially non-governmental organizations (NGOs), are shifting away from non-profit towards for-profit while increasing in the number of financial institutions represented by small entity in remote areas (Campion & White, 2001; Mix 2010). The fear that a for-profit approach by micro finance will result in high market profit as well as the neglect of the poor has not materialized, instead there may be an increase in diversification in the operations by microfinance institutions in different directs (Charitonenko & Campion, 2003). This may not have a negative effect as it enables these institutions to explore new innovative ideas in financing the efficient amongst the poor. The influx of a number of commercial bank into microfinance may, to a large extent, reshape the financial landscape. The economy of scale and scope from non-microfinance activities of these institutions may be used to further develop the microfinance sector.

### 3.2.2 Deposit

Asia microfinance is a prime example of how saving (deposit) can help strengthen the productivity and increased investment, the microfinance in sub-Saharan Africa has also helped increase the number of bank account and saving holders in addition to those provided by other institutions (WSBI, 2008). On the contrary, commercial banking in Africa has rather witnessed a steady movement of asset by the wealthy to off-shore location rather than deposit to local financial institutions, which may explain the low rate of saving (The World Bank, 2006). Microfinance comprising non-bank financial institution, credit unions and financial cooperatives and a small number of NGOs reached an estimated 9 million depositors with a total volume of US$2.1 billion. The number of depositors in 2010 increased to 10.2 million clients (MIX, 2008). This trend in depositors growth is in line with a general consensus that the poor will deposit part of savings in the presence of an adequately and stable financial environment (Wisniwski, 1998). In order to protect the depositors, institutions engaged in deposit-taking are required to adhere to international standards such as Basel accord´s Principles 2 – permissible activities, 3 – licensing Criteria, 6 – capital adequacy, 7 – risk management procedure, 8 – credit risk (BIS, 2010).

### 3.2.3 Regulation (Risk Management)

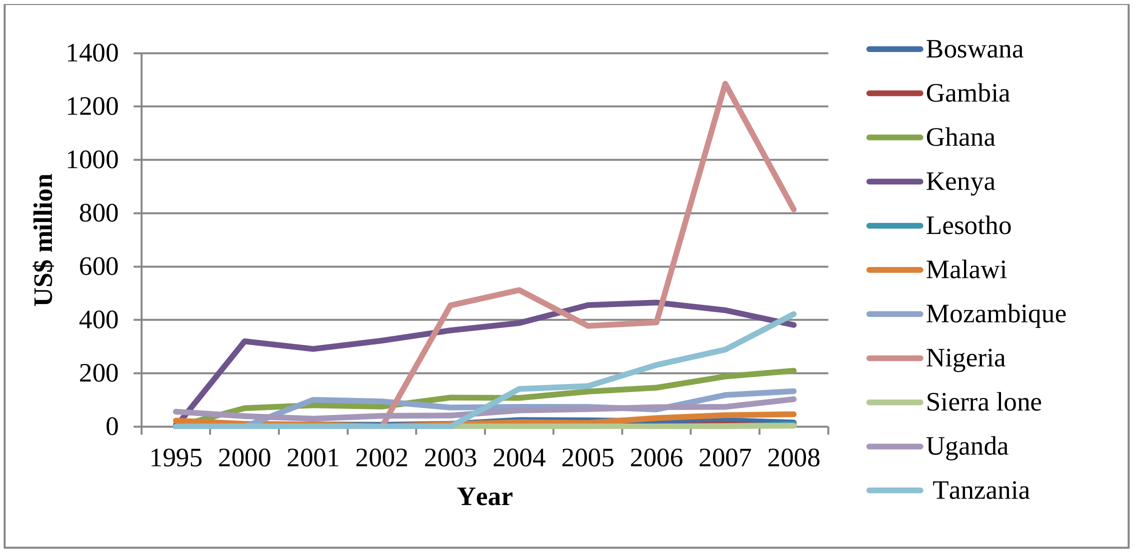
The number of regulated sub-Saharan microfinance institutions including those operated by commercial banks in 2003 was 71, while 92 institutions were unregulated (Lafourcade et al, 2005). The laissez-faire approach to enacting financial regulation may not necessarily be an appropriate generalization (Arun & Murinde 2005). In Ghana, legislation and regulation for rural and micro financial institutions are creating appropriate level of new entries and providing opportunities while improving performance. The regulator of microfinance in Ghana complies with international standards (BASEL), which focus on reserve requirements which are then changed according to a classification system based on loan recovery performance (Steel & Andah, 2003). Microfinance providers in most African countries do not only have to register but are expected to adhere to the procedures for compliance with capital adequacy and solvency requirements for deposit-taking and other institutions, these prudential rules described above as well as risk concentration limits (on single borrowers), liquidity limits, have been found to exist in other countries such as Tanzania, Benin and Guinea (Basu et al., 2004). Stringent regulatory and supervision has also helped improve the microfinance in Uganda with a capital adequacy level well above the minimum requirement (UCB, 2010). Although the banking and non-banking sector in Sub-Saharan Africa has made progress in generating profit over the years, the environment in which they operate is risky due to weak legal institution and low enforcement. This high risk is argued as the driver behind high returns (Flamini, McDonald & Schumacher, 2009).

### 3.2.4 Technology

Technological advancement has been instrumental in advancing and increasing financial services to rural dweller. For instance, mobile phones have been fully integrated into the financial operation through retail payment and checking price updates in the last decades (Porteous, 2006), The use of technology in microfinance in rural areas ranging from Automated Teller Machines (ATMs) or Point of Sales (POS), Interactive voice response (IVR) technology, Phone -Internet banking, Personal digital assistant (PDA), Management information system (MIS) to Credit scoring have proven to reduce not only operating cost but also aid risk assessment (Hishigsuren, 2006). Mobile phones are gaining popularity and are used by households to remit money to family and friends in remote Sub-Saharan, leading to synergy between banks and mobile operators in countries like Kenya. It was argued that mobile banking may be more favored in the rural areas in a number of countries if it connects to financial institutions (Comninos et al., 2008). On the operational front, the need to report to supervisors as well as keep track of business dates, develop methodology for calculating interest and lending/saving has increased the use of information and communication technology (ICT). To this end certain software over the years has been developed to specifically cater for microfinance taking their unique features into consideration (Augsburg & Schmidt, 2011).

## 3.3 Credit institution´s agricultural lending and sustainable investment in sub-Saharan Africa

Credit constraint is a major problem confronting the development of sustainable agriculture (Feder and Umali, 1993; Fernandez-Cornejo and McBride, 2002; Ahmad, 2005). Studies have shown that by providing credit to smallholders, adoption of new technology (e.g. hybrid maize) is encouraged and the ability of smallholders to bear risk increases (Diagne et al, 2009). All studies found that a credit constraint had a negative impact on the adoption of agricultural innovation, which ultimately might lead to limited agricultural growth and development and increased poverty. A number of rural smallholders source their savings for funds (when and if available) or from family and friends or other sources such as rich people or money lenders in the community who usually charge above market interest rates. There is doubt that such a situation will help promote sustainable agricultural development. Smallholders in Kenya have expressed their dismay at the credit situation they are facing, insisting that it was the main cause of low agriculture productivity. There is limited data available on lending from microfinance to small scale agriculture for in sub-Saharan Africa. It is, however, estimated that less than 10 per cent of total lending by commercial financial institutions in sub-Saharan Africa goes to agriculture with large scale farmers as core benefactors (Mhlanga, 2010). Figure 13 provides an overview of the lending pattern of commercial banks to agriculture in a number of selected sub-Saharan African countries between 1995 and 2008. The graph shows that lending in a number of selected sub-Saharan countries has experienced modest growth with some cases of slight decline.




*Source*: *Author´s modification (Mhlanga, 2010)*

**Figure 13: Value of commercial Bank lending to the agricultural sector of selected countries in Africa 1995 -2008 (USD million)**

Although microfinance institutions (MFIs) have helped facilitate credit to the rural smallholders by adopting a different approach based on business's cash flow evaluation or income as eligible collateral substitute, its impact has not been widespread (Salami et al., 2010). Co-operatives in rural areas have also helped spread agricultural credit. This is because information complied on respective members by the organization is useful not only in the loan assessment process but also repayment due to peer pressure. Furthermore, financial institutions do not have to engage in high infrastructure costs like in the case of institutional set-up (Admasu and Paul, 2010). Financial institutions can thus reduce transaction costs by aligning operations to those of the co-operatives.

83 per cent of enterprises and firms in sub-Saharan Africa were obliged to provide a form of security or deposit before they were granted loans by financial institutions (The World Bank, 2006). One major reason deterring commercial and for-profit financial institutions from disbursing credit to sub-Saharan Africa (smallholders) or small-scale agriculture is the lack of proper collateral and their documentation (Beck et al, 2009). Sub-Saharan African agricultural production is characterized by a disproportionately large fraction of agricultural output which is in the hands of smallholder farmers. The average land holding is about one to three hectares, thus agricultural asset (farmlands) is available in rural areas, a number of smallholders

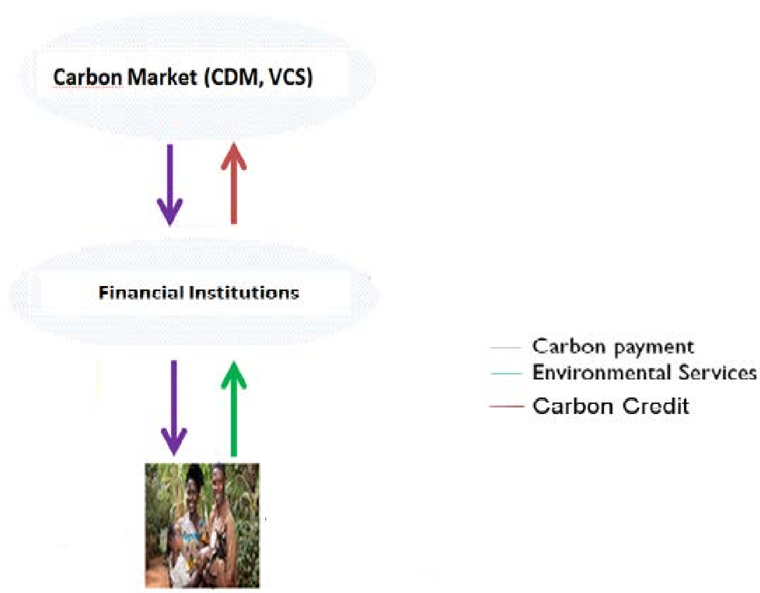
however lease or rent farmlands for cultivation (Ogunlela and Mukhtar, 2009). Collateral plays a major role in credit risk and capital requirement of an agriculture portfolio (Katchova and Barry, 2005). Credit risk variables such the probability of default (PD) and capital adequacy´s value-at-risk (VaR) have collateral evaluation as an integral element (Katchova & Barry, 2005). PD estimates the probability that an individual farmer will not be able to meet his/her obligation, in other words, the likelihood that the farmer´s asset will fall below the farmer´s debt. Value-at-risk (VaR) estimate probability distribution of credit losses conditional on portfolio composition (Thonabauer & Nosslinger, 2004). If the asset valuation of the rural smallholders at the initial period is perceived to be zero, default already occurs as at the time that the smallholder applied for the loan. This method of modeling credit risk does marginalize small-scale agribusiness and/or smallholders due to the high risk and even higher capital requirements that the commercial banks would face in the event of lack of collateral. However, the conventional method of modeling agriculture risk and lending may be discriminatory toward sustainable agriculture which offers stable income eligible as collateral apart from the conventional farmland.

The difficulty project investors face, especially in developing countries, in balancing profitability with the needs of people, NGOs etc. can be tackled by increasing local participation, long-term interests of projects, fair and competitive long-term price and uniform conservative environmental standard as well as contributing to peace and stability (Wagner, 2004). Financing projects which are developed to be socially and environmentally sustainable is a way financial institutions can and are contributing to sustainable agriculture and development. The Environmental Social Governance (ESG) factor which remains an indicator for sustainable investments, amongst others investment decision-making, may however not be quantitative but rather qualitative in nature (Bassen & Kovacs, 2008). Financial institutions in Nigeria and South Africa are working to improve their ESG in terms of lending and investment under the Equator Principles (a comprehensive set of environmental and social guidelines for the financing of projects over US$50 million) although progress has been slow (UNEP, 2007a). The joint venture between Diamond bank (Nigeria), the international financial corporation (IFC) and shell petroleum, were only ecosystem friendly efficient businesses profit from an investment fund of ca. US$1.5 million and Ned-bank´s Green Trust (South Africa) with US$770,000 in fund which focuses mainly on agribusiness are examples of how financial institutions are improving their ESG (UNEP, 2004). The total socially responsible investment fund for South Africa is estimated to be ca. US$1.4 billion. Although microfinance investment vehicles (MIVs) are promoting the use of ESG, enough is not being done across sub-Saharan Africa (CGAP, 2010a). With MIV concentrated in Eastern Europe and Central Asia (43 per cent), allocated investment to Africa (6 per cent) is quite minimal presumably due to the risks involved (CGAP, 2010b).

### 3.4 Sustainable agriculture opportunities for sub-Saharan credit institutions

Climate change due to the emission of greenhouse gases (GHGs) primarily carbon dioxide ($CO_2$) and other gases such as methane ($CH_4$) and nitrous oxide ($N_2O$) are a global threat. Agricultural is a contributor to GHGs, fertilizer usage, burning and felling burning of trees, land use change and animal dung releases $CO_2$ and $N_2O$. Activities such as afforestation and reforestation, the management of forest, soil, livestock, manure and land, sustainable biofuel production, energy efficiencies and biodiversity mitigates GHGs emissions (Seeberg-Elverfeldt, 2010). Sustainable agriculture practices provide a solution to climate change since it has the ability to store and capture $CO_2$. Certain rural smallholders and small-scale agribusinesses are therefore able to mitigate climate change by engaging in afforestation (reforestation). Carbon capture and storage is economically viable due to the ability to trade each ton of sequestrated carbon as an entity on the secondary market similar to those on the stock exchange. "*Taungya*" is an example of sustainable small-scale agroforestry practice; *Taungya* is the combined cultivation of timber trees and horticultural crops (Harrison, 2009). Others nitrogen fixing trees with energy potential such as *Calliandra*, *Sesbania sesban*, *Jatropha curcus* and P*ongamia pinnata* can be used in small-scale agroforestry with diverse benefits (Rossi & Lambrou, 2009). A variety of small-scale sustainable agroforestry by smallholders can be beneficial not only in the adaptation and mitigation of climate change, but could help improve food and energy security if well propagated (Seeberg-Elverfeldt, 2010).

There is need to explore not only the direct benefits small-scale agroforestry may provide to smallholders such as yield improvement and increased productivity, but also the indirect benefit such as capital formation and increase welfare which may have positive impact on banks, loans or agroforestry projects decision-making. This paper elaborates on Jatropha agroforestry, whereby an estimated 120,000 hectares is being cultivated in Africa by both corporate and small-scale farmers, Asia and Latin America have 760,000 and 20,000 hectares respectively (Brittaine and Lutaladio, 2010). The Jatropha tree has a high level of toxicity and is invasive in nature. Its oil production varies between 400 and 2,200 liters per hectares (Sielhorst et al, 2008). Although Jatropha seed has been in use in sub-Saharan Africa for ca. 50 years, predominantly in the making of soap and lighting, its socio-economic evaluation has being limited. Another aspect that has received less attention apart from the indigenous use is the carbon sequestrated through its cultivation in small-scale agroforestry (Hellings at el., 2012). It is argued that promoting carbon sink either through the Kyoto protocol or voluntary market provides a promising avenue to address the north-south equity issues, while noting that the conservation practices is beneficial to smallholders depending on the practice and household endowment (Tschakert, 2004). It is important to point out that the study above also emphasizes the need to assist smallholders financially, technically etc. in their pursuit of sustainability. To illustrate capture and storage (environmental service), a 3 hectares small-scale agroforestry with Jatropha may range from between 1100 and 2500 trees depending on density (Benge, 2006). Small-scale cultivation of Jatropha on marginal land or wasteland compared to large scale cultivation, although characterized by non-optimal growth, may be socio-economically viable. The carbon sequestrated is a mitigation measure which is eligible for compensation in the form of carbon credit. The sequestration potential of the small-scale cultivation is estimated to be 5.5 t CO2 $ha^{-1}$ $year^{-1}$ (Abhilash et al., 2010). The possible annual revenue from emission trading of 5.5 t CO2 $ha^{-1}$,using 2007 prices, on the clean development mechanism (CDM) and voluntary market is US$60 and US$68.75, respectively. The estimated cost of carbon market participation of a micro- to small-scale project (< 5000 ton $CO_2$/yr) is ca. US$65,000 for the CDM and ca. US$25,000 for the VCS which includes negotiation, project approval, project monitoring, verification, and insurance costs (Green Markets International, 2007; Lipper at el., 2011; De Pinto at el. 2010). Jatropha medicated soap production due to the simple local production techniques is observed in sub-Saharan Africa to be highly profitable and provides additional revenue to low-income earners (Eijck, 2007). The amount of soap derived from 13 liters of Jatropha oil, given an estimated five working hours, is 4.7k g (Henning, 2004). Seed cake residue which is a by-product of soap production serves as an organic fertilizer, applying this type of fertilizer on farmland is a way to generate carbon credit because it does not contribute to the release of $N_2O$ (Brittaine & Lutaladio, 2010).




*Source: Author*

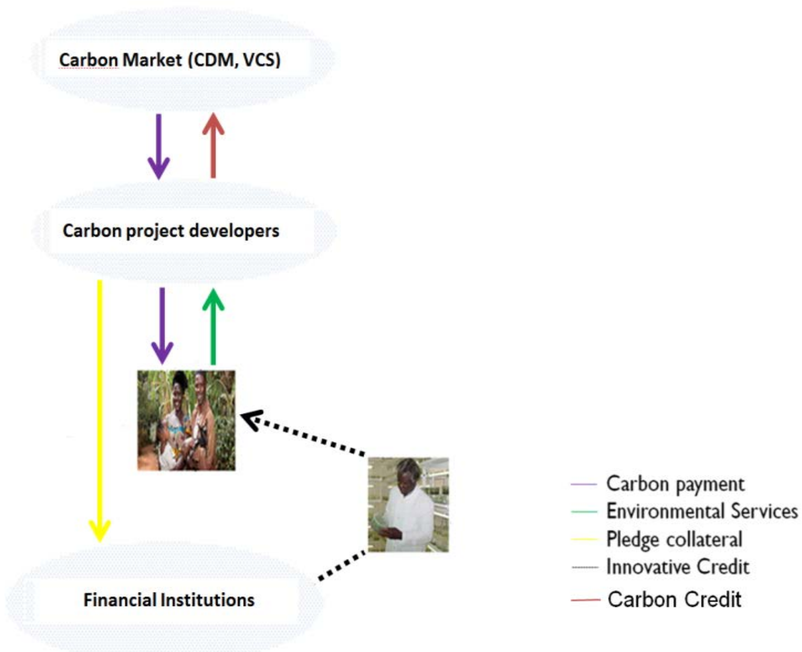
**Figure 14: Integrating financial institution into smallholder farmers into emission certification (Model A)**

Carbon trading presents a win-win situation for both carbon buyers and sellers especially for sustainable smallholders in developing countries (The World Bank, 2011b). Some literatures out on how to create a broker between the demand and the supply of carbon certificates via emission trading championed by financial institutions are reviewed and models of climate-agricultural based investments and lending are introduce hereafter.

"Carbon trading partners are to be linked by an investment vehicle with adequate financial capital willing to dedicate substantial capital to the project" (Perez et al., 2007).

"Accumulating and storing carbon may also yield higher returns whereby these returns may come with a lag or delay, if this is the case farmers may require a positive financial incentive, such as a loan, to be encouraged to bear the fixed and variable costs of adopting and maintaining conservation practices" (Antle and Diagana, 2003). The argument of the authors is that the carbon market can act as the financier of sustainability if stable financial institutions are in place.

Microfinance institutions may therefore reduce credit risk and promote sustainability by improving on their ESG factor and target rural climate certified smallholders and projects. The voluntary carbon certification process for smallholders, although still in its infancy, is starting to gain recognition as a conservation practices resulting in stable income through improved yield and carbon revenues (The World Bank, 2011c). The database of verified carbon standards estimates the number of agriculture, forestry and land use (AFOLU) related projects observed in countries such as Kenya, Tanzania, Uganda, South Africa, Mali and Madagascar with active participation from NGOs at 11 (VCS, 2012). Since the support for the inclusion of social and environmental risk in credit risk analysis of African banks is on the increase, smallholder carbon credit inclusion in risk calculation may lead to more lending (UNEP, 2007b). Carbon credit on one hand may to some extent improve smallholders asset base making them less risker as far as calculation of the probability of default is concern and on the other hand may help free up capital which would otherwise be tied to capital adequacy.




*Source: Author*

**Figure 15: Integrating financial institution into smallholder farmers into emission certification (Model B)**

## 3.5 Policy implication

The policies on (small-scale) agriculture drafted by Africa governments and international organization and donors which seeks the development of agricultural research, technology dissemination and adoption to sustain long-term productivity growth and national poverty reduction have not adequately addressed the agriculture and rural development (UKFG, 2012). Theoretically, where there is efficiency in small scale agriculture, government intervention in agriculture should be minimal rather market forces should prevail, thus the focus of policy interventions should be to offer an enabling economic environment for market-led development (Daio, 2007). Daio (2007) argues that the existence of institutional and market failures, ultimately leading to poverty trap, would however not permit such hands–off approach. Diversifying the income of poor smallholders in developing countries are slim therefore effective policies which may help broaden this opportunity have to be formulated. This formulation should give rise to innovative institutional arrangements between the public and private sector which guarantees the growth of both sectors.

The existence of a Equator principle for financial institution to foster development based on the framework of International Finance Corporation Performance Standards on social and environmental sustainability and on the World Bank Group environmental, Health, and Safety Guidelines should pave way for a sub-Saharan Africa version directed at microfinance institutions (EP, 2011). The limited number of financial institutions from sub-Saharan Africa, namely six, who are signatory to the Equator principle mainly from South Africa and Nigeria signals a need by government and national regulator to push for ESGs from a bottom-up.

### 3.6 Conclusion

The problems confronting sub-Saharan agriculture and a move towards a sustainable agriculture are complex and far reaching. As the demand for and the prices of food and fossil fuel continue to surge, with Africa being the most vulnerable, concerns about sustainability and climate change are genuine. In order to ensure sustainable food and energy security, agriculture development in a sustainable manner has to be the main focus. With the food versus fuel and poverty elevation debate heating up in sun-Saharan Africa, a possible solution amongst others is in sustainable small-scale agroforestry with energy potential. The guidelines of international climate consensus such as the CDM and voluntary carbon markets are continuously amended to accommodate rural sustainable smallholders in developing countries. The eligibility for carbon credit certificate due to sustainable farming and resulting trading on carbon market means smallholders are recipient of stable long-term income. The active participation of financial and non-bank financial institutions on the carbon projects may provide climate financing capacity building and a base for the asset valuation of these local smallholders in credit risk management process. The opportunities that climate mitigation instruments presents can be used to reverse the trend of credit constraints due to lack of collateral (farm asset or stable income). A number of issues however need further investigation, such as the actual cost and revenue as well as risks of climate financing and sustainable lending through accurate case studies.

## Chapter 4[*]: Adverse Selections and Microfinance in Rural Africa: Signaling through Environmental Services

### 4.1 Introduction

Microfinance institutions (MFIs) remain risk-neutral and are highly competitive, consequently, they grant credits to borrowers whose expected business turnover is at or above the break-even point (Batabyal and Beladi, 2010). Urban business ventures have an advantage in that they are often able to signal the profitability of their business either through partial self-financing or collateral. In comparison, signaling in rural businesses – predominantly small-scale agriculture – is difficult to ascertain because many operate at subsistence levels. However, it is suggested that 'Economic growth in agriculture, particularly in the subsectors that directly or indirectly involve smallholders, tenants, and wage earners, is an important precondition for economic growth and poverty reduction in rural areas' (Pederson, 2003). The problem of adverse selection in formal lending may however be resolved if borrowers are given the means to accumulate assets and if loan applications are based on evaluation of the aforementioned assets (Armendariz and Morduch, 2005). The comparison of microfinance activities between different regions in developing countries (see Table 5) indicates that sub-Saharan African MFIs have to catch up with other regions in terms of loan volume and lending, which in turn can be attributed to adverse selection and signaling issues. This paper explores how environmental service certification, obtained through the use of sustainable agricultural practices, can serve as a signal to MFIs of an agricultural business's self-financing capability. This certification also functions as an instrument to reduce adverse selection problems within a pooling system of small farmers. Additionally, this paper examines the role policy makers and MFIs can play in assisting smallholders with the process of obtaining environmental services certification – and in doing so, help them grow assets and build banking relationships.

MFIs in the context of this paper cover commercial and non-commercial banks, non-governmental organizations (NGOs) and co-operatives, all of which have the primary objective of serving small and medium enterprises (SMEs) and poor households.

This paper is structured as follows: the next section provides a literature review on credit advancement to urban and rural (agricultural) areas, adverse selection, and microfinance agricultural investment. The notion of sustainable agriculture investment and carbon credit payments are also introduced. Then the theoretical framework of adverse selection is described using the Batabyal and Beladi (2010) approach. This is followed by a section incorporating the concept of environmental services into the adverse selection model and aiming to justify lending to smallholders engaging in sustainable farming practices. The penultimate section discusses ways in which policy makers and MFI practitioners can improve agriculture financing and investment in a sustainable manner and some conclusions are presented in the final section.

**Table 5: Activities and performance of microfinance institutions by region (2001)**

| Activities | Africa | Latin America | Asia (incl. Indonesia) |
|---|---|---|---|
| **Percent of MFIs** | 45 | 18.6 | 36.4 |
| **Percent of members** | 15.4 | 19.9 | 64.7 |
| **Members/MFI (in 000)** | 19 | 62 | 95 |
| **Percent of savings** | 5.6 | 45.2 | 49.2 |
| **Savings/MFI (in $ million)** | 3 | 79 | 28 |
| **Percent of loans** | 27 | 33.9 | 63.4 |
| **Loan Vol./MFI (in $ million)** | 2 | 69 | 52 |
| **Loan repayment rate (%)** | 88.7 | 93.1 | 95.6 |
| **Female members (%)** | 69.9 | 73.3 | 87.8 |
| **Average loan size ($)** | 261 | 418 | 153 |
| **Average loan size (% of per capita GDP)** | 82 | 33 | 35 |
| **Average deposit size ($)** | 75 | 590 | 62 |
| **Average deposit size (% of per capita GDP)** | 24 | 20 | 7 |

*Source: Pederson, 2003*

## 4.2 Literature review

MFIs in a number of sub-Saharan African (SSA) countries have adequate liquidity although not quite comparable to other developing regions. The sufficient level of liquidity of these MFIs can be attributed to increased deposit-taking, as well as the participation of commercial banks. In order to monitor the capital base of MFIs in SSA while protecting depositors, most sub-Saharan countries have licensing, supervision, and regulatory frameworks. Sub-Saharan microfinance institutions are undergoing financial transformation experienced by developed countries in the past, which saw them evolve into full-scale banks focused on SME lending. For example, in Tanzania, the National Microfinance Bank (NMB) shows promising signs of transitioning into a full-scale bank with an estimated 750,000 depositors and 20,000 micro-borrowers with an average loan amount of US$400 (Sacerdoti, 2005). These numbers are similar to those recorded in 2001 for all Ghanaian Rural and Community banks (RCBs) which have 1.2 million depositors and 150,000 borrowers, while an additional eight saving and loans companies have 160,000 depositors and 10,000 borrowers (Basu et al., 2004). These figures support the argument that emphasizes the importance of deposit services in the transformation process. The number of formal borrowers (small entrepreneurs or households) is modest, suggesting to some that this segment of the population may not be interested in lending services. However, the fact that these borrowers continue to patronize moneylenders with less rigorous requirements and interest rates as high as 300 per cent per annum undermines this assumption (Pandey, 2007). The cost-covering interest rate charged by MFIs – although in no way comparable to the moneylender rate noted above – remains high because of transaction costs and clients' risk profiles. However, evaluation methods such as cash flow-based lending, scoring techniques, and banking relationships may result in MFI interest rates lower than those offered by conventional banks.

MFIs' geographical business operations can be divided into urban and rural microfinance, which have different issues but all aim to provide services to the poor and SMEs. The word 'poor' in the urban context is broad as it refers to migrants from rural areas, salary-earning residents, and entrepreneurs. Owing to the large number of these sub-classes of poor in urban areas, there is a high demand for credit in developing countries (Pandey, 2007). Microfinance to the poor with loans of $100 and above is based on the principle that borrowers invest in micro-ventures that yield profits sufficient to repay their debt (Dixon et al., 2007). Using collateral substitutes such as group lending or peer pressure may not be adequate in urban microfinance; rather, individual lending (based on the self-selection principle) applies (Simtowe et al., 2007).

Some notable collateral substitute and repayment incentives in individual lending, such as mandatory saving and investment in MFI equity through purchase of shares, have helped to spread financial services to the poorest of the poor in urban areas. Individual lending relies on exogenous factors such as repayment and collateral (collateral substitute) which are client-quality attributes important to MFI sustainability and influence the interest rate charged. The assumption that all urban poor and SMEs benefit from MFIs' financial services because their ventures are profitable may not be well grounded. Data from India, which is comparable to other developing countries, indicates that only 4.7 per cent of urban borrowers receive formal financing, which accounts for 2.7 per cent of a borrower's working capital requirement (Mohapatra, 2007). This underutilization of urban MFIs by the poor may be the result of the presence of alternative means of obtaining funding such as through family, friends, moneylenders, and informal savings and credit schemes, all of which are crowding out MFIs. It may also be argued that the high liquidity observed among certain financial institutions in sub-Saharan countries may indicate reluctance to expand credit to the private sector due to high risk (Sacerdoti, 2005).

Rural microfinance, it is argued, has shown some improvement in a number of sub-Saharan countries such as Ghana, Benin, and Guinea. Reasons for improvement include management and interest rate (deposit and lending) autonomy, as well as the adoption of international best practice such as credit risk management (Basu et al., 2004). However, the MFIs' financial sustainability, as measured by the operational break-even point, remains a major concern in sub-Saharan Africa and may be a reason for the high interest rate spread among MFIs within the region. This heterogeneous interest spread among sub-Saharan MFIs is a result of bad debt, lack of collateral, and poor judicial loan recovery process (Sacerdoti, 2005). Strict refinancing conditions for African MFIs from commercial banks, international funding agencies and donors – especially during an economic downturn – is shifting MFIs from non-profit to for-profit entities (Dixon et al., 2007). The lack of adequate risk instruments to reduce the diverse risk (systemic, covariant) present in rural areas is also a major hindrance in strengthening the rural financial market. Thus, when lending to individuals in rural areas, MFIs are concerned with issues of moral hazard and adverse selection. Lack of quantitative information regarding clients and risk is limiting the supply of funds by MFIs. This becomes evident when looking at agricultural loans as a percentage of total bank loans. In sub-Saharan Africa, this ranges between 2.5 and 13 per cent in 2003 compared to c. 54.1 per cent estimated in India (Sacerdoti, 2005; Patel, 2010). Currently, the average loan size to agricultural smallholders by rural MFIs in Tanzania is US$200, while in Kenya and Ethiopia it is $180 and $100, respectively.

Small conservation farmers engaged in environmentally friendly practices are often able to generate stable revenue through carbon credits. To illustrate the magnitude of an environmental service payment, the carbon project in Mozambique operated by the World Bank generated $40.50 per hectare per year (almost half the average credit loan amount) for each household in 2004 (Jindal et al., 2008). Another issue raised by Pederson (2003) is the lack of commitment from rural MFIs to finance smallholders' term investments, which are typically more long-term projects. Term investments include conservation activities (which may provide environmental services) and can be a means for smallholders to attain food security, accumulate assets, and generate revenue. However, funds for environmental services registration (upfront costs) which generate carbon credits are mainly made available by NGOs funded by donors or international funding agencies. These NGOs fill the investment vacuum left by financial institutions, since data to date shows little to no involvement from these institutions.

Carbon credit investment may be viewed as an asset which generates other assets by providing stable cash flow to smallholders, and as such, becomes a sustainable asset-based development approach for the poor. An example of asset-based development in the financial sector is 'banking the unbanked poor', where the poor have access to a savings facility (Ssewamala et al., 2010). This example corresponds to the recent argument that on a global scale, alleviating poverty and reducing income inequality can be achieved through social, human, and economic capital capacity building. The estimated cost of registration for a long-term, micro-scale carbon project is $25,000–65,000, depending on the type of carbon market. Aggregate revenue of a project approximately 40 years in duration is about $1.25 million (Benjamin, 2012a). While the decision of rural microfinance to engage in short-term lending is based on repayment capability, long-term investments of substantial amounts and with higher risk require adequate future project appraisal and collateral, which MFIs are unlikely to undertake. The lack of data on financial institutions' direct or indirect investment in carbon credit registration and verification may also indicate reluctance to engage in sustainable long-term investment. If farmers are willing to switch to environmentally friendly farming systems and NGOs accredit the environmental services, then MFIs may provide upfront investment secured by the assets that will be generated (in this case, carbon credits).

### 4.3 Adverse selection theoretical framework

In the model proposed by Batabyal and Beladi (2010), the aim is to explore how adverse selection relating to risk information asymmetry in developing countries can be reduced with the help of signalling tools such as borrower self-financing. Carbon projects by certain type of farmers have being observed to be self-financed by these farmers (Shames and Scherr, 2010). A comparative analysis of the interactions between MFIs and borrowers with and without self-financing is examined. In analyzing the model, it is necessary to consider the characteristics of poor borrowers in rural areas. These borrowers need loans to complete or complement business projects they have established or intend to establish. The outlook for success of these businesses, either low or high, may only be known to the respective entrepreneur. Businesses of high quality have a high probability of posting positive profits and a low probability of zero profit. Low-quality businesses have a lower probability of realizing a positive profit but higher probability of seeing zero profit. Loans to facilitate these projects bring MFIs and rural entrepreneurs together; however, MFIs are cautious of risk and therefore tend to lend to all borrowers under the 'optimistic' assumption that they all make zero profit in the worst case scenario. In the absence of information about these probabilities, MFIs can either lend to all businesses or to none. The assumption holds that repayment will be made to MFIs by borrowers if, and only if, their businesses make a profit. Since MFIs aggregate all rural lending, and ultimately repayment, it is important to investigate the equilibrium repayment amount in such a pooling system. The fact that all businesses or projects (both high and low quality) of rural entrepreneurs are financed as long as they yield zero profit means MFIs could be regarded risk neutral entities. Therefore, for MFIs to break even, returns from the funds have to be equal to the opportunity costs. From a MFI's perspective, to maintain sustainability (ensure break-even), borrowers' profits must be greater than the ratio of the opportunity cost of the fund to the probability of loan repayment. To MFIs, all projects for which loans are applied are assumed to have a high probability of realizing high profits, irrespective of the quality of the project (pooling equilibrium; see Appendix). This means high-quality businesses with probabilities of low profits may be left out when the pooling system is used. These assumptions explain the vulnerability of MFIs, especially in the case where a large proportion of the projects are of low quality.

The issue of adverse selection will continue to prevail as long as common repayment terms and conditions apply to all businesses receiving loans from MFIs, without regard to quality. It remains to be seen whether high-quality businesses can send a clear signal to MFIs regarding their profitability. Signaling may lead to preferential terms and conditions for said businesses. One example of project quality signaling is self-financing. According to Batabyal and Beladi (2010), signaling will lead to a separating system, rather than a pooling system, where quality borrowers are identified and given different terms and conditions. The self-financed section of the business can be used as a signal while it acknowledges that borrowers have opportunity costs for these funds. The borrower's payoff is described as a function of the type of business project, loan repayment sum, and self-financed fraction of the business (Batabyal and Beladi, 2010). The slope of an indifference curve in a (R, f) space is negative if the repayment amount is quite small, which signifies a higher utility for self-financed businesses. From this utility function, it is clear that a borrower's expected payoff decreases with an increase in the loan repayment amount and/or portion of the business that is self-financed. By identifying businesses which are partially self-financed, MFIs can categorize businesses as high or low quality. Such a separating system provides individualized loan contracts to low and high-quality business projects. This separating system ensures that only high-quality businesses receive preferential terms. For a separating equilibrium to exist, signal cost should not be too costly for the borrower to bear. A high-quality borrower should have a minimum amount of self-financing, signaling a positive expected payoff. For low-quality projects, this minimum amount is zero, and as such, yields a negative payoff. Borrowers with low-quality businesses will not self-finance and will take loans as long as expected profits are higher than repayment, while high-quality business borrowers will self-finance and take loans as long as repayment is less than or equal to MFIs' ideal borrower's profit equation (see Appendix). This should eventually lead to differences in loan contract repayment amounts.

### 4.4 Environmental services as a signaling tool

Issues confronting agricultural finance are quite similar to those experienced in environmental services financing (referred to henceforth as carbon finance). According to Havemann (2011), smallholders' carbon finance and investment, like agricultural finance, has a number of obstacles, including carbon mitigation standards, modest benefits, high upfront costs, information asymmetry, carbon price and demand volatility, and land management and tenure. However, financial risks associated with smallholders can be reduced if carbon-financed projects are established for sustainable farmers with affordable upfront costs. Smallholders with carbon credits can be viewed as diversifying the business of agriculture which, when combined with affordable climate insurance comparable to that of ENSO (El Niño Southern Oscillation) insurance programs in Peru, may prove a success (Havemann, 2011). A certified farmer may overcome many barriers to agricultural financing and may pose less of a risk. Since the risk of lending to these sustainable farmers is perceived to be low, what consequence might this have on MFIs' adverse selection and farmers' credit contract terms? Carbon revenue or credit can therefore be recognized not only as a source of collateral but also as a signaling mechanism.

There is growing concern for climate mitigation and adaptation programs, particularly those targeting smallholders on the African continent, as Africa will be one of the most acutely affected landmasses. This provides ample opportunity for the development of carbon credit markets. One of the first smallholder carbon credit community projects in Africa started in 2010 and is located in Kenya. It is expected to generate carbon revenues totalling $350,000 with an initial payment made in 2011 of

\$80,000 (World Bank, 2011b). This paper argues that a borrower (farmer) with carbon credits from a sustainable farming activity is likely to have a strong probability of a quality business and thus high-profit prospects compared with those without carbon credit. Since the upfront costs of environmental certification are primarily covered by donors and international agencies, acquiring this form of signaling is thus not too costly to smallholders. These high upfront costs are later recovered from the expected total revenues generated from smallholders' environmental services (carbon credit) sales. This may explain the limited benefit which these farmers themselves derive from participation in environmental services. Thus, certified farmers can be said to be self-financing part of their business, while non-certified farmers have no self-financing.

In the pooling system, farmers or borrowers without carbon credit will enjoy access to credit as long as the probability of profit is high; on the other side, certified farmers with low-profit probability are shut out of the credit market entirely. In a separating system, these borrowers without carbon credit have zero profit and corresponding loan terms. Therefore, a separating system in agriculturally sustainable lending will be preferred by certified smallholders. $P_{Carbon}$ is the probability of a high quality business with carbon certification and carbon revenue. This business may have a positive profit due to increased yield from conservation denoted as $\pi>0_{Carbon}$. The probability that high quality business may have positive profit due to diversification is high and denoted as $P_{hq\ Carbon}$, while the probability of a high quality carbon business will have zero profit is low an equals $1\text{-}p_{hq\ Carbon}$. The Probability of loan repayment, $P(P)$, Increases as portion of high quality business projects $PP_{hq\,\text{carbon}}$ increases this however lowers the repayment amount for carbon generating projects

$$R_{carbon} = \frac{1+r}{P(P)}, \tag{1}$$

Ultimately $\Pi_{\text{Carbon}} \geq \frac{1+r}{P(P)}$ holds (2)

Therefore quality businesses will self-finance, for carbon certified borrowers implies:

$$f^* = \frac{\Pi - \frac{1+r}{P_{hq}}}{\frac{1+\beta}{P_{lq}} - \frac{1+r}{P_{hq}}} \quad (3)$$

(See appendix for proof)

### 4.5 Policy implication

The contribution of global financial institutions (i.e. commercial banks) to sustainability is indexed by the environmental social governance (ESG) indicator. The Equator Principles set guidelines for these financial institutions' sustainable and social investments (Benjamin, 2012b). Similar investment mechanisms in microfinance – such as the microfinance investment vehicle (MIV) which also seeks to enhance ESG – are not adequately implemented in Africa (Benjamin, 2012b). Therefore, including MFI participation in the Equator Principles may be a way of improving MFIs' overall long-term sustainable investment, including the geographically wide spread of certified environmental services in sub-Saharan Africa. Instead of national financial regulators issuing advisory directives to financial institutions on the need to invest in sustainable agriculture – which has had little impact – a sustainable ESG threshold may be enacted for all financial institutions by these national institutions. National and international authorities (e.g. International Finance Corporation (IFC) – World Bank Group) should further provide a training and information platform to MFIs on the importance and profitability prospects of financing and/or lending to environmental projects. While aiming to lure MFIs into sustainable investment, the issue of property rights – one of the biggest obstacles to smallholder carbon and agriculture finance – has to be resolved. Participation of smallholders in certified environmental services, especially in sub-Saharan Africa, is expected to increase as a result of international efforts to promote climate mitigation and adaptation; however, if the issue of property rights is not addressed, this will be of little interest to financial institutions and project developers. National agencies should endeavor to establish and equip rural authorities with a proper registrar who records land titles and rights as well as local judiciaries to settle disputes in a short period of time. Adopting a bottom-up approach for identifying new and pre-existing conservation practices among smallholders, with verifiable environmental and economic benefits, will go a long way in promoting productivity and carbon market participation. NGOs should therefore tap into the vast wealth of local knowledge and also introduce new approaches which best fit each region's unique characteristics.

## 4.6 Conclusion

Uninformed risk about borrowers (predominantly farmers), limited levels of signaling, and land tenure are some of the major problems confronting MFIs lending in sub-Saharan Africa. This may explain, to some extent, the limited participation of MFIs in agricultural investment. As a growing number of farmers engage in internationally certified sustainable practices to protect the environment and from which they derive significant economic benefit, these issues can be addressed. How would these farmers and/or businesses perform in the project evaluation scheme of MFIs, and what would that mean in terms of contract conditions? The results not only suggest that adverse selection, associated with unknown risk, is minimized through certification, but also that certification may lead to preferential treatment in loan contracts. Certification may also be a profitable new business venture for MFIs.

## Appendix

**Theoretical framework:**

$P$: High quality business probability

$1-P$: Low quality business probability

$\pi>0$: business with positive profit

$P_{hq}$: probability that high quality business will have positive profit (High)

$P_{lq}$: Probability that low quality business will have positive profit (Low)

$P_{lq} < P_{hq}$

$\pi=0$ business with zero profit

$1-p_{hq}$: Probability that High quality business will have zero profit (low)

*1-*$p_{lq}$: Probability that low quality business will have zero profit (High)

R: Repayment amount to MFIs (restriction: only if $\pi>0$)

*$1: is the a*ssumed cost of project

r: Opportunity cost of fund to MFIs (r>0)

**A. Equilibrium Repayment amount (Pooling equilibrium):**

$P\lfloor P_{hq}R+(1-P_{hq})0\rfloor+(1-P\lfloor P_{lq}R+(1-P_{lq})0\rfloor=1+r$ **:** Condition for MFIs break even from financing all project (4)

$R=\dfrac{1+r}{P(P)}$ **:** Repayment amount in a pooling equilibrium (5)

$P(P)=PP_{hq}+(1-P)P_{lq}$ **:** Probability of loan repayment

$P(P)$: Increases as portion of high quality business projects $PP_{hq}$ increases

*i, i ={hq, lq}* : high or low quality business

$P_i(\Pi-R)+(1-P_i)0\geq 0$ or $\Pi\geq R$ **:** MFI´s Project success estimate for all borrowers (6)

$\Pi\geq\dfrac{1+r}{P(P)}$ **:** Condition specification for project success (substitute in equation 3 by the results from 2) (7)

MFIs wants its borrowers to undertake project i as long as P is high enough: this occurs if from equation (4)

$P_{hq}\Pi-(1+r)\geq 0$ or $\Pi\geq\dfrac{1+r}{P_{hq}}$: Condition for high quality business project is satisfied

$0\geq PP_{lq}\Pi-(1+r)$ or $\Pi\leq\dfrac{1+r}{P_{lq}}$ **:** Condition for low quality business project is satisfied

(Elimination of R from the condition above implies that a low quality business will not necessarily have a negative return after loan is repaid)

P = P*: solution of equation $\Pi=\dfrac{1+r}{P(P)}$ → P or P* < 1

**P>P*: all business will be undertaken as then** $\Pi\geq\dfrac{1+r}{P(P)}$ **holds**

**P<P*: No business (*high or low*) will be undertaken as then** $\Pi \leq \frac{1+r}{P(P)}$ **holds**

If r is large compared to $\Pi$ MFIs and P (P) is small (proportion of low quality business project is rather large) → MFI´s can break down

**B. Self-financing (signaling) of business projects:**

P>P* = $\Pi \geq \frac{1+r}{P(P)}$ → all business undertaken by borrowers (pooling equilibrium)

Adverse selection in pooling equilibrium = common repayment terms for all borrowers

*f* = self-financing fraction of business project

$\beta =$ opportunity cost of fund to borrower

$P_i[\Pi-(1-f)R]+(1-P_i)0-(1+\beta)f = P_i(\Pi-R)-f[(1+\beta)-P_iR]$: Borrower's Expected payoff function→ decrease as either *R* or *f* increases (8)

$\frac{dR}{df}=-\frac{(1+\beta)-P_iR}{(1-f)P_i}=-\frac{\frac{(1+\beta)}{P_i}-R}{(1-f)}<0$ as longs as $\frac{(1+\beta)}{P_i}$ >R : Marginal utility of indifference curve in (f, R) space for small repayment amount by borrowers of project type *i* (9)

**C. Separating Equilibrium:**

$R_i=\frac{1+r}{P_i}$ : MFI´s condition for differentiate repayment amount

$\frac{1+r}{P(P)} \leq \Pi \leq \frac{1+r}{P(P)}$ : MFI`s project success threshold assumption (10)

f = f*: | $P_{lq}(\Pi-R_{hq})-f\lfloor(1+\beta)-P_{lq}R_{hq}\rfloor=0$ : Minimum amount of self-financing to effectively signal project type and expected payoff : the case of low quality business (11)

$$P_{hq}(\Pi-R_{hq})-f\lfloor(1+\beta)-P_{hq}R_{hq}\rfloor>0$$

$P_{lq}\left[\Pi-\left(\frac{1+r}{P_{hq}}\right)\right]-f\left[(1+\beta)-P_{lq}\left(\frac{1+r}{P_{hq}}\right)\right]=0$ : Same as above by substituting equilibrium repayment into (8) (12)

$$f^* = \frac{\Pi - \frac{1+r}{P_{hq}}}{\frac{1+\beta}{P_{lq}} - \frac{1+r}{P_{hq}}} < 1\text{: simplifying (9)} \qquad (13)$$

Were $\Pi < \left[\frac{1+r}{P_{lq}}\right] < \left[\frac{1+\beta}{P_{lq}}\right]$

$(\beta - r) > 0$ : Marginal cost of signaling

if $(\beta - r) > 0 \downarrow \rightarrow P_{hq}\uparrow \rightarrow f\uparrow$ similarly if $\pi\uparrow \rightarrow P_{lq}\uparrow \rightarrow f\uparrow$

f = 0: Low quality businesses will not self-finance → they will accept MFI loan if R≤ $\pi$

f = f*: High quality businesses will self-finance → they accept MFI loan if $R_i \leq \frac{1+r}{P_{hq}}$

MFI will offer loans repayment amount of $R_i = \frac{1+r}{P_{lq}}$ if f =0

MFI will offer loans repayment amount of $R_i = \frac{1+r}{P_{hq}}$ if f = f*

# Chapter 5*: Credit risk modeling and sustainable agriculture: Asset evaluation and rural carbon revenue

## 5.1 Introduction

Rural sub-Saharan Africa—consisting of remote and isolated communities with limited basic infrastructure—does not foster an optimal business environment. The main source of income for rural dwellers comes from small-scale agriculture of one- to-three hectare of farmland. However, financing this livelihood may be difficult, as smallholders have limited or no access to financial services. Rural borrowers plagued by lack of assets, small loans amounts and inadequate business information, result in high transaction and information-gathering costs for formal lenders (Randhawa and Gallardo, 2003; Abukasawi et al., 2007). As such, formal financial institutions are extremely cautious about rural agricultural lending. These institutions, including microfinance, are more likely to invest in businesses located in urban and semi-urban areas where acquiring information is easier, assets are more readily available and transaction costs are lower. The success of microfinance predominantly in urban areas in sub-Saharan Africa has been argued by some authors (Carlton et al., 2001; Afrane, 2002). A global increase in rural financing by non-bank financial intermediaries (NBFIs), non-governmental organizations (NGOs), commercial banks and credit unions has indeed been observed in the last couple years; however, this trend has not been the case in rural sub-Saharan Africa (Baydas et al., 1997; Delfiner and Peron, 2007; Benjamin Olatunbosun, 2012). Microfinance actors in sub-Saharan Africa—especially commercial banks—are increasing their market share by reaching out to more depositors (Segrado Chiara 2005; Gupta Sarita, 2008). It is estimated that microfinance institutions in sub-Saharan Africa mobilize 72 percent of their liability in the form of deposits, which are then used as a source of funds for loans (Lafourcade et al., 2005). Equity of these microfinance institutions only accounts for 25 percent of assets. Increased savings in microfinance has yet to result in improved access to credit and higher loan amounts for rural agricultural entrepreneurs (Mahieux et al., 2011; Lapenu and Zeller, 2001). In order to protect depositors in cases where deposit insurance schemes do not exist, financial institutions need to be regulated by international banking standards and guidelines (BIS, 2012). As risk management fast becomes a regulatory prerequisite, it is less feasible for microfinance institutions to take on the same level of credit risk as before (Fernando, 2008). Collateral evaluation and business information are fundamental components of risk management which influence loan pricing (interest rate). In as much, what does risk management in microfinance mean for rural agricultural financing?

Due to adverse selection, formal financial institutions in sub-Saharan Africa may have failed to segment rural agriculture by mode of operation. This failure makes it difficult to observe ongoing trends and their benefits. Community-based or individual-based agriculture, including agroforestry, dairy production and small-scale farming, may choose conservation practices over conventional ones. Measurement of the direct benefits of conservation agriculture, such as improved yields, higher productivity and higher farm revenues; require proper data compilation which can aid MFIs in the assessment of the smallholder's creditworthiness (McIntyre et al., 2008; FAO, 2011b; Nyanga, 2012). The indirect benefit—namely reduction in emissions of greenhouse gases (GHG)—should also be considered, since the resulting carbon certification may provide an additional asset-base for smallholder farmers. Asset acquisition has been posited as one effective strategy in poverty reduction, given a certain minimal household endowment (Sadoulet et al., 1998).

This paper explores the existing framework for credit-risk modeling while incorporating an innovative approach to agricultural lending. First, a comprehensive literature review examines the role of microfinance in rural agricultural as well as agriculture conservation and its monetary evaluation. Section 5.3 explores international asset evaluation and credit-risk modeling. Data on the unique characteristics of South Africa's real farmland prices and real debt per hectare is presented in section 5.4. Section 5.5 applies the models discussed in section 5.3 to data described in section 5.4 by evaluating assets with and without ecosystem revenues. Results and conclusion are presented in the last section.

## 5.2 Literature review

### 5.2.1. Issues and challenges of agricultural micro-financing

In rural agriculture lending, the concentration of credit extension to one particular sector, e.g., maize farming, exposes financial institutions to higher covariant risk (Christen and Pearce, 2005). Diversification in the business operations of smallholder farmers may reduce income vulnerability as well as covariant risk for financial institutions. In Kenya, business diversification through off-farm economic activities in rural areas stabilized farmers' incomes (Jayne, et al., 2010).

Other factors that decrease the ability of sub-Sahara African smallholder farmers to repay loans include lack of business knowledge, non-membership in co-operatives and irregular cash-flow (Oke et al., 2007). In the absence of borrower information, financial institutions depend upon banking relationships and collateral to deal with adverse selection (Jimenez and Saurina, 2004).

Collateral to a financial institution is also an instrument to ascertain that the loans granted for a specific project are channeled into that project. Collateral type and acceptability are ultimately decided by the respective financial institutions. In agriculture, conventional collateral is often limited to farmland (Abukasawi et al., 2007). Other collateral types may include household appliances; social collateral, such as weekly mandatory savings ("cash collateral"); and use of the Group Guarantee Lending Model (GGLM) (The World Bank, 2007a). Through GGLM, loans are granted to groups rather than individuals, and all group members are liable in the event of default (Bunning, 2004). To a certain extent, GGLM could be considered successful, although there is little to no evidence that social collateral increases the likelihood of repayment and/or reduces chance of default (Paal and Wisemann, 2006; Simtowe et al., 2007). It may be difficult for microfinance institutions to quantify GGLM guarantee, making default estimation problematic. Credit granted to rural borrowers on the basis of GGLM could also lead to the collapse of MFIs in the event of simultaneous group default.

The small credit amount allocated to rural farmers, apart from increasing transaction costs, may result in low operating efficiency ratio (total operating expense/average loan portfolio), making microfinance less profitable (Young et al., 2005). Increasing the amount of microcredit to credit-worthy customers is not only beneficial to the lender but can also support economic growth. As such, individual lending to clients with fixed earning assets is gaining ground amongst MFIs (Ledgerwood, 1999). The question is, if individual lending offers credit opportunities to a certain kind of small farmer, e.g., carbon-certified farmers in sub-Saharan Africa? To answer this question, the extent to which sustainable farming affects stability of income and/or asset acquisition must be examined.

### 5.2.2. Impact of agricultural conservation and sustainability practices on smallholders

Certain traditional agricultural methods employed in rural sub-Saharan Africa—in conjunction with the effects of climate change, low-soil fertility and slow innovation adoption—are responsible for low productivity and biodiversity loss. Sustainable food security is a growing concern as population increases and available resources are exhausted. Attaining sustainable food security may require the adoption of conservation agriculture. The Food and Agriculture Organization (FAO) defines conservation agriculture as "a concept for natural resource-saving, which strives to achieve acceptable profits with high and sustained production levels while concurrently **conserving** the environment" (Thiombiano and Meshack, 2009). According to this definition, benefits are twofold: improved profit and ecosystem/environmental services. These benefits indicate a new form of diversification in today's agriculture. Increases in output (yield) and profits gained by rural smallholders due to conservation efforts have been documented by a number of research articles (Wagstaff and Malachy, 2010; Dumanski et al., 2006). A research project on conservation agriculture in Lesotho for *likoti*—a method of cultivation by digging holes in, rather than tilling, the soil—is another prime example (Laura, 2010). Smallholder production data (farm revenue) are compiled by research institutions, NGOs and smallholders for economic impact assessment purposes. For example, yields of 0.73 tons per hectare were recorded for small maize producers in Qacha's Nek (Lesotho) when using *likoti*. This is a stunning 265 percent increase in yields given the 0.2 tones/hectare average yield for maize using conventional practices.

For *likoti*, the profit margin was 1,065 Maloti per hectare. In the absence of the conservation program, it is unlikely this information would have been measured and recorded so comprehensively. As a result, in a situation like this, MFIs could gain valuable information about the income status of small maize farmers in Qacha's Nek using *likoti*. MFIs are therefore able to monitor farm business over time, improving calculation of risk evaluation and informed decision-making (Ashta, 2007; Stewart et al., 2010).

However, the adoption of conservation agriculture is not without its challenges. Land tenure, farmers' attitudes, low investment, knowledge gaps and high labor demand are predominant issues. Yet these issues are not insurmountable, as demonstrated in South Africa, Zimbabwe, Zambia, Kenya and Tanzania, all of which have seen a substantial increase in the successful adoption of conservation methods (Thiombiano and Meshack, 2009). Some threats to the success of conservation agriculture with respect to income stabilization are outside the control of farmers, such as climate changes and natural disasters. Issues and realization of conservation adoption are discussed in detail by Giller, et al. (2009) and remain beyond the scope of this paper. The primary focus of this paper is the indirect benefits—namely, certified environmental services—realized from rural conservation agriculture.

The indirect benefits of conservation method is particular important as increasing atmospheric greenhouse gases (GHG) and their mitigation are at the center of international debate. The United Nations (UN) and the World Bank group have established guidelines as well as climate funds (Global Environmental Fund - GEF) and emission schemes (e.g., Clean Development Mechanism) in developing and financing national mitigation and adaptation projects in diverse sectors, including agriculture (UNFCCC 2006; IEG World Bank 2011; Persson, 2011). One example is the compliance (or regulatory) market, where developed countries purchase certified emission reductions (CERs) from developing countries via the UN clearing house to meet their national emissions reduction target. Financing of mitigation and adaptation projects on a regional and local scale may also be achieved through voluntary carbon market participation, which is less rigorous compared to the compliance (or regulatory) market. The introduction of the trading of emission credits on these carbon markets is argued to be a cost-efficient approach in combatting climate change by placing a price on pollution, ultimately leading to fewer emissions (Dudek et al., 1997; Ecosystem market place, 2008). In agriculture, combating climate change will be through carbon capture and storage. Conservation agriculturalists of *likoti*—again, a method which offsets GHGs via no tillage (carbon storage)—would not only qualify for carbon credit but also allow participation in a secondary carbon market (West and Post, 2002; Govaerts, 2009). Small-scale agroforestry, practiced in countries such as Kenya, Tanzania and Uganda, also provides environmental services through matured tree carbon sequestration (TIST, 2012). Other agricultural practices that sequestrate carbon are discussed in detail by Jarecki and Lal (2003). When carbon credits are traded to carbon emitters or polluters, the credits become an additional source of income for farmers (Baker, 2002).

There is need to further examine, on a global scale, community and individual carbon sequestrations in rural areas, which is important for placing a monetary value on potential and verified programs.

### 5.2.3. Pricing Environmental Services

This section explores the monetary value of carbon credits obtained through conservation agriculture and agroforestry. Around the globe, carbon projects are being carried out in rural areas on community and individual bases. In this section, agroforestry and agriculture are not distinguished.

Carbon sequestration payment for conservation and rehabilitation in the Philippines is expected to mitigate between 5230 $tCO_2e$ (tones of $CO_2$ equivalent) and 11759 $tCO_2e$ valued at approximately US$70,554 at a carbon price of $6 per ton $CO_2$ (Murdiyarso and Herawati, 2005). In Indonesian, local communities are expected to sequestrate 16.85 million tons of $CO_2$ worth US$26 million over a span of 30 years (Crooks, 2009). In Mexico, around 400 smallholders generated carbon credits valued at approximately US$204,000, while in India, individual household annual income from carbon offset was US$280 (Smith and Scherr, 2002). This is on par with small-scale agroforestry carbon revenues observed in Kenya, Tanzania and Uganda, where households earned approximately US$280 for tree cultivation through intercropping (TIST, 2012).

Reducing Emissions from Deforestation and Forest Degradation (*REDD*) project in Cameroon, comprising 830,000ha of rainforest, would generate carbon credit revenue of US$64 million even at carbon prices as low as USD$3/ton $CO_2$ (Crooks, 2009). The Ibi Batéké Project in the Democratic Republic of Congo is expected to generated 500,000 carbon certificates (CER) valued at US$2.5 million at current low prices of US$4.92 (The World Bank, 2011a). The small farmer community project in Kenya is estimated to generate carbon revenues of US$350,000 with an initial payment to the community of US$80,000 made in 2011 (The World Bank, 2011b). In Mozambique, the World Bank's carbon project generated US$40.50 per hectare per year which was funneled into a community fund from which each household received US$34.70 per hectare per year (Jindal et al., 2008). Investment in community carbon projects by the World Bank in Africa is estimated at US$62 million which represents 10 percent of the World Bank's total global carbon portfolio (Jindal et al., 2008).

According to the Center for International Forestry Research, one of the many potential benefits of carbon sequestration is reduction of poverty through increases in income and capital accumulation amongst rural producers (Smith and Scherr, 2002). To a large extent, this corresponds with this paper's hypothesis, particularly in terms of capital accumulation.

## 5.3 Model

The Bank of International Settlement seeks to globally improve the financial soundness of commercial and non-commercial financial institutions through unified standards and guidelines (BIS, 2012). These standards and guidelines act as operational blueprints for thresholds for these financial institutions (Bandyopadhyay, 2008). Agricultural loans under international standards are to be treated as retail loans, and the risk is to be weighted using the "5 Cs" approach (Bandyopadhyay, 2008). The five Cs for risk evaluation are:

a. character of borrower (reputation)

b. capital (leverage)
c. capacity (volatility of earnings)
d. collateral
e. condition (macroeconomic cycle)

Due to adverse selection and information asymmetry that are prevalent especially in rural areas, a number of the components of the 5Cs cannot be used. When information asymmetry is present, formal lenders rely on collateral as a marker of a borrower's ability to repay the loan. Collateral (asset) evaluation is therefore at the center of financial institutions' risk management modeling. With risk modeling, financial institutions can anticipate default and cost of default using Probability of Default (PD) and Loss Given Default (LGD), respectively (Hull, 2009). These measurements determine the percentage of a financial institution's working capital that must be set aside as a buffer to protect depositors in the event of default. Katchova and Barry (2005) provide a detailed description of the relationship between PD, LGD, Expected Loss (EL), Unexpected Loss (UL) and bank capital adequacy requirement when using farmland as the only eligible asset. This paper argues that agricultural asset evaluation in the presence of conservation should not be limited to farmland; rather, it should include net cash flow from environmental services. This paper estimates the Distance-to-Default (DD) and the PD for farmland in southern Africa with and without certification under the assumption above. The PD is an indicator of client´s creditworthiness and directly influences the pricing of loans (interest rates). Measuring PD involves three steps:

a. evaluation of the market value and volatility of assets
b. estimation of the DD
c. mapping DD to historical default and bankruptcy frequency

### 5.3.1 Evaluation of the market value and volatility of assets

Katchova and Barry's (2005) model evaluating future farmland value was extended to include environmental services evaluation. A farmland price follows a stochastic process, while environmental services involve a fixed or constant payment. Using Merton's pricing model, we can therefore determine:

$$Asset_{conserv}{}^{0} = A_0 + Cre^{-rT}$$

$$A_T = A_0 \exp\left[ Normal\left( \left( \mu - \frac{\sigma^2}{2} \right) t + \sigma \sqrt{t Z_t} \right) \right]$$

$$Asset_{conserv}{}^{T} = A_0 \exp\left[ Normal\left( \left( \mu - \frac{\sigma^2}{2} \right) t + \sigma \sqrt{t Z_t} \right) \right] + Cr$$

$Asset_{conserv}{}^{0}$ is today's value of total farm asset (farmland) value taking fixed carbon revenue from environmental services into account.

$A_T$ equals the value of farmland at any point in time in the future.

$\mu$ and $\sigma^2$ are the mean and variance of return on farmland.

$Asset_{conserv}{}^{T}$ is the future value of farm asset plus constant carbon revenue.

$Z_t$ is the Wiener process (stochastic continuous).

The market value of farm asset ($Asset_{conserv}$) flows into the DD.

### 5.3.2 Distance-to-Default

The DD calculates the number of standard deviations the asset value is away from the default point, or threshold (Pu Chen and Willi Semmler, 2013).

$$\text{Distance-to-default (DD)} = \frac{\text{Asset Market Value - book value of the firm's debt}}{\text{Asset Value Volatility}}$$

Additional information required for the DD calculation is the book value of the firm's debt and asset value volatility.

### 5.3.3 Mapping DD to historical default and bankruptcy

The solution to the DD equation can be mapped into a historical default and bankruptcy database in which a similar DD can be used as a comparison in identifying an overview of default occurrences.

### 5.3.4 Black–Scholes Option Pricing Model and PD Calculation

Taking a closer look at the nominator of the DD it is clear that asset – debt = equity. The asset market value and market value of equity are interrelated, as illustrated by Merton in the pricing model. Given that equity holders have the right—but not the obligation—to pay back the debt of the firms (i.e., limited liability), and that they have residual claim on assets, indicates a linkage. In other words, equity is a call option (right to buy) on the farm's assets with a strike price equal to the sum of all debt. The Black-Scholes option pricing model as a unique case of Merton´s model provides a proxy for DD as well as the PD.

The value of equity (including environmental services) is derived using Black and Scholes's call option function, given as $E = A_0 Cr_0 N(d_1) - De^{-rT} N(d_2)$.

D is the book value of debt at time t.

N ($d_1$) denotes the probability that asset exceed a certain level or price.

N ($d_2$) is the probability that call option will be exercised or that assets will fall below debt.

$$N(d_1) = \frac{\ln\left(\frac{A_0 + Cre^{-rt} *}{D_T}\right) + \left(\mu + \frac{\sigma_A{}^2}{2}\right)T}{\sigma_A \sqrt{T}}$$

$$N(d_2) = \frac{\ln\left(\frac{A_0 + Cre^{-rt} *}{D_T}\right) + \left(\mu - \frac{\sigma_A{}^2}{2}\right)T}{\sigma_A \sqrt{T}}$$

In the Black and Scholes model, N (d2) is a proxy for the number of standard deviations an asset is from default and therefore a good proxy for DD. The PD is the probability that the value of the asset will be less than the book value of farm liability by the time the debt is to be repaid.

PD = Pr [$\text{Asset}_{\text{Conserv}}{}^{T} \leq D_T$ | $\text{Asset}_{\text{Conserv}}{}^{0} = A_0 + Cre^{-rT}$ ]

$$PD = \Pr\left[A_0 \exp\left[Normal\left(\left(\mu - \frac{\sigma^2}{2}\right)t + \sigma\sqrt{tZ_t}\right)\right] + Cr < D_T\right]$$

After rearranging:

$$PD = \Pr\left[ -\frac{\ln\left(\frac{A_0 + Cre^{-rt}}{D_T}\right) + \left(\mu - \frac{\sigma_A{}^2}{2}\right)T}{\sigma_A \sqrt{T}} \geq Z_t \right]$$

The Black and Scholes model considers the random content of the asset return to be normally distributed Zt~N(0, 1); it therefore follows that default probability can be defined in terms of Cumulative Normal Distribution (Crosbie and Bohn, 2003).

$$PD = N\left[ -\frac{\ln\left(\frac{A_0 + Cre^{-rt}}{D_T}\right) + \left(\mu - \frac{\sigma_A{}^2}{2}\right)T}{\sigma_A \sqrt{T}} \right] \qquad \text{or} \qquad PD = N(-DD)$$

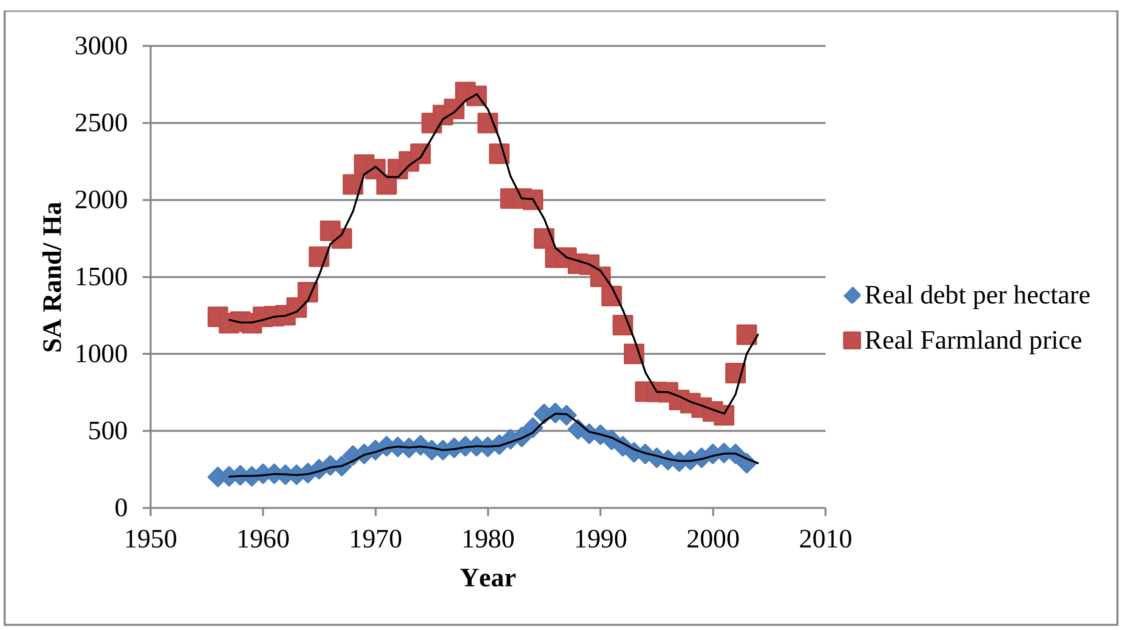
## 5.4 Data

### 5.4.1 South African Real Farmland Prices

The lack of data on smallholders' farmland prices in sub-Saharan Africa ultimately lead to the use of available commercial farm data from South Africa's farm prices using Obi (2006). However, this does not change the main hypothesis of this paper. Farm revenue, land rent and total value of farm production (productivity) generally determine an investor's willingness to pay for a farmland and thus influence farm prices. The positive correlation between farm prices and farm income has being argued by certain authors (Hattingh and Herzberg, 1980). Farm producers are, however, negatively affected by falling farm prices which handicaps their borrowing capabilities. From the 1930s to early 1970s, the prices of farmland in South Africa enjoyed significant upward trends which may have also reflected investors' perception of agriculture as being profitable. In 1973, South Africa's farmland accounted for 78 percent of total assets owned by commercial farmers; twenty years later it dwindled to 67 percent due to the drop in farm prices, which was a result of political issues (Obi, 2006).

### 5.4.2 South Africa's Real Farm Debt

Farmers' debt significantly contributed to the variances in farmland prices as cheap available loans will enhance purchasing power. Moreover the debt of farms is also linked to the interest rate on debt and inflation which determines profitability and future farm revenue. Prior to the 1990s in South Africa real farm debt increased as farmland prices increased due to effective farmland demand depicting a positive correlation which is in line with economic theory (Obi, 2006). Higher demand for farmland thus loans slightly increases interest rate from their initial low levels (Obi, 2006). Therefore a positive correlation between real interest rates and farm prices in South Africa also existed. However, contrary to economic expectation a negative correlation between real interest rate and farm prices was observed from the mid-1990s mainly due to policy issues (Obi, 2006). In the long term, as farmland prices continued to decrease, there was an increase in the interest rate, this increase in interest rate may have in some cases could lead to higher farm indebtedness (were variable rates apply) and decrease in real farm debt.




*Source: Author´s modification (Obi, 2006)*

**Figure 16: Real Farmland Prices and farm debt South Africa (1955 – 2000)**

**Table 6: Real farm asset (farmland) mean, return and volatility and Real farm debt mean in South African Rand (1980 – 2001)**

| | Real farmland Prices per ha in S/Rand | Real farm debt per ha in S/Rand |
|---|---|---|
| **Mean** | 1344 | 425 |
| **Return on asset $\mu$** | -40% | - |
| **Historical Volatility $\sigma$** | 7% | - |

## 5.5 Result

### 5.5.1 Distance to default without environmental services

At the beginning of 2001 the value of one hectare of farm land in South Africa had to drop by $\ln\left(\frac{A_0}{D_T}\right) = \ln\left(\frac{600}{355}\right) = 0.524$ (52.4 %) in order for the farmer to default on his debt. The DD at the end of this period would be $\frac{0.524 + \left(-0.4 - \frac{(0.07)^2}{2}\right)}{0.07} = 174.5\%$, so that each hectare of farmland was approximately 1.745 standard deviations above the default threshold.

It is rather important to anticipate what the DD will be in a couple years. For instance, suppose T=2. It follows that in two years the $DD = \frac{0.524 + \left(-0.4 - \frac{(0.07)^2}{2}\right)2}{0.07\sqrt{2}} = -2.82$, meaning each hectare of farmland will be 2.82 standard deviations **below** the default threshold. The probability of default per hectare of farmland at the end of 2003, judging from the normal distribution, would be 99.99 percent.

### 5.5.2 Distance to default with environmental services

The hypothetical inclusion of certified environmental services for each hectare of farmland using FAO stats of 3 tCO2e per $ha^{-1}year^{-1}$ of sequestration appears plausible (Louis, 2011). However in order to keep the situation rooted in the real world—where low prices prevail on the carbon market—this paper will not use the FAO's optimistic price of US$10/tCO2e and instead use the more realistic price of US$5/tCO2e or 69.2Rand/tCO2e. The carbon revenue generated by a certified South African farmer is valued at approximately 207.6R (R=Rand), bringing the total farm asset in 2001 to 808R (see appendix). Each hectare of farmland with environmental services would have to drop 113.9 percent for the farmer to default at the beginning of 2001 while the DD at the end of the period was approximately 650 percent. These are impressive figures compared to the results calculated without environmental services. Forecasting into 2003, the value of each hectare of farmland with environmental services was approximately 0.176 standard deviation above the default threshold, while the probability of default was 43 percent. Despite decreasing farmland prices, the future probability that farm asset (including environmental services) will fall below debt was less that 50 percent. This could become a major argument for lending to certified farmers.

## 5.6 Conclusion

In sub-Saharan Africa there are a number of sustainable agricultural practices used by smallholders which stabilizes income and capital accumulation as well as generates carbon revenues. Carbon credit generated in sub-Saharan Africa relative to carbon investment portfolio is way below average due to complexity of registration, low carbon prices, knowledge gap and cultural differences. Compared to other continents, there is a need to improve on carbon credit generation by replicating the success had by certain sub-Saharan rural areas. However, identification of existing sustainable small-farmers with carbon revenue can go a long way toward improving risk management and easing lending constraints to rural agricultural. Financial institutions' allocation of credit to carbon revenue earners could promote climate mitigation and adaptation. Increasing credit volume to certified small farmers may foster the adoption and promotion of innovation, leading to an increase in agricultural output and productivity in rural areas. One of the advantages formal lenders have in lending to certified smallholders, apart from reduced risk, is that less capital adequacy is required. These funds could be invested in ongoing business operations to improve profitability. This is one of the first articles to explore synergies between formal credit and sustainability via carbon credit. There is still an enormous need for further research on this issue, particularly since additional research could shape future policy decision-making.

## Appendix

**Table 7: Real farm debt and Farmland Prices South Africa (1980 – 2000)**

| Year | Real Farm Debt in Rand /ha | Real Farmland Prices in Rand /ha |
|---|---|---|
| **1980** | 395 | 2500 |
| **1981** | 410 | 2300 |
| **1982** | 445 | 2010 |
| **1983** | 460 | 2010 |
| **1984** | 520 | 2000 |
| **1985** | 610 | 1750 |
| **1986** | 615 | 1625 |
| **1987** | 600 | 1625 |
| **1988** | 510 | 1585 |
| **1989** | 480 | 1580 |
| **1990** | 475 | 1500 |
| **1991** | 440 | 1375 |
| **1992** | 400 | 1187 |
| **1993** | 360 | 1000 |
| **1994** | 350 | 755 |
| **1995** | 325 | 753 |
| **1996** | 310 | 750 |
| **1997** | 300 | 700 |
| **1998** | 310 | 680 |
| **1999** | 325 | 650 |
| **2000** | 350 | 625 |
| **2001** | 355 | 600 |

*Source: Author´s estimation of Obi (2006) data*

## Chapter 6[*]: Certified conservation farming: a strategy to overcome smallholder's credit constraints?

### 6.1 Introduction

In parts of sub-Saharan Africa, agricultural small and medium enterprises (SMEs) are confronted with credit constraints. Several authors have found that over 50 per cent of farm households in developing countries are formal credit constrained (Muayila and Tollens, 2012; Zahidul Islam et al. 2011; Simtowe et al. 2009; Khandker and Faruqee, 2003*;* Blackman 2001).This limited credit access slows agricultural development in these countries. In a situation where credit for agricultural investment is not available, agricultural development is hampered by the absence of modernization, proper marketing channels, and cash management (Barry and Robison, 2001). Limited lending by formal financial institutions to rural agricultural SMEs can therefore, in part, be attributed to information imperfection i.e. lenders are unable to observe which borrowers are involved (Sacerdoti 2005; IFAD 2003; IFC 2013; Benjamin 2013a; Su, 2012) Information asymmetry, moral hazard and covariant risk associated with smallholder farmers compounded by lack of adequate collateral are considered incalculable risks for banks (Swinnen and Gow, 1999). However, there is a potential strong demand for agricultural credit in developing countries (Swinnen and Gow, 1999).

In general, information asymmetry (adverse selection) and moral hazard together, is always an issue in credit demand, however, increasing the interest rate and collateral requirement results in financial institutions having a pool of bad clients and risky projects, ultimately yielding a reduction in bank return (Stiglitz and Weiss, 1981). Limited liability causes borrowers to invest in projects with relatively higher risk corresponding to higher payoff; increasing the interest rate would result in less risky projects being crowded out due to a low payoff, thus, credit rationing of high risk projects (Wette 1983). Increasing the liability of borrowers through a higher collateral requirement as a means of credit allocation increases the riskiness of the loans as borrowers cannot offer the required collateral (Stiglitz and Weiss, 1981). Collateral requirement is therefore not used as a rationing tool to eliminate excess demand if borrowers are risk averse and risk neutral, as this may also lead to adverse selection, therefore reducing lenders' profit (Stiglitz and Weiss, 1981; Wette 1983). These authors argue that amongst observationally identical borrowers in a single-contract equilibrium scenario given a level of (excess) demand, some receive loans, while others are denied loans due to randomized selection. Banks therefore choose an optimal interest rate for all borrowers with limited liability, which remains unchanged even in the presence of excess credit demand (Stiglitz and Weiss, 1981). The model of Stiglitz and Weiss (1981) has been criticized for considering interest rate and collateral a separate entity rather than a simultaneous incentive process from a sorting perspective (Su, 2012). An interest rate/collateral combination may lead to incentive-compatible contracts, which segments risk-making rationing insignificant as adverse selection is eliminated (Su, 2012). Random rationing also depends on the evaluation of the project in the borrowing pool; a positive elevation of a project by both bank and borrower does not lead to adverse selection, thus the validity of risk-sorting (Su, 2012). Therefore borrowers that may have been denied loans due to collateral constraints are no longer the result of random rationing, as described by Stiglitz and Weiss, (1981) (Su, 2012). Collateral is accepted by a financial institution if it is valuable enough to mitigate the risk of the advanced loan, while banking policies may also reduce the number of high-risk borrowers (Besanko and Thakor 1987; Swinnen and Gow 1999).

It is important to search for new approaches in dealing with information imperfection in agricultural credit risk in order to foster rural development, for instance considering new forms client evaluation, collateral and insurance policies (Boucher et al., 2008; Barry and Robison, 2001). Extension services with ecosystem services (EES) may help overcome the aforementioned information imperfection. The projects embarked on by the EES participants are mostly well documented due to monitoring, verification and reporting requirements. Thus comprehensive records are available on the business cycle, agricultural output, as well as all possible revenue sources of individual smallholders (Masiga et al. 2012). These schemes are often run by non-governmental organizations (NGOs) and provide training on ways to improve agricultural productivity through knowledge spillovers along with helping to generate additional income from payment for ecosystem services. For example, the International Small Group Tree Planting Programme (TIST) trains small and medium farmers on conservation techniques, including zero tillage, (organic) fertilizer application, mulching, terracing, climate change mitigation through tree planting, and rainwater harvesting. In addition, farmers receive assistance from TIST in accessing formal credit.

This strategy not only improves farmers' human capital, especially skills related to record-keeping and farm management, but also introduces carbon certification as an additional source of income (Tham-Agyekum et al. 2010; Evenson and Mwabu 1998; Pagiola et al. 2008). EES have led to improvements in and diversification of farm revenues among adopting farmers (Delgado 1999; Diagne and Zeller 2001; Kagwiria 2013). Ecosystem and conservation farming by smallholders in developing countries contributes to the alleviation of poverty by helping farmers accumulate capital (Pretty 1999; Pagiola et al. 2005; Thierfelder et al. 2012; Havemann and Muccione 2011; Montagnini and Nair 2004). Moreover, carbon registration demonstrates that agriculture SMEs have already self-financed part of their project therefore sending a positive signal regarding their managerial abilities (Benjamin 2013b).

This study investigates the impact of smallholder participation in EES on credit constraints and credit conditions in the case of Kenyan TIST participants. Participation may have beneficial effects since higher incomes, more diversified sources of income, and an extra source of collateral (future income from carbon sequestration) may lower risk premiums charged by financial institutions. In addition, skills provided through the TIST network may be perceived by financial institutions as an indicator of business viability and trustworthiness. We use the model of Han et al. (2009) to investigate whether farmers can be sorted into quality groups that are offered different contract types, using EES as a quality measure.

The remainder of this article is structured as follows: Section 6.2 introduces the theoretical framework of the sorting and screening model and develops the hypotheses. Section 6.3 elaborates on relevant data used in this study. Section 6.4 carries out an econometric regression in order to verify the hypotheses. Section 6.5 discusses potential hurdles within the OLS analysis while section 6.6 then concludes.

## 6.2 Theoretical Model

The model described by Han et al. (2009) combines two previous theoretical models: Berger and Udell (1990) and Bester (1985). The former model argues that financial institutions may require collateral from and/or impose higher interest rates on observed risky borrowers (Sorting by observed risk), whereas the latter argues that the creditworthiness of borrowers is screened via the collateral put up by borrowers (Sorting by private information). As both are important possible mechanisms we use the combined model of Han et al. (2009). This model, contrary to the one of Stiglitz and Weiss' (1981) single-contract equilibrium with optimal interest rate, depicts a screen and sorting mechanism resulting in optimal interest rate/collateral indifference curve and multiple-contract equilibrium. An alternative would be the model of Milde and Riley (1988), but they use loan size to screen participants, rather than observable characteristics.

As pointed out by Lambrecht (2009), Han et al. (2009) use the term signaling, which is an unfortunate choice, as they have in fact a sorting and screening model.[4] Borrowers are sorted according to observable characteristics and then screened through a menu of contracts. Thus we will refer to observable characteristics. To stay consistent with the notation of Han et al. (2009) we will denote the characteristics as *s*.

In their article, Han et al. (2009) assume that financial institutions know the return on a project but are not familiar with the business ability of borrowers. Therefore, these formal institutions sort clients based on an observed characteristic. Examples of such characteristics are business records and involvement in EES both of which can be observed by the lender without significant cost. One issue with observable

[4] Note that if borrowers consciously engage in EES to get better credit terms, and this engagement is costly then we would have a signaling model. However, we do not model this decision and as such we are not dealing with a signal model

characteristics is that they do not perfectly measure quality, thus borrowers who seem to have a high degree of creditworthiness may in fact not be very creditworthy.

Following Han et al. (2009) we model farmers with and without EES who demand credit for a farming project. This farming project requires an exogenous investment (*K*) which is completely financed by formal institutions. The success of the farming project depends on the farming ability θ of the farmer with a probability p(θ). Highly-skilled farmers are denoted by $\theta_H$ and low-skilled farmers denoted as $\theta_L$, $\{\theta_H, \theta_L\} \in (0,1)$. A farmer repays if the project is successful and defaults if it fails. The probability of project success is equal to farming ability of the farmer p (θ) = θ. Credit contract is made up of interest rate *r* and collateral *C* where repayment of credit = (1+ *r*) *K*.

The Project (farming) return is:

$$return = \begin{Bmatrix} (1+\theta)K \rightarrow \text{with probability } (w.p.) \rightarrow \theta \\ 0 \rightarrow \text{with probability } (w.p.) \rightarrow (1-\theta) \end{Bmatrix}$$

The utility function of the farmer at the end of the period for a successful project for a farmer with EES is ($U^{S|EES}$) = (Initial wealth (*W*) + potential cash flow from carbon credit (*B*) + project return – credit repayment:

$$U^{S|\text{EES}} = (W + B) + ((1+\theta)\, K) - (1+ r)\, K = (W + B) + (\theta - r)\, K \qquad \text{w.p.} \quad \theta. \qquad (1)$$

Similarly for a conventional farmer:

$$U^{S|Conventional} = (W + ((1+\theta)\, K) - (1+ r)\, K = W+ (\theta - r)\, K \qquad \text{w.p.} \quad \theta. \qquad (2)$$

In case the project fails we have ($U^F$)→ Initial wealth – Collateral pledge (due to default):

$$U^{F|\text{EES}} = (W + B) - C \qquad \text{w.p.} \ 1 - \theta. \qquad (3)$$

$$U^{F|Conventional} = W - C \qquad \text{w.p.} \ 1 - \theta. \qquad (4)$$

Thus the expected project utility (EU) is:

$$EU^{EES} = \theta U^{S|\text{EES}} + (1 - \theta)\, U^{F|\text{EES}} = (W + B) + \theta^2 K - r\theta K - (1 - \theta) \qquad (5)$$

$$EU^{Conventional} = \theta U^{S} + (1 - \theta)\, U^{F} = W + \theta^2 K - r\theta K - (1 - \theta) \qquad (6)$$

Prior to the sorting process the bank estimates that the distribution of farmers over types is equal, i.e. $P(\theta_H) = P(\theta_L) = 0.5$. Moreover, the bank assumes that the probability of observing a high-quality characteristic of a highly-skilled farmer, $\bar{s}$, is equal to that of observing a low-quality characteristic of a low-skilled farmer, $\underline{s}$, i.e., Pr ($\bar{s}$ |$\theta_H$) = Pr ($\underline{s}$ |$\theta_L$) = $\alpha$. The conditional probabilities of observing the respective characteristic from the different types of farmers are:

$$\Pr(\theta = \theta_H \mid s = \bar{s}) = \Pr(\theta = \theta_L \mid s = \underline{s}) = \frac{0.5\alpha}{0.5\alpha + 0.5(1-\alpha)} = \alpha, \qquad (7)$$

and

$$\Pr(\theta = \theta_L \mid s = \bar{s}) = \Pr(\theta = \theta_H \mid s = \underline{s}) = 1 - \alpha \qquad (8)$$

The latter conditional probability represents the case of a low skilled farmer participating in a conservation program, i.e., the probability of a low-skilled farmer having a high-quality characteristic and vice versa. The conditional probability $\alpha$ is assumed to be $\geq 0.5$. If $\alpha$ is less than 0.5 then $s$ is not a good measure of quality. With better information, formal institutions could design contracts for each type of farmer. Thus the bank offers two types of contracts: one for highly-skilled farmers $\Gamma(r_H, C_H)$ and one for low-skilled farmers $\Gamma(r_L, C_L)$. Assuming separate contracts, the expected profits of the bank are, in the case of

a. High quality characteristics:

$$E\bar{\pi} = \alpha[\theta_H(1+r_H)K + (1-\theta_H)C_H - K] + (1-\alpha)[\theta_L(1+r_L)K + (1-\theta_L)C_L - K] \qquad (9)$$

b. Low quality characteristics:

$$E\underline{\pi} = (1-\alpha)[\theta_H(1+r_H)K + (1-\theta_H)C_H - K] + \alpha[\theta_L(1+r_L)K + (1-\theta_L)C_L - K] \qquad (10)$$

### 6.2.1 Self-selection mechanism and screening

Bank contracts can screen individuals and promote self-selection if two conditions are satisfied: *individual rationality* and *incentive compatibility*. For both lender and farmer, the *individual rationality* condition states that if the expected utility of undertaking the project is larger than the utility of not undertaking it then the project will be undertaken. Given $W$ for conventional farmers and $W + B$ for the sustainable farmer, it follows that the menu of contract for borrowers, given the expected utility of the project, under the individual rationality condition is:

$$EU_i^{EES}(\Gamma_i) = (W + B) + \theta_i^2 K - r\theta_i K - (1-\theta_i)C \geq W + B$$

$\rightarrow \theta_i^{\,2}K - r\theta_i K - (1-\theta_i)C \geq 0,$ (11)

Similarly the expected utility of conventional farming project is:

$EU_i^{cv}(\Gamma_i) = W + \theta_i^{\,2}K - r\theta_i K - (1-\theta_i)C \geq W$

$EU_i^{cv}(\Gamma_i) = \theta_i^{\,2}K - r\theta_i K - (1-\theta_i)C \geq 0$ (12)

For the formal financial institution this condition implies:

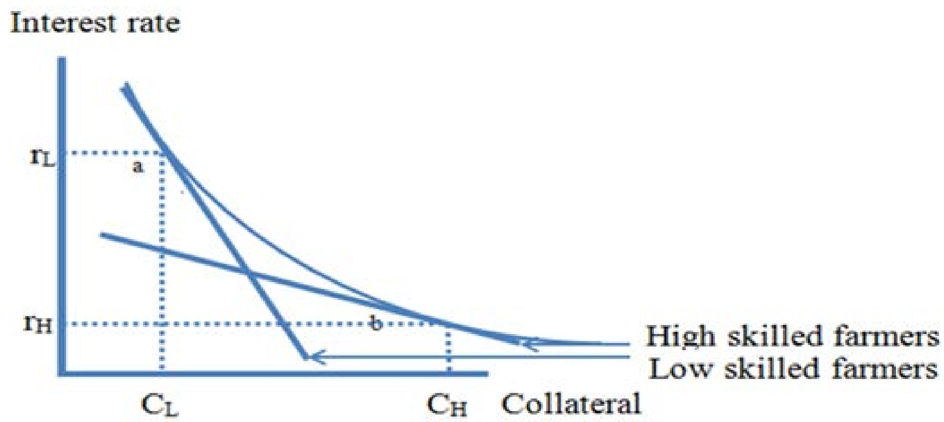
$E\overline{\pi} \geq 0$ if characteristic $s = \bar{s}$ and $E\underline{\pi} \geq 0$ if the characteristic $s = \underline{s}$

For farmers, the *incentive compatibility* ensures that it is optimal to choose contracts meant for them and not to opt for the other contract, i.e. for a high-(skilled) quality farmer $EU_H(\Gamma_H) > EU_H(\Gamma_L)$ and low-quality farmers $EU_L(\Gamma_L) > EU_L(\Gamma_H)$, for both of those sorted into the EES and conventional group. To further elaborate on the farmer's participation condition, a *high-skilled* farmer who has a high-quality characteristics $\bar{s}$ will maximize his expected utility by choosing a combination of low interest rate and high collateral such that $EU_{HEES}(\Gamma_H) > EU_{H\,EES}(\Gamma_L)$, and a low skilled farmers high-quality characteristics $\bar{s}$ such that $EU_{LEES}(\Gamma_H) > EU_{LEES}(\Gamma_L)$. The same condition holds for conventional farmers.

Under the *individual rationality* and *incentive compatibility* conditions contracts can be designed such that, given the characteristics, farmers are separated into high- and low-quality. In order to separate, the bank needs to offer for each type of characteristic two types of contracts such that $\begin{cases} if\ \mathrm{r_L} > \mathrm{r_H} & \text{then } \mathrm{C_H} > \mathrm{C_L} \\ if\ \mathrm{r_L} < \mathrm{r_H} & \text{then } \mathrm{C_H} < \mathrm{C_L} \end{cases}$ (proof: see appendix).

The intuition is that each type of farmer will settle for the contract that matches their skills. Within the EES group the contracts separate the low skilled farmer from the high skilled ones, and the same occurs in the conventional group. However, high skilled farmers with EES probably face even better contract terms than high skilled without EES.

The separation mechanism is illustrated in figure 17, which depicts the marginal (dis)utility of interest rate and collateral between low-skilled and high-skilled farmers.




*Source: Authors modification of Han et al. 2009*
*Note: subscripts denote farmer's type*

**Figure 17: Multiple contract equilibrium: Depicted are the indifference curves in r and C from a Bank´s perspective and for two types of farmers in a choice contract**

Depicted are the indifference curves in r – C for both the bank and the two types of farmers. On the y-axis of the graph are the interest rates r of the farmers, and on the x-axis is the collateral requirement. For credit terms, low-skilled farmers maximize their utility at point "a" while highly-skilled farmers maximize utility at point "b". From the above graph (Fig. 1) it is obvious from the indifference curve that a highly-skilled farmer would prefer collateral to interest rates, as this set of farmers is willing to pledge more collateral or assets for a substantially lower rate of interest. In contrast, a low skilled farmer has an opposite preference therefore pledging less collateral for a high interest rate.

## 6.3 Data and Variables

Agriculture accounts for approximately 75 percent of the Kenyan labor force, while 75 percent of total agricultural output is attributed to smallholder farmers (holding between 0.58 and 2.5ha farmland). Therefore, is an important sector for job creation and poverty alleviation (Salami et al. 2010; Orodho, 2006). An estimated three quarters of the population (32.3 million) are rural dwellers, of which 70 per cent are "poor" smallholder farmers located in the central and western regions (IFAD 2013). These areas are characterized by medium to high agriculture production potentials since other regions are either arid or semi-arid areas with frequent drought (IFAD 2013).

Conversely, these arid and semi-arid constitute about 80 per cent of the land surface and are inhabited by 20 per cent of the total population (Orodho, 2006). The study area covered includes: Embu, Meru and Nanyuki, which are humid and semi-arid regions of Eastern and Rift valley provinces located in the central and western regions of Kenya. Maize, poultry, vegetables, beans, agroforestry and potatoes are some of the major agricultural produce produced in all three areas. We randomly sampled 210 farmers from these regions, whereby ca. half are members of the The International Small Group Tree Planting (TIST). No interviewee declined to be interviewed corresponding to a 100 per cent rate of return of. Smallholders ($\text{farmsize} \leq 2.5 \text{ ha}$) were predominant throughout with ca. 55.7 per cent of them growing cash crops such as coffee or/and tea.

TIST is undertaking projects in conjunction with the Clean Air Action Corporation's (CAAC), a private carbon developer, to establish small-scale agroforestry in Kenya, India, Tanzania, Uganda, Honduras and Nicaragua. These projects not only help to rehabilitate ecosystems such that they are more productive but also validate and verify carbon sequestration through the verified carbon standard (VCS) and the Climate, Community and Biodiversity standard (CCB) (Shames et al., 2012). TIST creates small groups of farmers to organize the tree planting and provides training in Kenya and have so far established tree cover on an estimated 4,597 ha, sequestrating 209, 613 tons of carbon (Masiga et al., 2012). In April 2013, a survey was carried out in the eastern, central, and rift valley provinces of Kenya where 130 smallholder farmers were randomly sampled. A structured questionnaire was developed and pilot-tests conducted before interviews were conducted amongst agricultural SMEs.

## 6.4 Empirical analysis

In Table 8 characteristics of the data used to assess the determinants of credit access in a set of regression analyses performed below are shown. Summary statistics show that 88 per cent of all interviewees report to have been able to obtain a loan, whereas for 12 per cent were not. However, we cannot be certain about the correct interpretation of "0" statements, since we cannot distinguish between "rejected application for credit", "those that did not try to obtain credit" because they anticipated a rejection and "those that are not in need of credit". Approximately 42 per cent of smallholders stated that they keep written business records. Average number of cattle on farm is 1.52 in this sample and the average farm size is one hectare. 97 per cent of all farmers cultivate zero to five hectares, approximately 2 per cent of farms have a size of six to eight hectares, and the remaining farmer has a farm with a size of 16 hectares. Average total revenues among 130 smallholders is approximately 114,000 Kenyan shillings (Ksh); average distance to the nearest market is approximately 2.1 km. Education, measured in years of formal schooling, is 8.8 years. 66 per cent of all interviewees state to be member of TIST program and 82 per cent of all interviewees have a neighbor who is a TIST member.

**Table 8: Descriptive statistics (referring to models shown in Table 12)**

| Variables | N | Mean | Standard Deviation | Min. | Max. |
|---|---|---|---|---|---|
| **Credit access (yes/no)** | 130 | 0.88 | 0.30 | 0.00 | 1.00 |
| **Maintains business records (yes/no)** | 130 | 0.42 | 0.50 | 0.00 | 1.00 |
| **Cattle (apiece)** | 130 | 1.52 | 1.61 | 0.00 | 15.00 |
| **Farm size (hectares)** | 130 | 1.00 | 2.00 | 0.05 | 16.00 |
| **Total revenues (in 000 Ksh)** | 130 | 114.74 | 113.11 | 8.20 | 730.00 |
| **Education of farmer (in years)** | 130 | 8.75 | 3.68 | 0.00 | 16.00 |
| **Distance to market (in km)** | 130 | 2.08 | 2.94 | 0.01 | 20.00 |
| **TIST member (yes/ no)** | 130 | 0.66 | 0.48 | 0.00 | 1.00 |
| **Neighbor is TIST member (yes/ no)** | 128 | 0.82 | 0.39 | 0.00 | 1.00 |

A first approach to obtain information about differences between the successful and unsuccessful farmers in accessing formal credit markets is computing descriptive statistics for these groups separately. In Table 9, descriptive statistics of successful applicants are presented. A comparison of information with those who failed at accessing credit markets (Table 10) reveals that there are substantial differences between these groups' socioeconomic indicators: successful applicants tend to have approximately 2.4 times more cattle, larger farms (factor 1.7), and substantially higher revenues (factor 2.7) compared to unsuccessful ones. They attend school longer (more than three years more), and are located closer to the nearest market (on average 1.8 km compared to 4.3 km). This indicates that some farmers might fail at accessing credit markets because they are less solvent, have less collateral and/or because they are less skilled. Surprisingly, successful applicants keep written records less often (42 per cent versus 48 per cent) and are less likely to be a member of TIST, even though TIST offers advantages especially for smallholders' with limited resources. Given the variety of potential reasons for credit market access, it is at this stage impossible to identify one particular reason. We will shed more light on this matter by assessing these factors simultaneously in a multiple regression framework.

**Table 9: Descriptive statistics for those farmers *with* access to credit markets**

| Variables | N | Mean | Standard Deviation | Min. | Max. |
|---|---|---|---|---|---|
| **Credit access (yes/no)** | 115 | 1.00 | 0 | 1.00 | 1.00 |
| **Maintains business records (yes/no)** | 115 | 0.42 | 0.50 | 0.00 | 1.00 |
| **Cattle (apiece)** | 115 | 1.63 | 1.76 | 0.00 | 15.00 |
| **Farm size (hectares)** | 115 | 1.04 | 1.90 | 0.05 | 16.00 |
| **Total revenues (in 000 Ksh)** | 115 | 123.75 | 116.73 | 8.20 | 730.00 |
| **Education of farmer (in years)** | 115 | 9.13 | 3.63 | 0.00 | 16.00 |
| **Distance to market (in km)** | 115 | 1.78 | 2.23 | 0.01 | 15.00 |
| **TIST member (yes/ no)** | 115 | 0.68 | 0.47 | 0.00 | 1.00 |
| **Neighbor is TIST member (yes/ no)** | 114 | 0.84 | 0.37 | 0.00 | 1.00 |

**Table 10: Descriptive statistics for those farmers *without* access to credit markets**

| Variables | N | Mean | Standard Deviation | Min. | Max. |
|---|---|---|---|---|---|
| **Credit access (yes/no)** | 15 | 0.00 | 0 | 0.00 | 0.00 |
| **Maintains business records (yes/no)** | 15 | 0.47 | 0.52 | 0.00 | 1.00 |
| **Cattle (apiece)** | 15 | 0.67 | 1.05 | 0.00 | 3.00 |
| **Farm size (hectares)** | 15 | 0.61 | 0.99 | 0.05 | 3.60 |
| **Total revenues (in 000 Ksh)** | 15 | 45.62 | 33.71 | 10.00 | 120.00 |
| **Education of farmer (in years)** | 15 | 5.87 | 2.75 | 0.00 | 8.00 |
| **Distance to market (in km)** | 15 | 4.39 | 5.73 | 0.5 | 20.00 |
| **TIST member (yes/ no)** | 15 | 0.53 | 0.52 | 0.00 | 1.00 |
| **Neighbor is TIST member (yes/ no)** | 14 | 0.64 | 0.50 | 0.00 | 1.00 |

In a first step, we investigate determinants of credit accessibility in a logistic regression framework. Correlation coefficients between variables used in the logistic regression models are shown in Table 11. Correlation between independent variables is generally low. We conclude it is safe to use them simultaneously in a regression framework since multicollinearity-related biases are unlikely to play a role.

**Table 11: Correlation matrix, referring to models presented in Table 12**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Credit access (yes/ no) | 1.00 | | | | | | | | |
| 2 | Maintains business records (yes/ no) | -0.06 | 1.00 | | | | | | | |
| 3 | Cattle (apiece) | 0.21 | 0.07 | 1.00 | | | | | | |
| 4 | Farm size (hectares) | 0.09 | 0.06 | 0.49 | 1.00 | | | | | |
| 5 | Total revenues (in 000 Ksh) | 0.21 | -0.06 | 0.11 | 0.09 | 1.00 | | | | |
| 6 | Education of farmer (in years) | 0.24 | -0.20 | 0.10 | 0.14 | 0.48 | 1.00 | | | |
| 7 | Distance to market (in km) | -0.27 | 0.24 | 0.15 | 0.18 | -0.09 | -0.16 | 1.00 | | |
| 8 | TIST member (yes/ no) | 0.08 | 0.26 | 0.11 | 0.23 | -0.11 | -0.16 | 0.25 | 1.00 | |
| 9 | Neighbor is TIST member (yes/ no) | 0.16 | 0.11 | 0.07 | 0.15 | -0.05 | -0.14 | 0.23 | 0.58 | 1.00 |

Models 1 to 3 (Table 12) establish the baseline model, where essential socioeconomic characteristics of smallholders are controlled for. The results indicate that collateral, such as the number of cattle in possession of the farmer and size of farm, improve the chances to access formal credit markets. We also control for the farmer's formal education, measured in years, which turned out to have a positive effect. Education is considered a crucial precondition for improved labor productivity and ability to adopt new technologies (Huffman, 2001; Huffman and Orazem 2007; Jamison and Lau 1982).

**Table 12: Determinants of access to formal credit markets among Kenyan smallholders**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Maintains business records** | 0.31 | -0.11 | 0.01 | -0.87 | -0.88 |
| | (0.678) | (0.694) | (0.707) | (0.824) | (0.841) |
| **Cattle (apiece)** | 1.09** | 0.97** | 0.94** | 1.06** | 1.60*** |
| | (0.447) | (0.407) | (0.416) | (0.428) | (0.608) |
| **Farm size (hectares)** | 0.93 | | 1.07 | 1.10 | 2.18** |
| | (0.723) | | (0.742) | (0.797) | (0.988) |
| **Education of farmer (in years)** | 0.26*** | 0.19* | 0.19* | 0.26** | 0.15 |
| | (0.101) | (0.099) | (0.103) | (0.122) | (0.137) |
| **Distance to market (in km)** | -0.31*** | -0.22** | -0.29** | -0.36*** | -0.47*** |
| | (0.111) | (0.107) | (0.115) | (0.129) | (0.159) |
| **Total revenues (in 000 Ksh)** | | 0.01 | 0.02* | 0.02** | 0.02* |
| | | (0.009) | (0.009) | (0.010) | (0.010) |
| **Tist member (yes/ no)** | | | | 2.39** | |
| | | | | (0.950) | |
| **Neighbor is TIST member (yes/ no)** | | | | | 2.76*** |
| | | | | | (1.056) |

| | | | | | |
|---|---|---|---|---|---|
| **Constant** | -0.79 | -0.71 | -1.21 | -2.92** | -3.19** |
| | (0.918) | (0.894) | (0.974) | (1.345) | (1.571) |
| | | | | | |
| **Observations** | 130 | 130 | 130 | 130 | 128 |

*Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Coefficients represent odd-ratios of a logistic regression where the dependent variable equals 1 if smallholder is a borrower and 0 otherwise.*

Total revenues earned also seem to increase the probability to obtain credit at a formal credit institution, whereas distance to market has the opposite result. Banks are likely to search for these characteristic among applicants for credit to identify farmers with progressive production methods, higher and more stable incomes and therefore and a lower risk of default. Maintaining business records, according to the result, appears not to be an important factor at the early stage of loan application; rather collateral, collateral substitutes and human capital characteristics are of importance. In models 1 and 2, the baseline model is varied in such a way, that potential collinearity between farm size and total revenues become visible. The results of model 3 confirm those derived in models 1 and 2, indicating robustness and that collinearity between total revenues and farm size is not an issue here.

In a next step, the results of model 3 can be compared with those of models 4 and 5. The latter two models confirm earlier results, and allow investigating the effect of TIST membership. Model 4 controls for TIST membership of an individual and the corresponding coefficient suggests that TIST membership positively affect the probability to obtain credit. TIST membership is associated with a 2.76 higher chance to access credit market compared with non-members. This may indicates that skills, information, and technologies provided through the TIST network, such as improving productivity, using natural and chemical fertilizer, mulching, avoiding erosion as well as the opportunity to market ecosystem services have a beneficial effect on credit access. Furthermore, TIST program facilitates loans from formal financial institutions on behalf of the smallholders for purchasing seed, farming implements for planting and educating their children (Shames et al. 2012).

In model 5, the hypothesis is tested that it is not the membership per se that affects the ability to access credit, but is merely information, technology, etc. provided through the TIST network. Here, we do not control for TIST membership, but for the fact that an individual's *neighbor* is a TIST member. By performing this test we are able to separate the effect of formal membership and information transfer through the TIST network and subsequent spillover effect. The results indicate that the *neighbor's* membership also has a positive impact on an individual's ability to obtain credit, indicating that spillovers play a role in addition to returns to ecosystem services which are solely possible for formal TIST members. This phenomenon is not new to scientific literature as similar behavior has been observed for the U.S., India, Ghana, and Mozambique, but in this case the source for spillovers are not pioneering locals but an external institution (TIST), increasing skills by socializing knowledge (Bandiera and Rasul 2006; Conley and Udry 2010; Foster and Rosenzweig 1995; Parman 2010, Ryan and Gross 1943).

In a second step, we investigate those individuals who have successfully applied for credit. We are particularly interested in the interest rate these individuals pay. In Table 14 the correlation coefficients between relevant variables used in corresponding regression models are shown. Given the low correlations between explanatory variables capturing general farm and credit characteristics (see variables no. 2 - 8) we conclude that controlling for these variables does not bias our results. High correlations can be observed between different types of income, as some variables, such as off-farm revenues and non-agricultural revenues (see variables no. 8 - 10), measure similar activities.

**Table 13: Descriptive statistics (referring to models shown in Table 15)**

| Variables | N | Mean | Standard Deviation | Min. | Max. |
|---|---|---|---|---|---|
| **Credit interest rate (%)** | 52 | 12.92 | 5.34 | 2 | 20 |
| **Maintains business records (yes/no)** | 52 | 0.42 | 0.5 | 0 | 1 |
| **Cattle (apiece)** | 52 | 1.63 | 1.33 | 0 | 7 |
| **Farm size (hectares)** | 52 | 0.86 | 1.26 | 0.1 | 8 |
| **Conventional credit institution** | 52 | 0.13 | 0.34 | 0 | 1 |
| **Microcredit institution** | 52 | 0.62 | 0.49 | 0 | 1 |
| **Co-operative bank** | 52 | 0.31 | 0.47 | 0 | 1 |
| **Income share from cropping** | 52 | 57.03 | 37.08 | 0 | 100 |
| **Income share from off-farm revenues** | 52 | 42.97 | 37.08 | 0 | 100 |
| **Income share from non-agriculture** | 52 | 43.18 | 27.21 | 0 | 100 |
| **Income share from ecosystem payments** | 52 | 1.00 | 2.53 | 0 | 13.33 |

For the analysis of the determinants of credit interest rate, descriptive statistics are presented in Table 13. Unfortunately, we do not have all information necessary to run regression on all 130 farmers; in fact, we lose those individuals without credit access and those with incomplete information, resulting in 52 individuals to be used in empirical tests. Descriptive statistics indicate that the mean interest rate among the 52 smallholders who report credit access is 12.92 per cent per annum, with a reported minimum of two and a maximum of 20 per cent.[5] Explanatory variables were collected to capture smallholders' socioeconomic characteristics to assess their ability to check the risk of default as well as the credit institution's banking practices. Approximately 42 per cent of all interviewees confirmed that they maintained written business records, an activity which is central for a bank's client quality perception. As for collateral, average farm size totals 0.86 hectares, with a minimum of 0.1 and a maximum of eight hectares.[6] Other tangible assets that may be pledged as collateral by famers in the absence of real estate are cattle and cars, motorcycles, certain farm implements, home appliances, and cash deposits. Farmers kept on average 1.6 cattle on their farms while off-farm cash-flow was on average 77,500 Kenyan shillings (Ksh) per annum. The most common credit source for loans is microcredit institutions (62 per cent). 31 per cent of interviewees reported practicing co-operative banking, while only 13 per cent are customers of conventional credit institutions. The contribution of on-farm revenue to total revenue averaged approximately 57 per cent which reaffirms the importance of (traditional) crop production in the income matrix of smallholders. Income shares from off-farm revenues and non-agricultural activities sum up to a total of 43 per cent each. The amount of off-farm revenues in the Kenyan case corresponds with the finding of Jayne et al. (2003) who estimate this value to be 40 per cent.

The share of income from ecosystem services as a portion of total income, which should be an incentive for smallholders to engage in ecosystem conservation, is quite small. This may be due to the low price of carbon (see also Shames (2013)). On average, this source of income contributes only one per cent of total income, with 18 out of 52 smallholders receiving no ecosystem payments at all. This finding is in line with that of

[5] We excluded those individuals who reported to have been granted credit from other sources, such as family members, friends, or other informal channels. Because we cannot tell whether these individuals are (formally) credit constraint or whether they chose to lend money informally for other, unobservable reasons.

[6] 51 out of 52 interviewees reported to own the land they cultivate. One out of 52 reported to have only leased the land.

Tschakert (2004) who found that the percentage for Senegal ranges between 1 and 4.5 per cent. Two interviewees reported revenues from ecosystem conservation in the range of 12 to 14 per cent, indicating that among non-participants of ecosystem conservation practices there is still a large room for increases in income, collateral substitute (cash-flow), and act as a positive observable characteristics.

**Table 14: Correlation matrix, referring to models presented in Table 15**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Credit interest rate (%)** | 1 | | | | | | | | | | |
| 2 | **Maintains business records (yes/ no)** | -0.35 | 1 | | | | | | | | | |
| 3 | **Cattle (apiece)** | 0.16 | 0.21 | 1 | | | | | | | | |
| 4 | **Farm size (hectares)** | -0.11 | 0.05 | 0.55 | 1 | | | | | | | |
| 5 | **Conventional credit institution (yes/ no)** | 0.15 | 0.23 | 0.07 | -0.08 | 1 | | | | | | |
| 6 | **Microcredit institution (yes/ no)** | -0.03 | -0.04 | -0.04 | 0.19 | -0.5 | 1 | | | | | |
| 7 | **Co-operative bank (yes/ no)** | 0.06 | -0.06 | 0.15 | 0.01 | -0.14 | -0.33 | 1 | | | | |
| 8 | **Income share from cropping** | 0.18 | -0.02 | 0.33 | 0.24 | 0.22 | -0.02 | -0.03 | 1 | | | |
| 9 | **Income share from off-farm revenues** | -0.18 | 0.02 | -0.32 | -0.24 | -0.22 | 0.02 | 0.03 | -0.99 | 1 | | |
| 10 | **Income share from non-agriculture** | -0.18 | 0.02 | -0.32 | -0.24 | -0.22 | 0.02 | 0.03 | -0.99 | -1 | 1 | |
| 11 | **Income share from ecosystem payments** | -0.01 | 0.07 | 0.25 | 0.14 | 0.21 | -0.04 | -0.16 | 0.32 | -0.32 | -0.32 | 1 |

In Table 15 the results of a set of OLS regressions are presented. The low number of observations complicates standard tests on statistical significance here. However, the signs and size of coefficients allow an evaluation of the correlates of credit interest paid by Kenyan smallholders. Most importantly, farmers with the ability to maintain business records seem to experience a reduced interest burden compared to their peers who do not keep business records. The results indicate that banks are willing to provide credit at lower interest rates if the borrower is able to provide transparency about his business by providing insights into the farm's financial situation. As for collateral, farm size is negatively correlated with lending rates, indicating that banks prefer real estate over other forms of collateral. The interest rate of credit granted decreases by approximately 1.2 to 1.3 per cent with every additional hectare of farm size, underlining the importance of collateral in the form of real estate. Conversely, the number of cattle owned by the borrower may be also accepted as collateral, even though borrowers have to pay a premium for this form of collateralization. The formal and informal interaction with a number of financial institutions operating in rural mount

Kenyan region reveal that cattle, to a certain extent, are eligible as collateral. The rationale behind the bank's behavior may be explained by the fact that cattle may be sold, stolen or slaughtered. There could also be certain variables driving the positive relationship between cattle ownership and interest rates charged, such as the availability or otherwise of insurance for cattle, or the prevalence of pestilence in livestock as well as measurement error. This positive correlation may be in line with the argument of Stiglitz and Weiss (1981) that higher interest rate rations high risk activities, such as cattle ownership.

**Table 15: Determinants (OLS) of credit interest rates among Kenyan smallholders**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Maintains business records** | -5.00*** | -4.89*** | -4.89*** | -4.88*** | -5.03*** |
| | (1.273) | (1.290) | (1.290) | (1.290) | (1.262) |
| **Cattle (apiece)** | 1.62*** | 1.54*** | 1.54*** | 1.54*** | 1.71*** |
| | (0.439) | (0.436) | (0.436) | (0.436) | (0.459) |
| **Farm size (hectares)** | -1.21** | -1.24** | -1.24** | -1.24** | -1.19** |
| | (0.507) | (0.523) | (0.523) | (0.522) | (0.502) |
| **Conventional credit institution** | 3.30* | 3.03 | 3.03 | 3.02 | 3.60* |
| | (1.930) | (2.030) | (2.030) | (2.031) | (2.008) |
| **Alternative forms of credit** | *reference* | *reference* | *reference* | *reference* | *reference* |
| **Income from cropping (%)** | | 0.01 | | | |
| | | (0.018) | | | |
| **Off-farm revenues (%)** | | | -0.01 | | |
| | | | (0.018) | | |
| **Income from non-agriculture (%)** | | | | -0.01 | |
| | | | | (0.018) | |
| **Income from Ecosystem payments (%)** | | | | | -0.21 |
| | | | | | (0.232) |
| **Constant** | 12.98*** | 12.53*** | 13.58*** | 13.59*** | 13.00*** |
| | (1.201) | (1.581) | (1.396) | (1.399) | (1.213) |
| **Observations** | 52 | 52 | 52 | 52 | 52 |
| **R-squared** | 0.29 | 0.30 | 0.30 | 0.30 | 0.30 |

*Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

We also include controls for the type of credit, e.g. microcredit, co-operative or conventional. The results suggest that loans taken out at conventional credit institutions are substantially more expensive compared to alternative forms of credit. The advantage of having access to a microcredit institution or co-operative in terms of interest rate amounts to approximate reduction of 3 to 3.6 per cent. Commercial banks in Eastern

Africa appear to have strong preference for educated clients, collateral, liquidity and low-risk assets while advances to agriculture including smallholders are minimal. Average real interest rate from this region was estimated at 15.9 per cent (Čihák and Podpiera, 2005). Microfinance in contracts provides credit to lower-income clients including those otherwise unbanked (smallholders) while size of loan is typically small; however larger amounts are no longer a rare occurrence. Risk management is to a large extent joint liability with some cases of collateralization in recent years, while average interest rate was ca. 13 per cent (Robert et al. 2009). Co-operatives are more of an empowerment instrument which are mostly government support with average interest rate, in some case, of 5 per cent (Develtere et al. 2008). A reason for the difference in interest rate may be attributed to the cost of capital which in the case of commercial banks is capital market based and in microfinance and Co-operatives is donor /aid and subsidy based, respectively.

Most importantly for this study, we test for differences in terms of credit conditions depending on farmers' income sources. We include variables capturing the effect of income share from traditional farming versus more innovative forms of farming. For example, in model 1, we estimate the effect of the share of income from traditional farming on interest burden. The result indicates that farmers with a large share of income from traditional cropping must pay more in interest. The corresponding coefficient indicates that jumping from one extreme (100 per cent of income from traditional agriculture) to the other (zero per cent) results in a reduction of the interest rate in the order of one per cent. Conversely, the share of income stemming from off-farm revenues or non-agricultural activities – two metrics capturing very similar activities – corresponds with lower interest rates of the same magnitude. Interestingly, the share of income from ecosystem payments is correlated with significantly lower interest rates. Jumping from one extreme (0 per cent income from ecosystem services) to the observed maximum of 13.33 per cent results in a decrease in the interest rate of 2.1 per cent. The orthodox interpretation of statistical significance of these coefficients would suggest accepting the hypothesis that this coefficient does *NOT* reflect a correlation between TIST membership and more favorable credit terms. However, McCloskey and Ziliak (1996) argue that the concept of statistical significance is unreliable if the underlying number of observations is small, as it is the case here.[7] Therefore, we may also consider the possibility that credit institutions reward innovative forms of economic activities, with a reduced interest rate for off-farm revenues and innovative practices of conservation agriculture, but prefer conforming this finding by adding more observations to the analysis in future research.

In another set of regressions (not shown here) we additionally include control variables for loan size and physical height of an individual farmer. The rationale for the former is that interest rates on larger loans might be lower per unit borrowed, and hence constitute a potential explanatory factor of interest rate. The rational for including physical height is that we cannot rule out the possibility that there are characteristics reflecting a farmer´s quality, which we are unable to observe and therefore unable to incorporate in our regression framework. To minimize the risk of omitted variable bias, we use height as a proxy for "quality", as this metric is strongly correlated with health, nutrition, and human capital (Schick and Steckel, 2010; Steckel, 1995). However, neither of these affects our results; in fact, the results remain virtually unchanged. Including this control, however, reduces our number of observations we therefore prefer to continue our analysis with our basic model as shown in table 15.

## 6.5 Research shortfalls

Some of the issues confronting this study are the limited number of observations and to a certain extent: endogeneity. While little can be done to address the former, the latter can be resolved using an instrumental variable (IV). Endogeneity in this study may arise as a result of omitted variables and possible reverse causality. As earlier mentioned, we used height as an instrument instrumental variable to control for an omitted variable, which did not change the outcome of our analysis. However, the possible existence of a reverse causality remains, that is to say that improved productivity and quality (possibly as a result of participating in EES) may lead to credit-access, rather than the vice versa. Although this may be difficult to test in our case, we

[7] Keep in mind that irrespective of a dataset's data structure, large (small) numbers of observations lead to smaller (larger) standard errors.

use a relevant case study from another part of sub-Saharan Africa to make a case for unlikely reverse causality. The study by (Ali and Deininger, 2014) on credit rationing in rural Ethiopia argued that credit access to once constrained smallholder farmers in areas with high productive potential could improve productivity by an estimated 11 percent. Credit-constrained farmers in Peru and the Philippines could have increased production by 26 and 37 per cent, respectively, if they had had access to adequate credit (Godquin and Sharma, 2005; Guirkinger and Boucher, 2008).These results therefore align with the findings from other studies that accessibility to credit allows for the adoption of agricultural innovation, which may lead to higher productivity.

## 6.6 Conclusion

While the direct impacts of rural small and medium enterprises conservation, extension services with ecosystem services (EES) farming on living standards and ability to cope with climate change in sub-Saharan Africa is well understood, research on the possible secondary benefits e.g. access to credit by farmers who participate in these activities is slim (Masiga 2012; Shames et al. 2012; Shames, 2013). Farmers participating in ecosystem service may benefit from their observable characteristics — and thus creditworthiness — to financial institutions in order to obtain access to credit and better credit terms. This can substantial contribute to rural development as small farm households in sub-Saharan Africa may allocate a substantial percentage of formal credit to income (input purchase) and consumption smoothing. In the event of a temporary credit constraint, farmers in Malawi were observed to have preferred to hold credit reserves for future shocks at the expense of current income for investing in farm production and improve future consumption smoothing (Zeller, 2001). Improved credit market access may encourage the adoption of new technologies and strategies since increased monetary resources allow setbacks and shocks to be dealt with more flexibly (Khandker and Faruqee, 2003; Zeller, 2001).

EES farmers may therefore improve their chances of obtaining loans amongst others by gaining valuable physical collateral through PES as an acceptable form of securitization within an extension and ecosystem services program. In the theory section we utilize the model of Han et al. (2009) to show that EES can serve as a sorting mechanism for financial institutions to obtain information about a farmer's business and creditworthiness. We have also shown that credit contract separation improves the loan terms for farmers.

Moreover, empirical evidence for the existence of the game theory model implies that physical securitization and human capital may lead to separation equilibrium in credit contracts. In order to connect this hypothesis to a real-world scenario, unique data was collected from sustainable Kenyan smallholders participating in carbon agroforestry project. Our results indicate that financial institutions are willing provide credit at lower interest rates if smallholders are able to maintain business records, which allow financial institutions to gain insight into the farm's financial situation. Banks adjust the credit conditions according to the quality of the borrower's collateral; a low risk for default is observed if farm land can be offered as collateral, other forms of collateral result may also lead to lower interest rates. Most importantly for this study, the empirical evidence suggests that smallholders pay a premium for traditional farming, with no income from sectors other than agriculture. Conversely, farming that includes ecosystem conservation activities seems to offer advantages in terms of less interest paid, as this type of income can increase farmers' incomes and reduce the risk of credit default. We also find evidence that members of TIST, a program encouraging and helping smallholders to diversify their income by participating in ecosystem services, are more likely to access formal credit markets.

## Appendix

The maximum expected utility of a highly-skilled carbon farmer is:

$E\overline{U_H}(\Gamma_H) = \theta^2{}_H K + \mathrm{W} + B - \min\overline{Y}_{\mathrm{H}}$, where, the absolute min

$\overline{Y}_{\mathrm{H}} = \frac{\left[1 - \overline{\theta} - (1-\alpha)\theta_L{}^2\right]K}{\alpha}$ →this is net transfer or repayment to the bank by high farmer,

thus $\overline{Y}_{\mathrm{H}} \geq \frac{\left[1 - \overline{\theta} - (1-\alpha)\theta_L{}^2\right]K}{\alpha}$. Since the high quality farmer has the possibility to negotiate, he/she will keep the value of $\overline{Y}_{\mathrm{H}}$ as low as possible.

For a *highly*-skilled farmer with a *low-quality* characteristics, choosing a low interest rate and pledging higher collateral will result in expected utility:

$E\underline{U}_H(\Gamma_H) = \theta^2{}_H K + \mathrm{W} - \min \underline{\mathrm{Y}}_\mathrm{H}$, where, min $\underline{\mathrm{Y}}_\mathrm{H} = \frac{\left[1 - \underline{\theta} - \alpha\theta_L{}^2\right]K}{1-\alpha}$ → net transfer or repayment to the bank by high farmer with low quality characteristics is expected to be higher than that of a high skilled framer with high quality characteristics.

In the case of a low-skilled farmer with a high-quality characteristics who chooses a high interest rate and pledges low collateral, maximum expected utility is:

$E\overline{U}_L(\Gamma_L) = \theta^2{}_L K + \mathrm{W} + \mathrm{B} - \min \overline{Y}_L$, where, the absolute min $\overline{Y}_L = \frac{\left[1 - \overline{\theta} - \alpha\theta_H{}^2\right]K}{1-\alpha}$. The low-skilled farmer with a low-quality characteristics who chooses a high interest rate and pledges low collateral will have maximum expected utility of:

$E\underline{U}_L(\Gamma_L) = \theta_L{}^2 K + \mathrm{W} - \min \underline{Y}_L$, where, the absolute min $\underline{\mathrm{Y}}_\mathrm{L} = \frac{\left[1 - \underline{\theta} - (1-\alpha)\theta_H{}^2\right]K}{\alpha}$

which is expected to be higher than that of a low-skilled farmer with a high-quality characteristics.

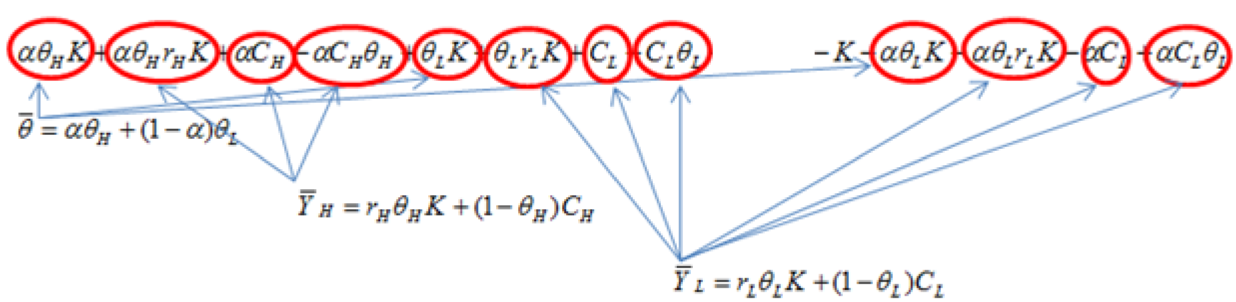
**Individual rationality:**

Starting with expected profit of Banks in the case of a good observable characteristics equation 9

$$E\overline{\pi} = \alpha\left[\theta_H(1+r_H)K + (1-\theta_H)C_H - K\right] + (1-\alpha)\left[\theta_L(1+r_L)K + (1-\theta_L)C_L - K\right]$$

This can be rewritten as under the assumption of a truly competitive capital market

$$E\overline{\pi} = K\overline{\theta} - K + \alpha\overline{Y}_H + (1-\alpha)\overline{Y}_L = 0$$



The Individual rationality constraints farmers both high and low skilled if the high quality Characteristics are observed: $E\overline{U}_H(\Gamma_H) = \theta^2{}_H K + \mathrm{W} + B - \min \overline{Y}_{\mathrm{H}} \geq \mathrm{W} + B$ → $\overline{Y}_{\mathrm{H}} \leq \theta^2{}_H K$. Similarly, for low farmer $E\overline{U_L}(\Gamma_L) = \theta^2{}_L K + \mathrm{W} + B - \min \overline{Y}_{\mathrm{L}} \geq \mathrm{W} + B$ → $\overline{Y}_{\mathrm{L}} \leq \theta^2{}_L K$.

Substituting Input $\overline{Y}_{\mathrm{H}} \leq \theta^2{}_H K$ and $\overline{Y}_{\mathrm{L}} \leq \theta^2{}_L K$ into the bank ´s expected profit $E\overline{\pi} = K\overline{\theta} - K + \alpha \overline{Y}_H + (1-\alpha)\overline{Y}_L = 0$ and subsequently solve for $\overline{Y}_{\mathrm{H}}$ and $\overline{Y}_L$ gives:

$\min(\overline{Y}_{\mathrm{H}}) = \frac{\left[1 - \overline{\theta} - (1-\alpha)\theta^2{}_L\right]K}{\alpha}$ and, $\min(\overline{Y}_L) = \frac{\left[1 - \overline{\theta} - \alpha\theta^2{}_H\right]K}{1-\alpha}$, farmers intend to keep expected net transfer to bank (Y) as low as possible. It then follows that the interval (Y) of high and low skilled farmers with high quality characteristics should lie between:

$$\frac{\left[1 - \overline{\theta} - (1-\alpha)\theta^2{}_L\right]K}{\alpha} \leq \overline{Y}_{\mathrm{H}} \leq \theta^2{}_H K \text{ and } \frac{\left[1 - \overline{\theta} - \alpha\theta^2{}_H\right]K}{1-\alpha} \leq \overline{Y}_{\mathrm{L}} \leq \theta^2{}_L K$$

The expected profit of Banks in the case of a low quality characteristics is:

$$E\underline{\pi} = (1-\alpha)\left[\theta_H(1+r_H)K + (1-\theta_H)C_H - K\right] + \alpha\left[\theta_L(1+r_L)K + (1-\theta_L)C_L - K\right]$$

$$E\underline{\pi} = K\underline{\theta} - K + +(1-\alpha)\underline{Y}_H + \alpha\underline{Y}_L = 0$$

$$\underline{\theta} = (1-\alpha)\theta_H + \alpha\theta_L$$

$$\underline{Y}_H = r_H\theta_H K + (1-\theta_H)C_H$$

$$\underline{Y}_L = r_L\theta_L K + (1-\theta_L)C_L$$

The utility function of farmers both (high and low skilled) if low quality characteristics are transmitted is: $E\underline{U}_H(\Gamma_H) = \theta^2{}_H K + \mathrm{W} - \underline{Y}_{\mathrm{H}} \geq \mathrm{W}$ → $\underline{Y}_{\mathrm{H}} \leq \theta_H{}^2 K$ for high skilled farmers. Similarly for low skilled farmer $E\underline{U}_L(\Gamma_L) = \theta^2{}_L K + \mathrm{W} - \overline{Y}_{\mathrm{L}} \geq \mathrm{W}$ → $\underline{Y}_{\mathrm{L}} \leq \theta^2{}_L K$

Substituting $\underline{Y}_{\mathrm{H}} \leq \theta_H{}^2 K$ and $\underline{Y}_{\mathrm{L}} \leq \theta_L{}^2 K$ into the bank´s expected profit $E\underline{\pi} = K\underline{\theta} - K + +(1-\alpha)\underline{Y}_H + \alpha\underline{Y}_L = 0$ and subsequently solving for $\underline{Y}_{\mathrm{H}}$ and $\underline{Y}_L$

$\min(\underline{Y}_{\mathrm{H}}) = \dfrac{\left[1 - \underline{\theta} - \alpha\theta_L{}^2\right]K}{1-\alpha}$ and $\min(\underline{Y}_{\mathrm{L}}) = \dfrac{\left[1 - \underline{\theta} - (1-\alpha)\theta_H{}^2\right]K}{\alpha}$. It then follows that the interval (Y), for high skilled farmers with low quality characteristics is should lie between $\dfrac{\left[1 - \underline{\theta} - \alpha\theta_L{}^2\right]K}{1-\alpha} \le \underline{Y}_{\mathrm{H}} \le \theta_H{}^2 K$ and $\dfrac{\left[1 - \underline{\theta} - (1-\alpha)\theta_H{}^2\right]K}{\alpha} \le \underline{Y}_{\mathrm{L}} \le \theta_L{}^2 K$

**Incentive compatibility:**

Using the incentive compatibility in combination with the expected utility for carbon farmers with high and low skills we get for $EU_H{}^{\mathrm{EES}}(\Gamma_L) < EU_H{}^{\mathrm{EES}}(\Gamma_H)$

$\mathrm{W} + \mathrm{B} + \theta_H{}^2\mathrm{K} - \mathrm{r_L}\theta_H\mathrm{K} - (1-\theta_{\mathrm{H}})\mathrm{C_L} < \theta_H{}^2 K + \mathrm{W} + \mathrm{B} - Y_{\mathrm{H}} \rightarrow \overline{\mathrm{Y}}_{\mathrm{H}}{}^{\mathrm{EES}} < \mathrm{r_L}\theta_H\mathrm{K} + (1-\theta_{\mathrm{H}})\mathrm{C_L} \rightarrow$

$\mathrm{r_H}\theta_H\mathrm{K} + (1-\theta_{\mathrm{H}})\mathrm{C_H} < \mathrm{r_L}\theta_H\mathrm{K} + (1-\theta_{\mathrm{H}})\mathrm{C_L} \rightarrow$

$-\mathrm{r_H}\theta_H\mathrm{K} + \mathrm{r_L}\theta_H\mathrm{K} < \mathrm{C_H} - \mathrm{C_H}\theta_{\mathrm{H}} - \mathrm{C_L} + \mathrm{C_L}\theta_{\mathrm{H}} \rightarrow \theta_H\mathrm{K}\,(\mathrm{r_L} - \mathrm{r_H}) > (1-\theta_{\mathrm{H}})(\mathrm{C_H} - \mathrm{C_L})$,

and for $EU_L{}^{\mathrm{EES}}(\Gamma_H) < EU_L{}^{\mathrm{EES}}(\Gamma_L) \rightarrow \mathrm{W} + \mathrm{B} + \theta_L{}^2\mathrm{K} - \mathrm{r_H}\theta_L\mathrm{K} - (1-\theta_{\mathrm{L}})\mathrm{C_H} < \theta_L{}^2 K + \mathrm{W} + \mathrm{B} - Y_{\mathrm{L}} \rightarrow$

$r_L\theta_L K + (1-\theta_L)C_L < \mathrm{r_H}\theta_L\mathrm{K} + (1-\theta_{\mathrm{L}})C_H \rightarrow$ where $\underline{\mathrm{Y}}_{\mathrm{L}}{}^{\mathrm{EES}} < \mathrm{r}_H\theta_{\mathrm{L}}\mathrm{K} + (1-\theta_{\mathrm{L}})\mathrm{C_H} \rightarrow$

$\theta_L\mathrm{K}\,(\mathrm{r_L} - \mathrm{r_H}) < (1-\theta_L)(\mathrm{C_H} - \mathrm{C_L})$

In combination with the expected utility for non-carbon farmers with high and low skills we get for $EU_L{}^{Conv.}(\Gamma_H) < EU_L{}^{Conv.}(\Gamma_L) \rightarrow \mathrm{W} + \theta_L{}^2\mathrm{K} - \mathrm{r_H}\theta_L\mathrm{K} - (1-\theta_{\mathrm{L}})\mathrm{C_H} < \theta_L{}^2 K + \mathrm{W} - Y_{\mathrm{L}} \rightarrow$

$r_L\theta_L K + (1-\theta_L)C_L < \mathrm{r_H}\theta_L\mathrm{K} + (1-\theta_{\mathrm{L}})C_H \rightarrow \underline{\mathrm{Y}}_{\mathrm{L}}{}^{Conv.} < \mathrm{r}_H\theta_{\mathrm{L}}\mathrm{K} + (1-\theta_{\mathrm{L}})\mathrm{C_H} \rightarrow$

$\theta_L\mathrm{K}\,(\mathrm{r_L} - \mathrm{r_H}) < (1-\theta_L)(\mathrm{C_H} - \mathrm{C_L})$ and for $EU_H{}^{Conv.}(\Gamma_L) < EU_H{}^{Conv.}(\Gamma_H)$

$\mathrm{W} + \theta_H{}^2\mathrm{K} - \mathrm{r_L}\theta_H\mathrm{K} - (1-\theta_{\mathrm{H}})\mathrm{C_L} < \theta_H{}^2 K + \mathrm{W} - Y_{\mathrm{H}} \rightarrow \overline{\mathrm{Y}}_{\mathrm{H}}{}^{Conv.} < \mathrm{r_L}\theta_H\mathrm{K} + (1-\theta_{\mathrm{H}})\mathrm{C_L} \rightarrow$

$\mathrm{r_H}\theta_H\mathrm{K} + (1-\theta_{\mathrm{H}})\mathrm{C_H} < \mathrm{r_L}\theta_H\mathrm{K} + (1-\theta_{\mathrm{H}})\mathrm{C_L} \rightarrow$

$-\mathrm{r_H}\theta_H\mathrm{K} + \mathrm{r_L}\theta_H\mathrm{K} < \mathrm{C_H} - \mathrm{C_H}\theta_{\mathrm{H}} - \mathrm{C_L} + \mathrm{C_L}\theta_{\mathrm{H}} \rightarrow \theta_H\mathrm{K}\,(\mathrm{r_L} - \mathrm{r_H}) > (1-\theta_{\mathrm{H}})(\mathrm{C_H} - \mathrm{C_L})$

From the equation above it is clear that a high quality farmer with EES pays a higher price for a wrong contract and would rather chose $\Gamma_H$, and low farmer without EES will prefer contract $\Gamma_L$

Merging the two incentive compatibility conditions we ultimately end up with,

$$\frac{1-\theta_{\mathrm{H}}}{\theta_H\mathrm{K}}(\mathrm{C_L} - \mathrm{C_H}) < \mathrm{r_L} - \mathrm{r_H} < \frac{1-\theta_L}{\theta_L\mathrm{K}}(\mathrm{C_H} - \mathrm{C_L})$$

From the equation above it is intuitive that:

$$\begin{cases} if\ \ r_L > r_H \ \ \text{then } C_H > C_L \\ if\ \ r_L < r_H \ \ \text{then } C_H < C_L \end{cases}$$

Given that banks are not aware of the private information of the sets of farmers (high and low) available, there has to be 2 types of contacts on the financial market. One contract would have high interest rate and low collateral while the other low interest rate and high collateral. It is essential to analyze the relationship between expected utility, interest rate and collateral in the presence of farmer's ability.

If expected utility of farmer is given as $EU_i(\Gamma_i) = W + B + \theta_i^2 K - r_i\,\theta_i\,K - (1 - \theta_i)\,C_i$ then the marginal utility of interest, collateral and carbon revenue are;

$$\begin{cases} \dfrac{\partial EU}{\partial r} = -\theta K < 0 \\ \dfrac{\partial EU}{\partial C} = -(1-\theta) \ < 0 \\ \dfrac{\partial EU}{\partial CF} = 1 \end{cases}$$

The marginal dissatisfaction of interest rate decreases as farmer's talent $\theta$ decreases so also it can be concluded that marginal dissatisfaction of interest rate increases as farmer's talent $\theta$ increases The marginal dissatisfaction of collateral decreases as farmer's talent $\theta$ decreases as these farmers already do not possess enough asset. The marginal satisfaction of carbon cash flow to farmer is 1. Farmers will thus choose the contracts which give them a better pay-off, thus high quality farmers with EES have a marginal rate of substitution ($MRS\text{-}_{r,C}$) (interest and collateral) which is higher compared to low farmers given that;

$$\frac{\partial r}{\partial C} \mid EU = -\frac{(1-\theta)}{\theta K}.$$

# Chapter 7: Conclusion and Policy implication

## 7.1 Summary of results

An adequate level of *sustainable* smallholder agricultural financing by financial institutions may improve rural agriculture productivity and lead to rural development. Sustainable agriculture as described by Gold (1999) is an integrated system of plant and animal production practices having a site-specific application that will over the long term:

- Satisfy human food and fiber needs;
- Enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- Make the most efficient use of nonrenewable and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
- Sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole.

Sustainability in a smallholder farmer context therefore encompasses a broad range of activities ranging from conservation agriculture and crop diversity (including agroforestry) to integrated pest management (IPM).

Sustainable agriculture is also inevitable given the adverse effect of climate change in sub-Saharan African (SSA). For instance, most international agendas (millennium development goal / sustainable development goal) on sustainable development in SSA stipulate a dual objective of poverty reduction and global climate protection (Schipper and Pelling, 2006). Sustainable agriculture forestry and other land use (AFOLU) programs which ensure effective management of the limited resources available to smallholder farmers and preserve the environment can also support rural development through new market entry. Small scale carbon certified agroforestry, apart from providing certain direct benefits such as improved soil fertility and erosion control, also sequestrates carbon from biomass which can be tradable on emission markets. International programs which support agriculture emission trading through market mechanisms usually provide initial financial and technical support to project developers and smallholder farmers, whereas investments by financial intuitions are limited or non-existent. Formal financial institutions (micro-finance and commercial banks) in SSA have generally allocated limited capital to smallholder agriculture enterprise.

The persistent low financing of agriculture by formal financial institutions which also affects potential "*sustainable smallholders*" may be detrimental to the long-term sustainable development of rural areas. The objective of national and international agencies to achieve sustainable development in rural areas may not materialize without the involvement of the private sector, especially formal financial institutions. The financial sector may complement national agencies in attaining sustainable development, as these agencies lack the adequate financial capital to sustain projects in the absence of international agencies (Eicher, 1989). A synergy between sustainable farming, ecosystem services and credit accessibility within an agroforestry carbon certified context may contribute to the aforementioned dual objective of poverty reduction and climate change mitigation if existing frameworks are adequately designed. A structured framework which takes into consideration the base benefits of small-scale carbon certified agroforestry to smallholder farmers, formal financial institution and environment into is essential. Institutional innovation which harnesses emission trading and environmental conservation may therefore be an important driver of poverty reduction and sustainable rural development in SSA.

One of the hurdles of engaging in sustainable agriculture in rural SSA—in this case participation in emission certified agroforestry programs and earning payment for ecosystem services (PES)—is the exclusion of certain types of smallholder farmers from such programs based on social status (wealth) and gender. The male-headed household, depending on factors such as tradition, religion, and social class, may be a member of a network or organization with limited female participation. In Kenya, it was observed that agriculture households headed by women did not to emulate farming systems of their male counterparts due to lack of information flow from male-headed to female-headed households (Collier, 1998). Collier (1998) further argues that networks are made up of people with identical levels of knowledge, leading to a pooling of individuals, whereas a spin-off of such social grouping is the exclusion of the poor. This effect may also be observed amongst sustainable agricultural networks and programs in rural

Kenya, ultimately leading to the exclusion of smallholder farmers due to differences in socioeconomic status. However, the success of sustainable programs depends on the willingness of smallholder farmers to participate in program-designed projects (Nair et al., 2009). The role of information sharing in the adoption of innovation has being emphasized by innovation theory, while appropriate channels of communication have being found to increase the speed of uptake of innovation (Rogers, 2003).

This study investigates whether voluntary smallholder emission certified agroforestry programs with PES result in a selection bias where only the wealthier, more educated farmers and younger farmers participate. Existing literature has suggested that aging smallholder farmers are less likely to adopt agricultural innovations which improve productivity since these farmers considerably reduce investments in their farms. This is due to the fact that strategic planning of older smallholder farmers tends to have a short-term orientation. A number of studies have also indicated that, depending on the opportunity cost of labor, a household with a substantially large number of family members may be more likely participate in agroforestry programs compared to a smaller household due to the availability of labor supply.

The results suggest that a smallholder´s membership in a formal and informal network (e.g., neighbors and family)—and also to a certain extent the smallholder's age, credit constraint and labor supply—positively influences participation in emission certified agroforestry programs with PES. Similar to the findings of Cole (2010) on the adoption of agroforestry with PES by smallholders in Costa Rica, this study also found that strong local networking facilitated the adoption of small-scale agroforestry on farms with PES. The results from the field study seem to *weakly* contradict a large body of literature, as the older the smallholder farmer in rural Kenya, the more likely it is that the farmer participates in the programs. The field study in rural Kenya, however, adheres to the general notion that availability of labor supply increases the chances of participation in emission certified agroforestry programs with PES. Although the results suggest a positive correlation between labor supply, age and program participation, caution needs to be applied to the interpretation of this relationship due to weak statistical significance. Schulz (2008), however, that argued that the correlation between labor supply and adoption of agroforestry by smallholders is mostly positive and that labor supply tends to act as a catalyst for agroforestry adoption. Farmers who are credit constrained were more likely to participate in sustainable programs with PES as these programs usually provide loans and savings facilities to members. Socioeconomic variables such as farm size (a proxy for wealth) and television/mass media (a proxy for alternative means of information) were found to positively (the former) and negatively (the latter) influence adoption of emission certified agroforestry. However, both variables were statistically insignificant. This result shows that education negatively influences adoption of emission certified agroforestry in rural Kenya. The findings of this study imply that emission certified agroforestry programs with PES in rural Kenya do not exclude poor farmers from participating based on socioeconomic status. Schluz (2008) also found that smallholder emission certified agroforestry programs do not exclude the poorest of the poor because such programs tend not to lay emphasis on socioeconomic status.

Access to agricultural financial services in rural sub-Saharan Africa is necessary for pro-poor growth (Poulton et al., 2006). To support pro-poor agriculture growth, financial institutions have to efficiently allocate funds and broaden their range of financial products. In the last couple of decades, the financing of smallholder entrepreneurs in the agriculture sector by financial institutions in rural sub-Saharan Africa has remained consistently low and in some case experienced sharp decline (Sacerdoti, 2005). Limited lending and investment in rural agriculture still occurs, despite the increase in the number of financial and non-financial institutions in SSA and their general above-average performance (Sacerdoti, 2005). Certain formal institutions such as micro-finance banks, despite flexible collateral requirements, are not improving rural agriculture financing due to lending that is typically short-term and a focus on modernized agriculture and urban non-agricultural economies (Poulton et al., 2006).

This study reviews trends amongst sub-Saharan African financial institutions, based on secondary sources, in the last decade and the potential effect on rural agriculture financing. We found a substantial increase in the number of non-conventional and for-profit institutions in the rural financial sector. While this may lead to an increase in outreach and to some extent improve efficiency, it does not necessarily correspond to an increase in the level of agriculture funding due in part to the likely investment in non-agriculture enterprise. Compared to loan advancement, financial institutions require a reasonably high deposit. Farmers are more inclined to save money, rather than borrow, from financial institutions (Basu et al., 2004). Financial institutions across Africa would rather hold large deposits in order to access off-shore interest rates rather than advance loans to small and medium enterprise SMEs (Sacerdoti, 2005). This may be an indication of inefficient allocation of resources amongst some sub-Saharan African financial institutions. Protection of depositors and banking regulations in SSA are increasing, leading to the adoption of risk management strategies. International standards (equator principles) on environmental and social risk analyses for project financing are also being implemented by financial institutions. The equator principle (EP) is a risk management strategy meant to promote sustainable development (EP, 2011). Small banks in SSA have stated that they are constrained by regulations enacted to reduce their risk, leading to limited lending (Honohan and Beck, 2007). For instance, regulations which stipulate capital requirements as a buffer for credit risk based on a borrower's creditworthiness and collateral may imply that financial institutions would opt for less risky projects or investments. Standard creditworthiness and borrower risk evaluation may (not) be applicable to rural financing. The inability to measure and track rural agriculture risk may correspond to the presence of limited loan availability and extremely high interest rates (Honohan and Beck, 2007). There is an increase in the use of information and communication technology (ICT) for financial services in SSA. For instance, the provision of certain financial services through mobile phone companies (M-PESA) in Kenya and other parts of Africa has been widely taken advantage of and is perceived as a banking option for the poor. While this financial product is known for its simplicity in the process of transferring money, there is a need to incorporate this approach into credit accessibility. ICT innovations which are specifically tailored to the needs of rural businesses and clients should be further developed to foster stronger complementary (mobile phone payment) banking services. An automated credit approval system based on contract farming and warehouse receipts may be an option available to financial institutions when using ICT to improve credit assessment (Honohan and Beck, 2007).

We propose two models based on the aforementioned trends observed amongst financial institution in SSA to improve *sustainable* agriculture financing within the region. The existence of standards such as equator principle, although in its infancy, ensures that sustainable investments are being financed by financial institutions. The adoption of this standard by an increasing number of financial institutions in SSA may lead to an improvement in *sustainable* agricultural financing. In the face of stiff competition, financial institutions in rural areas may have to specialize in financing certain types of agricultural investments and offer a range of products. In the future, financial institutions may efficiently allocate resources to sustainable agriculture in rural areas and thus reducing greenhouse gases (GHGs) and promoting food security and poverty alleviation (e.g., small-scale carbon certified forestry with payment for ecosystem services (PES)). This investment may present a win-win situation for farmers and financial institutions by increasing smallholder incomes and providing financial institutions access to international capital. Other benefits that may accrue to smallholders due to investment in small-scale carbon certified forestry with payment for ecosystem services (PES) include acquisition of farm managerial skills, improved productivity and collateral substitutes. These benefits may increase smallholders' access to formal credit due to reduced risk of default. The use of ICT in carbon certification to monitor, verify and produce reports may also be extended to the risk assessment of financial institutions evaluating potential borrowers involved in small-scale carbon certified forestry.

Information asymmetries regarding borrowers, as well as proposed agricultural projects, may give rise to moral hazards and become hurdles for agriculture credit in sub-Saharan Africa (Simtowe et al., 2006). Financial systems in sub-Saharan African and other developing countries with limited non-bank financing and minimal product differentiation use inadequate risk pooling mechanisms in the credit evaluation process (Honohan and Beck, 2007). Risk-pooling using observable characteristics such as farmland, contract farming, credit registry, insurance, deposit, savings and payments remains one of the evaluation tools available to all financial institutions for individual risk assessment (Honohan and Beck, 2007). Efforts to minimize the dominance of commercial banks in the sub-Saharan African financial system and improve agricultural lending through the introduction of micro-finance and other institutions have been met with limited success. Information asymmetry and adverse selection also affect these institutions and are likely to lead to risk management strategies in which individual lending is based on high-collateral contracts, with the ultimate result being credit rationing (Boucher et al. 2008). Honohan and Beck (2007) argued that when safe borrowers are crowded-out of the financial market due to high interest rates (i.e., risky business), banks generally become reluctant to lend, leading to credit rationing despite high liquidity. The generalization of rural agricultural business by financial institutions in sub-Saharan Africa may result in a common credit risk-pooling system which ultimately results in a single interest rate or premium, as describe in a study by Stigliz and Weiss (1981). This may imply that, in general, agricultural practices in rural areas all have the same level of risk and lack of information regarding business and borrower quality which may lead to high interest rates and high collateral requirements.

This may not necessarily reflect the reality of rural agricultural systems, at least, in parts of sub-Saharan Africa with small-scale carbon certified agroforestry, where smallholders practice *sustainable* cultivation. These sustainable farmers keep some form of farm records due to participation in ecosystem services and also diversify farm revenues by earning payment for environmental services (PES). The agricultural system of these farmers is quite different from the conventional system in that it adapts/mitigates the adverse climatic and environmental conditions that confront these farmers and sustainably increases food production. This production system can, to a certain extent, reduce the covariant risk associated with agriculture. The certification of smallholder farmers based on emission reduction from a agriculture system resulting in PES serves as a proxy for sustainability.

The pooling system in agricultural credit by financial institutions in sub-Saharan Africa may discriminate against sustainable farmers and limit the spread of sustainable rural development. We use existing game theory by Batabyal and Beladi (2010) to provide some theoretical evidence that inequality may exist due to single risk-pooling if the impacts of sustainability are ignored. The signaling of business quality through smallholder self-financing of a portion of small-scale carbon certified agroforestry should be considered in credit evaluations. This may lead to a separation, rather than a pooling, equilibrium in credit contracts. Charging sustainable farmers the same premium as conventional farmers may lead to the exit of these farmers from financial markets as well as restrict participation in ecosystem services due to lack of incentives. Therefore, separation equilibrium is another way of encouraging and ensuring participation of creditworthy borrowers in financial markets and preventing financial institutions from operating at a loss. The use of separation equilibrium by financial institutions may also lead to the expansion of credit to the unbanked within the agricultural sector as well as limit credit rationing.

Africa´s financial system, dominated by financial and non-financial institutions with a large number of depositors and confronted with a weak judicial system (including land tenure), may tend to operate in a restrictive manner. Honohan and Beck (2007) and Sacerdoti (2005) have also identified the poor infrastructure that characterizes the sub-Saharan African financial system as one of the reasons for the limited lending that has resulted in credit constraints. To protect depositors and core investors and ensure a healthy financial environment, financial institutions worldwide have, over the last 10 years, standardized risk management under the aegis of the Bank of International Settlement (BIS). The BIS´s Basel committee on banking supervision (BCBS) issues regulatory guidelines on banking operations supervised by respective apex or central banks to ensure stability in the financial sector. Under the BCBS guidelines, exposure to credit risk by financial institutions must be identified, measured, monitored and controlled and capital must be set aside. Capital buffer requirements may affect bank lending by limiting the ability of institutions to advance loans while increasing interest rates if the banks are undercapitalized (Bridges et al., 2014). The spread of high interest rates could also be the result of a higher risk of borrower default (Honohan and Beck, 2007). Capital requirements and credit risk exposure certainly impact agricultural lending, especially in rural areas. Agricultural loans, similar to retail loans under international standards, are risk weighted based on collateral, capital leverage and volatility of earnings and assets. Therefore, the information asymmetry which prevails in rural SSA presents a major challenge to credit risk evaluation/exposure.

This study assesses the impact of payment for ecosystem services (PES) on the credit risk indictors of financial institutions. Risk indicators comprise the probability of default (PD), loss given default (LGD), and expected and unexpected losses (EL/UL).

These variables influence the amount of working capital which financial institutions set aside as a buffer due to credit advances to (*sustainable*) borrowers. Available data on agriculture land prices and credits per hectare in South Africa from 1990 - 2003 and secondary literature on PES from agroforestry per hectare were used to estimate credit risk exposure for *sustainable* and conventional borrowers. During this period the price of farmland per hectare, a conventional form of collateral amongst financial institutions experienced a considerable drop while credits per hectare remained consistent.

When a positive but minimal farm revenue per hectare is assumed, the distance to default and probability of default for the conventional farmer in the presence of falling farmland prices at the end of 2003 was (*negative*) -2.82 and 99.99 percent, respectively. The negative sign clearly indicates a high tendency of borrower default, and since the value is below the default threshold, financial institution may therefore ask for additional collateral. This study applies a conservative estimate of US$5 $tCO_2e$ for one ton of carbon equivalent which reflects current low market prices. Sustainable borrowers with PES, despite the drop in farmland prices, were above the default threshold (0.176) while the probability of default was 43 percent. This result therefore provides some evidence on the benefits of sustainability in agriculture to credit risk exposure.

Small-scale carbon certified agroforestry may lead to a win-win situation where smallholder farmers escape poverty through climate resilience and sustainability while earning PES (Cole, 2010). Nair et al. (2009) and Syampungani et al. (2010) argued that intercropping farmland with trees increases carbon stock and thus soil fertility which may improve farmers' livelihoods and benefit society, as well as grant access to emission markets. Emission trading, despite the immense imbalances between north and south, may help smallholder farmers in developing countries accumulate capital (Bumpus and Liverman, 2008). This accumulated capital, as well as PES, may also present an additional benefit for smallholder farmers in terms of accessibility to formal credit. A number of studies have stated that smallholder farmers in sub-Saharan Africa generally lack the collateral necessary to access formal credit, resulting in credit constraints (Salami et al., 2010; Honohan and Beck, 2007; Poulton et al., 2006). Stiglitz and Weiss (1981) and Wett (1983) argue that banks perceive all borrowers as engaging in the same kind of (risky) investment thereby charging an optimal interest rate and collateral requirement and randomly denying loan requests. This is a case of a single contract choice where increasing interest rates or collateral requirements may crowd out safe borrowers from the financial market leading to a portfolio of loans with high levels of risk. On the contrary, the combination of collateral and interest has being argued by Su (2012) to lead to a multiple contract choice. PES may not only provide physical collateral, i.e., cash flow, but may also signal quality of smallholder livelihood. This study hypothesized that *sustainable* smallholders with PES are less credit constrained and have better credit terms compared to conventional smallholders.

Theoretical evidence based on modification of the sorting and screen model of Han et al. (2009) was used to verify the hypothesis. The introduction of a sustainability indictor into the model resulted in the multiple contract choice. Financial institutions may end up charging two interest rates based on collateral availability which is in line with the reasoning of Su (2012) who argues that "the occurrence of rationing is sensitive to the ranking of projects in the borrowing pool."

Our results suggest that sustainable smallholder farmers and their immediate neighbors in rural Kenya were approximately 2.39 percent more likely to have access to formal credit (micro-finance and commercial banks) compared to conventional farmers. In the long-term, those sustainable farmers who do have access to credit and keep business records are also likely to have interest rates approximately 5 percent lower compared to conventional borrowers. However, participation in ecosystem services programs does *NOT* necessarily lead to favorable interest rates for farmers with formal credit due to the statistical insignificance of our results. Since the analysis is constrained by the limited number of observations and the likely endogeniety issues, caution should be exercised in interpretation. Nevertheless, participation in rural sustainable programs with PES may be a way to reduce the information asymmetry and moral hazard from a banking perspective. Participants not only benefit from farm management training but also gain access to formal credit through these programs; additionally, PES helps diversify on-farm income which, from a banking perspective, may reduce co-variant risk and probability of default. The survey of financial institutions on agricultural credit risk evaluation in rural Kenya indicates that these institutions may be more willing to advance loans to farmers with PES compared to conventional farmers, if—and only if—the ecosystem service was implemented with the their involvement.

### 7.2 Policy recommendation

The purpose of extension services in agriculture is essentially to provide access to information and technology in order to improve rural smallholder livelihoods and promote rural development (Davis, 2008). The decline in public extension services, despite certain levels of success, is due to high budget costs, unstainable models, and inefficiency, as well as lack of specificity to suit local needs (Davis, 2008). Extension services in rural areas in SSA have a major role to play in mitigating the effects of climate change by prompting practices such as small-scale agroforestry with PES amongst smallholder farmers. Kenya´s national agricultural sector extension policy (NASEP), which came into effect in 2005, emphasizes the use of agroforestry in climate adaptation/mitigation and natural resource management (Speranza et al., 2009). Despite formulation of environmental policies, public extension services in Kenya lack implementation capacity due to limited funds and know-how (Speranza et al., 2009). A number of innovative and efficient extension models which takes into account country and farm specific conditions while implementing sustainability programs can be replicated by policy-makers (Davis, 2008).

This study proposes a concrete strategy that extends beyond mere policy formulation, suggesting formulation of a national action plan for mitigation/adaptation that includes active collaboration with and between research institutions and private extension services specializing in carbon-certification. This novel approach prescribes a pro-active role for sub-Saharan African public agricultural extension services in adaptation and mitigation in the presence of climate change. Although public agriculture extension services which primarily focus on sustainable farming with forestry ecosystem services (as described in gov.mb (2008)) have been observed in developed countries, these services are rather limited in developing countries. Reforestation of farmland and training in micro-forestry by public agriculture extension services in the Manitoba province in Canada generated carbon revenues and economic incentives of between US$5 and $25 per acre (gov.mb, 2008). The Manitoba provincial government in Canada also put together a carbon credit registry and trained carbon verifiers (gov.mb, 2008). The involvement of agricultural extension services in the establishmentg of emission projects has a positive effect on participating farmers and bridges the knowledge gap in terms of carbon sequestration and financing (Seeberg-Elverfeld, 2010). Therefore, successful projects in developing countries which link emission research and smallholder farmers through specialized, mostly private extension services in agroforestry may complement public extension services. This may further promote agricultural activities, especially small-scale agroforestry, on the carbon market for *sustainable* farmers. Furthermore, monitoring, verification and reporting (MVR) of agroforestry carbon certification improves transparency which is often the hurdle confronting agricultural emission reduction that leads to its exclusion from certain emission markets. The restriction of sequestrated forest emissions on the European Union emission trading scheme (EU ETS) is recognized as one of the barriers to generating carbon revenues in sub-Saharan African (Gondo, 2012).

A national (agriculture) emission trading system which adheres to global standards and complements existing carbon markets – clean development mechanism and voluntary carbon market – could form the backbone of a market-driven mechanism for rural sustainable development. The Chinese government has completed plans to set up a unified emission trading system (ETS) to reduce $CO_2$ emissions (current local ETS is administered in two provinces and five cities with the carbon price of €9 per ton of carbon equivalent $tCO_2e$) (Li et al., 2014). The policy which brought about the aforementioned ETS and corresponding prices is argued to effectively reduce future $CO_2$ emission (Li et al., 2014). The path to an emission trading scheme for sub-Saharan Africa should consider following a local, regional, national and international pyramid to achieve economic of scope. Local emissions trading system which considers the opportunities and challenges existing in sub-Saharan Africa serves as a flexible and more affordable emission reduction tool (Niemack, and Chevallier 2010). The African carbon exchange (ACX) http://www.acxafrica.com in Kenya and African carbon credit exchange http://www.africacce.com in Zambia, a platform for carbon credits traded on the clean development mechanism and voluntary carbon markets, can enhance ETS creation. With a domestic ETS under development in South Africa, the country´s stock exchange involvement, which already trades carbon credit on its security index, could further develop the ETS, increasing local investment in African projects and promoting sustainable development (Niemack, and Chevallier, 2010; Waterford, 2008; DEA, 2011).

Financing of forestry in sub-Saharan Africa is based on government expenditure which may be limited/restricted due to the underestimation of the overall contribution of forestry to the economy. Gondo (2012) argues that the current domestic financing of forestry in Eastern and Southern Africa is plagued by low government allocation, although forestry also generates revenues through licensing, taxes, and fees, despite inefficiency. To increase domestic financing of forestry, it is argued that there is a need to increase revenues by formalizing activities involving forest operations (Gondo, 2012). Establishing an institutional agency which provides financial support to carbon certified agroforestry is another way national agencies can generate revenue through a low-carbon economy.

The participation of financial institutions in the financing of small-scale carbon certified agroforestry projects in sub-Saharan Africa has been rather limited. For instance, a limited number of small-scale carbon-certified agroforestry projects in sub-Saharan Africa have a high level of both non-financial and micro-finance institutional financing (Shames et al., 2012; Shames and Scherr, 2010). Local funding of small-scale carbon projects in sub-Saharan Africa is limited, leaving host countries to source funding from external investors (Pfeifer and Stiles, 2008). The limited financing of small-scale carbon certified agroforestry by financial institution may be due to lack of technical knowledge and lack of project benefits accruable to these institutions. The situation in rural Kenya, where a substantial number of financial institutions are not aware of smallholder payment for ecosystem service (PES) in agroforestry, is an example of the lack of awareness of sustainability by local financial institutions. Fletschner and Kenney (2011) argue that the low level of financing of rural business was due to the inability of financial institutions to appraise their clients’ businesses, as well as limited specific product lines and high collateral requirements. Financial institutions need to invest in local capability building by training their staff on sustainable financing and risk management, while emphasis should be placed on diversifying agricultural portfolios. Financial institutions’ lack of awareness and recognition of ecosystem services may lead to forgone revenue and/or improved agricultural lending. Investing in carbon certification may also serve as a long-term strategy for financial institutions in rural sub-Saharan Africa.

Financial institutions must broaden their definition of eligible collateral by including physical collateral that poor rural smallholder farmers, particularly women, possess (Fletschner and Kenney, 2011). In line with the results of this study, Shames et al. (2012) also argue that financial institutions are increasingly acknowledging membership (contract) in carbon projects with PES as a form of security; this may be perceived as an indirect benefit of sustainable farming. Gondo (2012) describes *eco-securitization* (cash-flow from ecosystem services) as an alternative to usual creditworthiness in evaluating collateral for forestry project financing. There is need for formal financial institution in sub-Saharan Africa to also shift attention to eco-securitization as an appropriate means of sustainable farming collateralization. This may not only increase loan advancement to farmers participating in carbon projects but also bank those farmers who were initially unbanked by providing them with bank accounts. The non-governmental organization (NGO) Environmental Conservation Trust (ECOTRUST) in Uganda intends to establish a financial institution which advances loans to farmers with PES from carbon-certified agroforestry (Shames et al., 2012). A proposed ECOTRUST bank with a local financial institution with adequate infrastructure and banking know-how may not only reduce transaction costs but also provide an opportunity for financial institution involvement in sustainable financing. Such collaboration may promote the spread of sustainable credit risk management amongst financial institutions in rural areas in sub-Saharan Africa. The financing of sustainable projects may further strengthen rural financial institutions´ equator principles as well as environmental, social and governance (ESG) procedure. In a number of sub-Saharan banks, ESG is not incorporated into standards evaluation due to the lack of guidelines on implementation, despite the continent´s environmental degradation (UNEP, 2007). The use of ESG in credit risk management and investment decision-making through sustainability credit risk assessment (SCRA) policies is argued to re-direct funds to projects that mitigate adverse social and environmental effects in sub-Saharan (UNEP, 2007).

Regional and international financial organizations, such as the African development bank (AfDB) and the international finance corporation (IFC), provide incentives that may increase the participation of African financial institutions in carbon financing, if adequately implemented. The AfDB´s African Carbon Support Programme (ACSP) on climate change and clean development mechanism (CDM) is expected to generate carbon revenues in excess of US$150 million at a carbon price of US$3 per ton ($tCO_2$ e) over the next 10 years (AfDB, 2013). ACSP´s capacity building and awareness tool for carbon trading mechanism is argued to target AfDB staff, project owners and government agencies (AfDB, 2013) Local financial institutions seem to not be integrated into the ACSP, even though they are likely financiers of such projects; this situation may not lead to substantial increase in the financing of carbon projects by local banks. However, commercial bank loans as a possible financing instrument for carbon projects in West Africa are proposed by the African investment fund (Pfeifer and Stiles, 2008). The lack of integration of rural banks into ACSP may be one of the reasons why local funding of small-scale carbon projects in sub-Saharan Africa is limited. The financing of investment which improves environmental standards in sub-Saharan Africa can be made through subsidized credits for local banks offered by international organizations or the establishment of a guaranteed fund to improve lending conditions for local banks (Paulais and Pigey, 2009).

Local banks often do not consider carbon revenues when evaluating project funding proposals as they perceive it to be an intangible asset with high price volatility and high risk (Pfeifer and Stiles, 2008). However, revenues from carbon projects could cover between 5 and more than 100 percent of total costs, depending on the type of project undertaken (Pfeifer and Stiles, 2008). Banks consider the financing of investment in sustainable agriculture as a high-risk venture primarily due to disruption of operation and legal issues, with credit risk also being a major issue (IFC, 2007). IFC can sensitize financial institutions to the importance of sustainability as an instrument of economic growth and help local banks design bank-area-borrower-specific financial products which address social and environmental imbalances. Local banks must, however, develop specific strategies for sustainable banking which align with their objectives and sustainability trends within their location (IFC, 2007). There are strong indications that the financing of sustainable projects and businesses by financial institutions amounts to higher returns, reduced risk and improved access to international capital for the financial institution involved (IFC, 2007). The IFC standard on social and environmental risk management in private-sector investment, the backbone of the equator principle, is applied by 43 financial institutions which finance 80 percent of global sustainable projects (IFC, 2007).

A social and environmental standard developed with IFC for micro-finance institutions purposely for the evaluation of agriculture carbon emission projects in developing countries could further increase IFC standards amongst other institutions aside from commercial banks. This provides an additional opportunity for micro-finance banks to access international capital for carbon projects that often require high up-front costs. Special loans from international financing institutions mitigate the risk for private sector institutions of participation in carbon projects by reducing overall exposure (Pfeifer and Stiles, 2008). Banks adopting this standard may not only contribute to the macroeconomic development of rural areas but also gain  a first mover advantage in best sustainability practices (IFC, 2007). The access of micro-finance institutions to a new market may result in increased environmental, social and economic benefits to poor smallholder farmers and improve their livelihoods.

Incentives such as the BioCarbon fund offered by the World Bank provide financial and technical support to forestry projects that sequestrate carbon and that are likely to increase land-use emission reduction activities in developing countries on the carbon market (World Bank, 2014). While diversifying the incomes of farmers through payment for ecosystem service (PES) is important, co-benefits such as biodiversity conservation and institutional innovation in rural areas are also important aspectsof BioCarbon Funded projects (World Bank, 2014). The World Bank´s forest carbon partnership facility (FCPF) fosters partnership on forest related emission reduction (World Bank, 2010). FCPF focuses on reducing emissions from deforestation and forest degradation **–** plus (*REDD+*) from a small-scale perspective. The objectives of the FCPF are to enhance capacity building within REDD+ as well as evaluate payment based on project performance through a readiness and the carbon finance mechanism to limit deforestation and alleviate poverty (World Bank, 2010). There is need for central, regional and local governments to work with rural communities and organizations to create awareness about forestry carbon financing as well as efficient implementation strategies. The BioCarbon fund and FCPF, which are accessible to host country authorities, may improve carbon-certified agroforestry under certain price conditions. For instance, the low price of carbon is a source of concern amongst experts when it comes to the ability and effectiveness of a market-driven mechanism to adequately price carbon and ensure a low carbon economy. In the case of serious action to control climate change given a global carbon market, a harmonized price of between US$28 and $200 $tCO_2e$ is appropriate (Australian Government, 2011). The global financial crisis and higher forecasted energy prices (less emission) in developed countries is suggested to have decreased world carbon prices while the estimated increase in future emissions from developing countries is helping stabilize world carbon prices (Australian Government, 2011). Winchester and Reill (2014) estimate a price between US$55 and $217 for each ton of carbon from 2015 to 2050 as a precondition for a favorable market for biomass energy with less land-use change, similar to the estimations of the Australian Government (2011).

## 7.3 Recommendation for future research

The analysis carried out in this study investigates potential synergies between small-scale carbon certified agroforestry (climate smart agriculture - sustainability) and agricultural financing. One of objectives of this analysis is to evaluate how smallholder carbon certification from agroforestry influences the credit risk evaluation of formal financial institutions (micro-finance and commercial banks) and smallholder credit accessibility. Another objective is to access the factors that determine the participation of smallholder farmers in small-scale carbon certified agroforestry with payment for ecosystem services.

Chapter 2 shows the ability of utility theory and the probit/logit model to serve as instruments for practical scenario analysis of ecosystem service adoption amongst smallholder farmers. This methodology shows how latent variables such as *networking* may influence observable factors, unlike a model strictly based on pure observable variables. Schulz (2008) suggests incorporating social capital into future research because a common approach used in studies on agricultural adoption often neglects this variable, one which may strongly influence adoption decision. This study takes the effect of social capital into account and proposes a platform on which stakeholders can communicate with and promote adoption of agroforestry carbon certification amongst smallholder farmers. The application of such a model to determine the factors that influence adoption of carbon certification in agroforestry in a rural setting, however, requires further research. A number of research studies on factors that affect the adoption of agricultural innovation with payment for ecosystem services by farmers have been conducted (Garbach et al., 2012; van der Horst, 2011; Schulz, 2008). However, adoption amongst smallholder farmers in sub-Saharan Africa is not adequately covered. While utility theory and latent variable categories have been used to analyze risk in agroforestry decision making by Senkondo (2000), they have found limited application in adoption of carbon certification in sub-Saharan Africa.

The game theoretic model applied in chapter 4 and chapter 6 indicates that carbon certification in agroforestry or sustainable farming may provide certain benefits to smallholder farmers and banks in terms of credit risk evaluation and collateral substitution. There is need to apply caution to the results of this analysis which is based on a cross-sectional data "one point-in-time" and a limited household survey. This type of one point-in-time analysis may not capture the true price of carbon which is highly volatile over time, and reporting done by farmers may lack a high degree of accuracy. To gain a long-term overview of the effect of small-scale carbon certified agroforestry on credit risk evaluation of, credit accessibility for and interest rates offered to smallholder farmers, it is important to use a time series. Time series data collected from a field study would provide a more comprehensive analysis on the possible long-term effect of sustainability on agricultural financing.

The credit risk modelling of formal financial institutions in chapter 5 suggests a lower probability of default for sustainable farmers. Aligning benefits from sustainable farming such as payment of ecosystem services (PES) to the risk management strategy of rural micro-finance may be an interesting extension for future research. Future research should therefore include a comprehensive cost and benefit analysis of ecosystem services for smallholder farmers and banks alike. In so doing the feasibility of financial institutions extending investment to ecosystem services while taking the opportunity cost of financing into account may provide new perspectives on agricultural financing.

Finally, while some of the direct effects of carbon certified agroforestry such as soil fertility and conservation and renewable sources of energy are well documented, not everything is known about the possible long-term indirect benefits, especially with regards to agricultural financing. There is an urgent need for such research to analyze in more depth the win-win situation associated with ecosystem services.

**Questionnaire 1**

**Macroeconomics (Europäisches Institut für Internationale Wirtschaftsbeziehungen -EIIW)**

**Bergish University of Wuppertal (BUW)**

**Analysis of agriculture conservation and rural formal lending in sub-Saharan Africa**

**Questionnaire (smallholder respondents)**

**If you have any queries contact: 910614@uni-wuppertal.de or Welfens@uni-wuppertal.de**

**Preamble:** Dear respondents, please be informed that this study is purely for academic work. We therefore solicit for your support and cooperation by providing the necessary information. As we are aware of the sensitivity of the financial data sought and the need to assure privacy, we promise to treat the information provided as confidential.

**Criteria**:

a. Decision-maker on farm activity: [ ]
b. Above 18 years of age: [ ]
c. Height [ ]

Enumerator…………………………...........

Respondent………………………………

**Section B: Socio-economic detail**

1. Number of household members working on farm ………………………………….
2. Do you have a cell phone a. Yes [ ] b. No [ ]

Farm Labor

| Member of household | Hours per day | Day per week |
|---|---|---|
| Farmer | | |
| Spouse | | |
| Children | | |
| 6 – 10 + | | |

| | | |
|---|---|---|
| 11 – 15 + | | |
| 16 – 17 + | | |
| 18 – 29 + | | |
| 30 – 59 + | | |
| External laborers | | |
| | | |

3. Number of hectare of farmland………………………………….
4. Location of farmland: a. on a slope [ ] b. on a plain [ ] c. on a plateau [ ] d. in a valley [ ]
5. Dwelling structure: a. Plastered house [ ] b. Non-plastered house [ ] b. Hut [ ]
6. Is farmland assessable by road: a. Yes [ ] b. No [ ]
7. Is there a school present in the community a. Yes [ ] b. No [ ]
8. Which type of institution is present: a. elementary school [ ] b. secondary school [ ] c. college [ ] d. Others [ ] specify..…………
9. What is the distance of farm to next major tarred road………………km
10. What is the distance of your home to the nearest market? ……………………km
11. Are you the owner of your farmland: a. Yes [ ] b. No [ ]
    If No, how much is the rent charge ………………………
    Does the owner influences your farming a. Yes [ ] b. No [ ]
12. How long have you being cultivating your farmland: ………………………………
13. What kind of farm implements is used on farmland: a. mechanized [ ] b. manual [ ]
14. Ownership of the following farm asset:

| **Type** | **Quantity** |
|---|---|
| Tractor | |
| Harrow (breaking up and smoothing soil) | |
| Plow (drawn by animals) | |
| Hoes | |
| Work cattle | |
| Cutlass | |
| Rake | |
| Cattles | |

| | |
|---|---|
| Cart | |
| Pigs | |
| Poultry | |
| Donkey/ horses | |
| Goats/mutton | |
| Others animals (specify………………….) | |

15. Type of cultivated Cash crop

| **Name** | **Cultivated** | **Percentage of own consumption** |
|---|---|---|
| Green beans | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Sweet potato | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Tomatoes | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Cabbage | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Baby corn | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Flowers | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Tobacco | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Maize | Annually [ ] Biannually [ ] Others (…..) [ ] | |
| Others (specify …………..) | Annually [ ] Biannually [ ] Others (…..) [ ] | |

16. Do you purchase seeds: a. Yes [ ] b. No [ ]
17. Amount paid for seedlings a. (in 2011)…………………… b. (in 2012)………………
18. Type of seed of seeds: a. Hybrid [ ] b. Genetically Modified [ ] c. Conventional [ ]
19. Do you use own harvested seeds: a. Yes [ ] b. No [ ]
20. Use of fertilizer a. Yes [ ] b. No [ ]

    If yes:

| Chemical fertilizer used: | amount used | amount paid | subsidized | Organic fertilizer Used: | amount used | amount paid | subsidized |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

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

21. Use of Plant protection a. Yes [ ]  b. No [ ]

If yes:

| **Pesticide (Chemical) used:** | **amount used** | **amount paid** | **subsidized** | **Biological Method used:** | **amount used** | **amount paid** | **subsidized** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

22. Are you a member of a (farming) cooperative: a. Yes [ ]  b. No [ ]

If yes, please specify: ……………………………………………………………………….

23. How long have you being a member: ……………………..(years)
24. Which one of these services doers your cooperative provide

    a. Training and extension services [ ] b. information exchange [ ] c. marketing of farm produce [ ] d. credit [ ] e. saving [ ]

25. Are there non-governmental organizations (NGO) and governmental organization promoting sustainable / conservation farming and ecosystem management in the region:

    a. Yes [ ]  b. No [ ]

    If yes how did you get to know of such organization: a. word of mouth [ ] b. mass media [ ] c. social organization (cooperative) [ ]

26. Are you a member of such organization: a. Yes [ ]  b. No [ ]
27. Do you participate in conversation farming / ecosystem program as a group within such organization: a. Yes [ ]  b. No [ ]

28. If yes,

| Type of conservation farming | Type of ecosystem provided |
|---|---|
| | |
| | |
| | |

29. What is your reason for participating in the ecosystem services/conservation program?

…………………………………………………………………………………………
…….

30. Why do you think you were admitted into the program

…………………………………………………………………………………………
…….

31. Are your neighbors also involved in ecosystem services/conservation program a. Yes [ ] b. No [ ]

If yes, distance to next neighbor participating in program………………

32. What percentage of land is delegated to Payment of ecosystem services? ……………%

33. Are there any extension / ecosystem agent assigned by the organization to your group

: a. Yes [ ] b. No [ ]

34. How often do these agents visit your group in a year:

a. Weekly [ ] b. Fortnightly [ ] c. Monthly [ ] d. Every three months [ ] 5 Others [ ] specify ……………

35. Have you always had trees planted on your farmland: a. Yes [ ] b. No [ ]

If yes, reason and year of planting ………………………………………………

How many trees do you have on your farmland………………………………….

36. What is the business of the group?

…………………………………………………………………………………………

37. What year did you join the group? ........................................................................

38. Did you pay membership fee in year 2012: a. Yes [ ] b. No [ ]

If yes how much is the membership fee…………..

39. How often does your group meet? ……………………………… times (week/month)
40. Which of the following represents the percentage of the time you attend such meeting last year? a. 1 – 20% [ ] b. 21 – 40% [ ] c. 41 – 60% [ ] d. 61 – 80% [ ] d. 81 – 100% [ ]
41. Is there penalty for lateness / non-attendance of meeting a. Yes [ ] b. No [ ]

    If yes,

    Lateness is: ……………………………

    Nonattendance is: ……………………..
42. How many members are there in the group: ……………………………..
43. Which of the following facilities/benefits does you group provide:
    a. Training [ ] b. Investment [ ] c. Monitoring [ ] d. credit [ ] e. others [ ] (specify…………………..)
44. Did you receive payment for ecosystem services (PES) in 2012 a. Yes [ ] b. No [ ]

    If yes, what was the amount……………………………………….
45. Which of the following direct cost are associated with conservation agricultural/ ecosystem program: a. travel expense [ ] b. information gathering [ ] c. external monitoring [ ] d. protection cost [ ] e. technical support [ ] f. Consultancy [ ]

    What is the aggregated direct cost of conservation agricultural / ecosystem program per year …………………………………… KES
46. Estimated agriculture production in 2011:

    Cash crops [ ] a. Bags …………….or b. value (kg/KES)…………………..

    Others [ ] a. Bags …………….or b. value (kg/KES)……………………

    Sold at: ………………………………………………………………………..
47. Estimated agriculture production in 2012:

    Cash crops [ ] a. Bags …………….or b. value (kg/KES)…………………..

    Others [ ] a. Bags …………….or b. value (kg/KES)……………………

    Sold at: ………………………………………………………………………..
48. How do you transport your farm produce to sales point: ………………………………..

49. What is the distance to market or sales point: ……………………………………………

50. Do you use your cell phone to obtain market information a. Yes[ ] b. No [ ]

51. Estimated agriculture production before joining conservation / ecosystem services program:

    a. Bags ……………………… or value b. (kg/KES)…………………..

52. Has participation in conservation agricultural / ecosystem program improved yields: a. Yes [ ] b. No [ ]

53. Did/do you source business relevant information a. Yes [ ] b. No [ ]

54. What was your monthly/yearly farm income in 20….: [ ]

55. Which of the following are yours source of income

| **Primary business** | | **Percentage contribution to income** |
|---|---|---|
| Farm [ ] | Off- farm [ ] | |
| a. Spouse: ……………….. <br> b. Other family members: ………………. <br> c. Gift <br> d. Remittance <br> e. Ecosystem revenue………… … <br> f. Others (specify)……… ………………… …… | a. Spouse: ……………….. <br> b. Other family members: ………………. <br> c. Gift <br> d. Remittance <br> e. Ecosystem revenue……… … <br> f. Others (specify)……… …………….. …… | |

**Section C: Banking and Finance detail**

56. Client of a formal banking institution: a. Yes [ ] b. No [ ]

    If yes which:

    [ ] Micro-finance (small loans)…………………………………………………….

    [ ] Conventional Bank..………………………………………………

    [ ] Co-operative Bank ...……………………………………………………..]

57. Year of registration with institution...………………………………………………

58. Are you or your neighbor having short term credit constraints i.e. you cannot get credit a. Yes [ ] b. No [ ]
59. Do you have crop damage insurance a. Yes [ ] b. No [ ]
60. Which of the following services does your bank provide:
    a. Saving [ ] b. Credit [ ] c. Investment [ ] d. Others [ ] (specify ………………)
61. Did you take credit from the formal banking institution: a. 2011 [ ] b. 2012 [ ] c. earlier [ ] (specify …………)
    If yes please specify the amount ………………………………………………………..
62. Did you take credit from other source in: a. 2011 [ ] b. 2012 [ ] c. earlier [ ] (specify …………)
    If yes please specify source………………………………………………………..
    If yes please specify the amount ………………………………………………………..
63. Do you have access to cell phone banking a. Yes [ ] b. No [ ]
64. Have you use phone banking in the past 12 month a. Yes [ ] b. No [ ]
65. What was the reason for obtaining credit (formal /informal):
    a. [ ] Farming business
    b. [ ] Non-farming business
    c. [ ] Daily Need / food
    d. [ ] Child education
    c. [ ] Health care
    e. [ ] Others (Specify ……………………………………………………..)
66. What was the interest rate charge on credit: ………………………..%
67. Type of Guarantee/ Security on loan:
    a. [ ] group Guarantee
    b. [ ] Government Guarantee
    c. [ ] Physical Collateral
    d. Others (specify……………………………………………….)

68. What was the duration (days/weeks/months) between loan application and loan collection………………
69. When was the loan due: …………………………………..
70. What was the amount (loan + interest) yet to be repaid as at this due date ………………………………………..
71. Did/would you pay part of an outstanding loan with ecosystem payments or farm profit:

    a. Yes [ ] b. No [ ]
72. Did you save part of your income in:

    a. 2011 [ ] b. 2012 [ ] c. earlier [ ] (specify date ……………)

    If yes please specify the amount ……………………………………………………..
73. What was the reason for saving

    a. [ ] Access to saving

    b. [ ] Access to credit

    c. [ ] Interest rate on saving

    d. [ ] survival strategy
74. What was the interest rate on savings: ………………………..%
75. Visitation frequency of loan officer to (your/group) business in 20…..

    a. Weekly [ ] b. fortnightly [ ] c. monthly [ ] d. quarterly [ ] e. others [ ] (specify……………)

**Section A: Demographics and personal details**

76. Name ……………………………………………………
77. Community ……………………………………………………………………….
78. Province/County ………………………………………………….
79. Age …………………
80. Religion …………………………………………….
81. Gender: a. Male [ ] b. female [ ]
82. Marital status: a. single[ ] b. Married [ ] c. Widow [ ] e. Divorced [ ]

83. Number of spouse if married ……………….. Age of spouse………………………

84. Occupation: a. Farming [ ] b Farming and ……………… c. others specify ………………..

85. Years of formal education……….Spouse Years of formal education……………….

86. School certificate: a. elementary school [ ] b. secondary school [ ] c. college [ ] d. Others

[ ] specify ..………….

87. Tribal / ethnic group ………………………………………………..

88. Number of individual in household………………………

89. Household composition

| **Age (years)** | **No. of males** | **No. of females** |
|---|---|---|
| 0 – 5 + | | |
| 6 – 10 + | | |
| 11 – 15 + | | |
| 16 – 17 + | | |
| 18 – 29 + | | |
| 30 – 59 + | | |
| 60 + | | |

90. Please indicate which of the following items you own (household Asset)?

a. Chair [ ]
b. Table [ ]
c. Lamp/ Lantern [ ]
d. Watch / Clock [ ]
e. Bed [ ]
f. Motor cycle [ ]
g. Bicycle [ ]
h. Radio , Cassettes, CD [ ]
i. TV / VCR [ ]
j. Concrete slab for dying [ ]
k. Rainwater reservoir [ ]

l. Others (specify) [ ]…………………………

91. In the past one year has your household purchased or spend money on any of the following

| **product** | | **Value of product** |
|---|---|---|
| Fabric | a. Yes [ ] b. No [ ] | |
| Male cloths | a. Yes [ ] b. No [ ] | |
| Female cloths | a. Yes [ ] b. No [ ] | |
| Child cloths (< 15) | a. Yes [ ] b. No [ ] | |
| Shoes, hats, umbrella | a. Yes [ ] b. No [ ] | |
| Kitchen utensils | a. Yes [ ] b. No [ ] | |
| Bedding | a. Yes [ ] b. No [ ] | |
| House improvement | a. Yes [ ] b. No [ ] | |
| School tuition | a. Yes [ ] b. No [ ] | |
| Loan payment | a. Yes [ ] b. No [ ] | |
| Books | a. Yes [ ] b. No [ ] | |
| Medicine, Pharmacy | a. Yes [ ] b. No [ ] | |
| Hospital Clinic | a. Yes [ ] b. No [ ] | |
| Social celebration | a. Yes [ ] b. No [ ] | |
| Trips / transportation | a. Yes [ ] b. No [ ] | |
| Energy (stove, electricity) | a. Yes [ ] b. No [ ] | |
| savings | a. Yes [ ] b. No [ ] | |
| Farm implements | a. Yes [ ] b. No [ ] | |
| Food (including processed) | a. Yes [ ] b. No [ ] | |
| Alcohol | a. Yes [ ] b. No [ ] | |
| Cigarettes | a. Yes [ ] b. No [ ] | |

**Thank You!!!**

## Questionnaire 2

**Private and Confidential**

This questionnaire is provided in connection with a study by Emmanuel Benjamin to assess the credit risk management in SME agricultural loan **[Kenya]** The study is being conducted in collaboration with **the [European Institute for International Economic Relations]** under a PhD program . Responses to this questionnaire will be used to develop general findings and conclusions without specific reference to institutions, clients or credits, except where information may be independently available in the public domain or where permission has been granted approval.

Responses to the questionnaire should be completed in as much detail as possible, and supported by relevant statistics and data where available.

1. **Types of Lending.**

    a. Describe the types of lending provided by your institution and the total volume and percentages of lending in each category and the interest rates charged on each of the above types of lending

| **Type of lending** | **Total volume** | **Percentage** | **Interest rate charged** |
|---|---|---|---|
| **Primary sector** | | | |
| Agriculture | | | |
| Mining | | | |
| forestry | | | |
| Fishery | | | |
| **Secondary sector** | | | |
| Manufacturing | | | |
| Processing | | | |
| Construction | | | |
| **Others (Specify)** | | | |
| Personal | | | |

| | | | |
|---|---|---|---|
| Mortgage | | | |
| Auto | | | |
| Educational | | | |

b. What types of risk management techniques does the Bank utilizes and what is the preferred (or most common) form used: A. collateralization B. Guarantor C. Insurance D. Securitization

| **Type of lending** | **Collateral required** | **Collateral preferred** |
|---|---|---|
| **Primary sector** | | |
| Agriculture | | |
| Mining | | |
| forestry | | |
| Fishery | | |
| **Secondary sector** | | |
| Manufacturing | | |
| Processing | | |
| Construction | | |
| **Others (Specify)** | | |
| Personal | | |
| Mortgage | | |
| Auto | | |
| Educational | | |

c. Which of the following credit criteria is used to determine borrower's creditworthiness in the primary sector esp. SME agriculture?

| **Factors** | **Reponses** | **Importance (rating)** |
|---|---|---|
| Income, past earnings and projected cash flow | Yes [ ] No [ ] | |
| Number of account at other institutions | Yes [ ] No [ ] | |
| Character and reputation | Yes [ ] No [ ] | |

| | | |
|---|---|---|
| Experience and depth of business | Yes [ ]   No [ ] | |
| Strength of business | Yes [ ]   No [ ] | |
| Ability to repay the loan with earnings from the business | Yes [ ]   No [ ] | |
| Sufficient invested equity to operate on a sound financial basis | Yes [ ]   No [ ] | |
| Potential for long term success | Yes [ ]   No [ ] | |
| The effect any business affiliate may have on the ultimate repayment ability of the applicant | Yes [ ]   No [ ] | |

d. Do you also rate credit worthiness of the primary sector using the following factors?

| **Factor** | **Reponses** | **Importance (rating)** |
|---|---|---|
| New application | Yes [ ]   No [ ] | |
| Late payment | Yes [ ]   No [ ] | |
| Delinquency | Yes [ ]   No [ ] | |
| Bankruptcy | Yes [ ]   No [ ] | |
| Credit history | Yes [ ]   No [ ] | |
| Outstanding debt | Yes [ ]   No [ ] | |
| Type of credit in used | Yes [ ]   No [ ] | |

e. Describe 5 key problems that exist in the loans procedure to SME agriculture?

1. ………………………………………………………………..
2. ………………………………………………………………..
3. ………………………………………………………………..
4. ………………………………………………………………..
5. ………………………………………………………………..

f. Do you group SME agriculture into method of farming i.e. conventional and conservation?

a. Yes [ ]   b. No [ ]

g. Do you pool or segment SME farm operation in credit contract term?

a. pooling [ ]     b. segmenting [ ]

If segmenting, please state criteria ……………………………………………….

2. **Security/Collateral.**

a. What proportion of lending is secured by category?

| **Type of lending** | **Percentage secured** |
|---|---|
| Primary sector | |
| Agriculture | |
| Mining | |
| forestry | |
| Fishery | |
| Secondary sector | |
| Manufacturing | |
| Processing | |
| Construction | |
| Others (Specify) | |
| | |
| | |

b. What portion of your total loan in the last five years is allocated to commercial and small medium enterprise agriculture SME?

| **Year** | **Commercial farms** | **SME** |
|---|---|---|
| 2012 | | |
| 2011 | | |
| 2010 | | |
| 2009 | | |

| | | |
|---|---|---|
| 2008 | | |

c. Are you aware of Payment for ecosystem services amongst SME conservation agriculturalist?
   a. Yes [ ]   b. No [ ]

d. Would you consider this an eligible collateral substitute in loan procedure?
   a. Yes [ ]   b. No [ ]

3. **Credit Recovery and Credit Risk Management.**

A. what type of securities does the Bank prefer from primary sector esp. esp. SME agriculture

| **Assets** | **Reponses** | **Importance** |
|---|---|---|
| Land | Yes [ ]   No [ ] | |
| Cash deposit | Yes [ ]   No [ ] | |
| Jewelry | Yes [ ]   No [ ] | |
| Bicycle | Yes [ ]   No [ ] | |
| Motorcycle | Yes [ ]   No [ ] | |
| Car | Yes [ ]   No [ ] | |
| Farm animals | Yes [ ]   No [ ] | |
| Farm implements | Yes [ ]   No [ ] | |

b. Describe 5 key problems that exist in the creation, recording (registration) and enforcement of security and collateral in SME agriculture?

1. ………………………………………………………..
2. ………………………………………………………..
3. ………………………………………………………..
4. ………………………………………………………..
5. ………………………………………………………..

………………………………………………………..

c. Does your institution have a credit recovery department that handles collection of credits in default? a. Yes [ ]   b. No [ ]

If yes, describe the following:

i. The organizational structure of the department, number of staff bank-wide, and the process for decision-making.

………………………………………………………………………………………
……

………………………………………………………………………………………
……

………………………………………………………………………………………
…….

ii. The qualification requirements and training process for staff in this department.

………………………………………………………………………………………
……

………………………………………………………………………………………
……

………………………………………………………………………………………
…….

iii. Any standardized procedures for handling credit recovery and whether a general operations manual or guide exists.

………………………………………………………………………………………
……

………………………………………………………………………………………
……

………………………………………………………………………………………
…….

d. At what point is a credit transferred to the credit recovery department for action?

…………………………………………………………………………………………………
………..

- 1 - **Private and Confidential**

a. Provide data on the level of agriculture non-performing loans (NPLs) in your institution on an annual basis **for the past 5 years** by amounts and percentages with reference to (i) aggregate amounts.

| Year | Amount | % of total NPLs |
|---|---|---|

| | | |
|---|---|---|
| 2012 | | |
| 2011 | | |
| 2010 | | |
| 2009 | | |
| 2008 | | |

4. **Credit Recovery Methodologies.**

a. For SME agricultural loan indicate the following information to the extent possible **on an annual basis for the past 4-5 years**: (i) average recovery rates (as a percentage of the total credit due, including interest components) (ii) average recovery rates (as a percent of nominal value of the credit); (iii) the average duration for recovery; and (iv) the average costs incurred in trying to collect the loans (e.g., costs of litigation, costs for external lawyers, valuation reports, auction or execution costs, experts.). The following table may be helpful for assembling the information in sections a. and b of this question.

| **Credit Recovery Method** | **Total Credits** | | **Ave. Recovery (% Total Due)** | **Ave. Recovery (% Nominal)** | **Ave. Duration** | **Ave. Costs Incurred** |
|---|---|---|---|---|---|---|
| | **No.** | **Amount** | | | | |
| Sale of credit to third party | | | | | | |
| Debt Rescheduling | | | | | | |
| Informal workout | | | | | | |
| Non-judicial foreclosure/Exec. | | | | | | |
| Judicial Foreclosure (immoveable) | | | | | | |
| Judicial execution (moveable) | | | | | | |
| Liquidation | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Formal Rehabilitation (e.g., concordat, administration, etc.) | | | | | | |
| Debt Equity Swap | | | | | | |
| Other | | | | | | |

**Private and Confidential**

5. **Information.** (This question deals with the quality of information available for credits)

a. Describe the type of information routinely requested by your institution from SME agriculture borrower:

I. in the case of a workout: a. financial statements [ ] b. cash flow projections [ ] c. pro forma statements [ ] d. Others specify ………………………………..

II. Seeking a new credit

……………………………………………………………………………………………………

III During the course of the course of a credit relationship in which the credit is performing

……………………………………………………………………………………………………

How would you describe the quality of the information provided by the SME agricultural debtors in each of the above instances? a. Good [ ] b. Fair [ ] c. Poor [ ] d. Not relevant [ ]

b. What steps does your institution follow to verify the integrity and accuracy of information provided by borrower (and borrowers in default)?

……………………………………………………………………………………………………

7. **Workouts**. In a debt rescheduling or a more extensive workout arrangement of SME agricultural loans, which one of the changes in the business does your institution require as a condition to rescheduling or workout?

a. change in agricultural management [ ]

b. cost cutting measures [ ]
c. sale of assets [ ]
d. provision of new collateral/security [ ]

How frequently are these changes implemented?

……………………………………………………………………………………………..

## References


Abhilash, C., Srivastava, P., Jamil, S. and Singh, N. (2010). Revisited Jatropha curcas as an oil plant of multiple benefits: critical research needs and prospects for the future,' in *Environmental Science and Pollution Research,* 18:127–131

Abukasawi, M., Abdelsalaam, A., Khojali, A., and Moussa M. (2007). "Study commissioned by the Central Bank of Sudan (BOS) Collateralization and Guarantee in the expansion of Microfinance in Sudan ," Final Document http://mfu.gov.sd/sites/default/files/collateral_study_-final.pdf (Accessed 27April 2012)

Adesina, A., and Chianu, J. (2002). Determinants of farmers; adoption and adaptation of alley farming technology in Nigeria. *Agroforest Syst.,* 55: 99–112

Adewojun J (2006) Food Security, Climate Variability and Climate Change in Sub-Saharan West Africa (AIACC, Washington, DC), AIACC Final Report Project No. AF 23.

Admasu, A., and Paul, I. (2010). Assessment on the mechanism and challenges of small scale agricultural credit from commercial banks in Ethiopia: the case of Adaá liben woreda Ethiopia,' in *Journal of Sustainable Development in Africa,* 12(3) :323 – 304.

Afrane, S. (2002). Impact Assessment of Microfinance Interventions in Ghana and South Africa: A Synthesis of Major Impacts and Lessons, *Journal of Microfinance* , 4(1):37 – 57

AfDB, (2013). African Development Bank African Carbon Support Programme http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/AfDB%20African%20Carbon%20Support%20Programme.pdf (Accessed 22 June 2014)

Ahma, W. (2001).Revisiting the Regulatory and Supervision Framework of the Micro-finance industry in Ethiopia; Norway: Drylands Coordination Group / Noragric

Ahmed, A. (2005). The impact of finance and funding on technology adoption,' in *Journal of African Development,* 7(1): 20-41.

Aker, C. (2010). Dial “A” for Agriculture: Using Information and Communication Technologies for Agricultural Extension in Developing countries. Paper presented at the Conference Agriculture for Development-Revisited, University of California at Berkeley, October 1-2

Aker, C., and Mbiti, M.(2010). Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives*, 24(3): 207-32.

Akinnifesi, K., Chirwa, P., Ajayi, O., Sileshi,G., Matakala, P., Kwesiga, Harawa, R. and Makumba, W. (2008). Contributions of agroforestry research to livelihood of smallholder farmers in southern Africa Taking stock of the adaptation, adoption and impact of fertilizer tree options. *Agric. J.*,3, 58-75. http://www.medwelljournals.com/fulltext/aj/2008/58-75

Ali, D., and Deininger, K. (2014). Causes and Implications of Credit Rationing in Rural Ethiopia: The Importance of Zonal Variation. *J Afr Econ.*, 23: 493-527

Anderson, C. L., Locker, L., and Nugent, R. 2002, Microcredit, social capital, and common pool resources, *World Development*, 32: 95 - 105.

Anim, F. (1999). A note on the adoption of soil conservation measures in the Northern Province of South Africa. *Journal of Agricultural Economics,* 50: 336–45.

Antle, J., and Diagana, B. (2003). ‘Creating Incentives for the adoption of sustainable agriculture practices in developing countries: The role of soil carbon sequestration in *American Journal of Agricultural Economics*, 85(5): 1178–1184.

Ares E. 2013 Carbon Price Floor. Tech. Rep. SN/SC/5927; House of Commons; URL http://www.parliament.uk/briefing-papers/SN05927/carbon-price-floor (Accessed 13 December 12)

Armendariz, B., and Morduch, J. (2005). *The Economics of Microfinance*, 2nd edn, Cambridge, MA: MIT Press.

Arun, T., and Murinde, V. (2010). Microfinance regulation and social protection,’ Paper presented at the Conference Experiences and lessons from social protection programmes across the developing world: what role for the EU, 17-18 June, Paris, France.

Asafu-Adjaye, J. 2008 Factors Affecting the Adoption of Soil Conservation Measures: A Case Study of Fijian Cane Farmers. *Journal of Agricultural and Resource Economics*, 33(1):99-117

Ashta, A. (2007). An Introduction to Microcredit: Why Money is Flowing from the Rich to the Poor, *Cahiers du CEREN Working Paper*, 21 p. 77-87

Atela, J.O. (2012) The Politics of Agricultural Carbon Finance: The Case of the Kenya Agricultural Carbon Project, STEPS Working Paper 49, Brighton: STEPS Centre

Augsburg, B., Schmidt, J., and Krishnaswamy, K. (2011).Free and open source software for microfinance: increasing efficiency and extending benefits to the poor,' In Ashta A (ed.), Advanced Technologies for Microfinance: Solutions and Challenges. IGI Global: Hershey, PA.

Aubert, J-É. (2005). Promoting Innovation in Developing Countries: A Conceptual Framework. World Bank Policy Research Working Paper 3554, Washington, DC: World Bank

Australian Government (2011)Strong Growth Low Pollution: Modelling a Carbon Price'. Available from: http://carbonpricemodelling.treasury.gov.au/carbonpricemodelling/content/report.asp (Accessed 22 July 2014)

Baker, S., Ritchie, C., and Reicosky, R.(2002). Justice and Hobbs "*No-tillage Seeding in Conservation Agriculture*," New York: CAB International

Balkenhol, B. (1991). 'Savings, Credit, and the Poor: What has the ILO done with the Financial Sector,' in *International Labour Review*,130 (5-6): 645-655.

Bandiera, O., and Rasul, I. (2006). Social networks and technology adoption in Northern Mozambique. *The Economic Journal*, 116 : 869-902.

Bandyopadhyay, A. (2008).Credit Risk Models for Managing Bank's Agricultural Loan Portfolio." ICFAI *Journal of Financial Risk Management*, 5(4): 86-102

Barrios, S., Bertinelli, L., and Strobl, E. (2006).Climatic change and rural-urban migration: the case of sub-Saharan Africa. *J Urban Econ*., 60:357-71.

Barry, P., and Robison, L.(2001). Agricultural finance: credit, credit constraints, and consequences. B.L. Gardner, G.C. Rausser (Eds.), *Handbook of Agricultural Economics*, vol. 1A. Elsevier, Amsterdam

Bassen, A., and Kovacs, A. (2008), 'Environmental, social and governance key performance indicators from a capital market perspective,' *The Journal for Business, Economics & Ethics*, 9 (2): 182-192.

Basu, A., Blavyand, R., and Yulek, M. (2004). Microfinance in Africa: Experience and Lessons from Selected African Countries,' in *International Monetary fund (IMF) working paper*, (174): 1 – 24

Basuki, T., van Laake, P., Skidmore, A. and Hussin Y.A. (2009). Allometric equations for estimating the above-ground biomass in tropical lowland Dipterocarp forests. *Forest Ecology and Management*, 257:1684–1694

Batabyal, A., and Beladi, H. (2010). A model of microfinance with adverse selection, loan default, and self-financing", *Agricultural Finance Review*, 70: 55–65. Doi 10.1108/00021461011042639

Baydas, M., Graham, D., and Valenzuela L. (1997). "Commercial Banks in Microfinance: New Actors in the Microfinance World." Washington D.C: USAID

Bayon, R., Hawn, A., and Hamilton K. (2009). Voluntary carbon markets: an international business guide to what they are and how. London; Earthscan

Beck, T., Fuchs, M., and Uy, M. (2009). Finance in Africa: Achievements and Challenges,' in *The World Bank Policy Research Working Paper*, (5020): 31 – 47

Beck, T., and Demirguc-Kunt, A. (2008). Access to finance: an unfinished agenda'. The World Bank. *Economic Review*, 22: 383–96.

Bekessy, S. and Cooke, B. (2011). Social and cultural drivers behind the success of PES. In: Ottaviani, D.and Scialabba, N. (Eds), Payments for Ecosystem Services and Food Security, FAO, Rome.

Bellassen, V., and Leguet, B. (2007). The emergence of voluntary carbon offsetting. Caisse des Depots Research Report No .11, September 2007

Benge, M. (2006), 'Assessment of the potential of Jatropha curcas, (biodiesel tree,) for energy production and other uses in developing countries;' *Ascension Publishing*, Available at: http://www.ascension-publishing.com/BIZ/jatropha.pdf (Accessed 27 April 2012).

Benjamin, O. (2012). Improving credit allocation to sustainable agriculture in Sub-Saharan Africa: Review of bio-based economy benefits. *OIDA International Journal of Sustainable Development*, 4 (10):15 – 24.

Benjamin, O. (2012b). Financial Lending and Investment in Sustainable Small-Scale Agribusiness in Sub-Saharan Africa: A Review of Carbon. Sequestration and Welfare Benefits", *African Journal of Science, Technology, Innovation and Development*, 4 (2):109 – 129.

Benjamin, O. (2013a). Credit risk modeling and sustainable agriculture: asset evaluation and rural carbon revenue. *Journal of Sustainable Finance & Investment,* 3: 57 – 69. doi: 10.1080/20430795.2013.765382

Benjamin, O. (2013b). Adverse selections and microfinance in rural Africa: signaling through environmental services. Enterprise Development and Microfinance 24, 28 – 39. doi: 10.3362/1755-1986.2013.004

Benjamin, O., Blum, M. and Punt, M. (2014). Conservation farming practices and credit terms among Kenyan smallholders: a strategy to overcome credit constraints? Unpublished

Berger, A., and Udell, G. (1990). Collateral, Loan Quality, and Bank Risk. *Journal of Monetary Economics,* 25: 21-42.

Besanko, D., and Thakor, A. (1987). Collateral and rationing: sorting equilibria in monopolistic and competitive credit markets. *International Economic Review,* 28: 671 – 689.

Besley, T. (1994). "How do market failures justify interventions in rural credit markets?". *World Bank Research Observer* 9, 22-47.

Bester, H. (1985). Screening vs Rationing in Credit Markets with Imperfect Information. *American Economic Review,* 75: 850-855.

Biggs, S. (2007). Building on the positive: an actor innovation systems approach to finding and promoting pro-poor natural resources institutional and technical innovations.
*International Journal of Agricultural Resources, Governance and Ecology*, 6: 144-164.

BIS, (2010). 'Microfinance activities and core principle for effective banking supervision,' Basel: Bank for international settlement (BIS) communication.

BIS, (2012). "About the Basel Committee." http://www.bis.org/bcbs/about.htm (Accessed 26 April 2012).

Blackman, A. (2001). Why don't lenders finance high-return technological change in developing-country agriculture. *American Journal of Agricultural Economics,* 83: 1024-1035

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. and Yanda, P. (2007). Africa Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change , M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

Boucher, R., Carter, R. and Guirkinger, C. (2008). Risk Rationing and Wealth Effects in Credit Markets: Theory and Implications for Agricultural Development. *American Journal of Agricultural Economics,* 90: 409-423. doi: 10.1111/j.1467-8276.2007.01116.x

Branca, G., Tennigkeit, T., Mann, W., & Lipper, L. (2011). 'Identifying Opportunities for Climate-Smart Agriculture Investments in Africa,' Rome: Food and Agriculture Organization of the United Nation & World Bank

Broecker, W. (1975). Climate change: Are we on the blink of a pronounced global warming? *American association of advancement of science,*189 (4201): 460 – 463

Bridges, J., Gregory, D., Nielsen, M., Pezzini, S., Radia, A. and Spaltro, M. (2014). The impact of capital requirements on bank lending. Bank of England working paper 486.

Brittaine, R., and Lutaladio N. (2010).'Jatropha: A Smallholder Bioenergy Crop: The Potential for Pro-Poor Development,' Rome: United Nations.

Brownbridge, M. (1998).The Causes of Financial Distress in Local Banks in Africa and implication for prudential Policy,' in *United Nations Conference on Trade and Development,* 132: 1 – 40

Bumpus, A., and Liverman, D. (2008). Accumulation by decarbonization and the governance of carbon offsets. *Econ. Geogr.*, 84: 127–155. (doi:10.1111/j.1944-8287.2008.tb00401.x)

Bunning, A. (2004).“A microcredit success story: Women make the difference.” *Development Bulletin*, 64:63-66.

Butzengeiger, S. (2005). Voluntary compensation of GHG emissions: Selection criteria and implications for the international climate policy system, HWWI, Research Report, No. 1

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

Campion, A., and White, V. (2001). 'NGO Transformation,' *microfinancegateway*, June 9. Available at: http://www.microfinancegateway.org/gm/document-1.9.28745/19230_N_073.pdf (Accessed 27April 2012).

Carlton, A., Manndorff H., Obara, A., Reiter, W. and Rhyne, E. (2001). “Microfinance in Uganda,” Commissioned by the Austrian Ministry of Foreign Affairs, Department for Development Cooperation Wien: Austria

Caveness, F., and Kurtz, W. (1993). Agroforestry adoption and risk perception by farmers in Senegal. *Agroforest Syst*., 21: 11–25.

Celebi, M., and Graves, F. (2009).Volatile CO*2 prices discourages* carbon capture and sequestration (CCS) investment. The Brattle Group. Available online http://www.brattle.com/system/publications/pdfs/000/004/713/original/Volatile_CO2_Prices_Discourages_CCS_Investment_Celebi_Graves_Jan_2009.pdf?1378772123 (Access 04 March 2014)

CDM rulebook 2014 clean development mechanism rules practice and procedure http://cdmrulebook.org/home (Accessed 27April 2012).

CGAP (2010a). 'CGAP Awards Recognize Three Microfinance Investors for Social Commitment,' *CGAP*, June 9. Available at: http://www.cgap.org/p/site/c/template.rc/1.26.14337/ (Accessed 27April 2012).

CGAP (2010b). MIV Survey Report Market Data & Peer Group Analysis, *CGAP*, June 9. Available at: http://www.cgap.org/gm/document-1.9.47373/CGAP_2010_MIV_Survey_Report.pdf (Accessed 27April 2012).

Challinor, A., Wheeler, T., Garforth, C., Craufurd P. and Kassam A. (2007). Assessing the vulnerability of food crop systems in Africa to climate change. *Climatic Change,* 83:381– 399 DOI 10.1007/s10584-007-9249-0

Charitonenko, S., and Campion, A. (2003). 'Expanding Commercial Micro Finance in Rural Areas: Constraints and Opportunities;' *Chemonics* June 9. Available at: www.basis.wisc.edu/live/rfc/cs_05a.pdf (Accessed 27April 2012).

Christen, P., and Pearce, D. (2005). "Managing risks and designing products for agricultural microfinance Features of an emerging model." Occasional Paper UK Department for International Development, 11: 1 - 86

Christiaensen, J., and Demery, L. (2007). 'Down to Earth: Agriculture and Poverty Reduction in Africa,' Washington D.C: The World Bank.

Čihák, M., and Podpiera, R. (2005). Bank Behaviour in Developing Countries: Evidence from East Africa. *IMF Working Paper* 05/129

Coase, R. (1960). "The problem of social cost." *Journal of Law and Economics*, 3: 1 - 44.

Cole, J. (2010). Social and environmental impacts of payments for environmental services for agroforestry on small-scale farms in southern Costa Rica. *International Journal of Sustainable Development & World Ecology*, 17(3):208–216

Collier, P. (1998). Social capital and poverty Washington, DC: World Bank.

Comninos, A., Esselaar, S., Ndiwalana, A., and Stork, C. (2008), 'M-banking the Unbanked,' *Research ICT Africa* 1(4): 1 – 20

Conley, G., and Christopher, R. (2010). Learning about a New Technology: Pineapple in Ghana. *The American Economic Review,* 100: 35-69.

*C*onning, J., and Morduch, J. (2011). Microfinance and Social Investment. Available online at http://www.financialaccess.org/sites/default/files/publications/microfinance-and-social- investment.pdf (Accessed 26 February 2014)

Conway, J., and Stevens, A. (2012). 'Industry Survey of Financial Advisors on Sustainable and Impact Investing' gatewaytoimpact.org, June 9. Available at:

http://www.gatewaystoimpact.org/images/gatewaystoimpact.pdf (Accessed 27 April 2012)

Crooks, A. (2009). “Financing Climate Adaptation and Mitigation in Rural Areas of Developing Countries.” Washington D. C: USAID

Crosbie, P., and Bohn, J. (2003). “Modeling Default Risk "Modelling Methothology". Moodys and K.M.V http://www.ma.hw.ac.uk/~mcneil/F79CR/Crosbie_Bohn.pdf (Accessed 27 April 2012)

Cull, R., Demirgüç-Kunt, A., and Morduch, J. (2008). *‘Microfinance Meets the Market,’* New York: The World bank

Current, D., Ernst, L., and Scherr S. (1995). The costs and benefits of agroforestry to farmers World Bank Res Obs 10 (2): 151-180 doi:10.1093/wbro/10.2.151

Davis, K. (2008).Extension in sub-Saharan Africa: Overview and assessment of past and current models, and future prospects. *Journal of International Agricultural and Extension Education,* 15(3):15–28.

DEA (2011). South Africa’s Second National Communication under the United Nations Framework Convention on Climate Change. Department of Environmental Affairs, Republic of South Africa, Pretoria.

Delfiner, M., and Peron, S. (2007).“Commercial Banks and Microfinance”. Central Bank of Argentina, *Munich Personal RePEc Archive (MPRA),* Paper No. 10229: 1 – 54

Delgado, C. (1999). Sources of growth in smallholder agriculture in Sub-Saharan Africa: the role of vertical integration of smallholders with processors and marketers of high-value items. Agrekon 165 – 189.

Demirguc-Kunt, A., and L. Klapper. 2012. “Measuring Financial Inclusion: The Global Findex Database.” Policy Research Working Paper 6025, World Bank, Washington, DC.

Dercon, S. (2000). Insurance against Poverty. Oxford; Oxford University Press

Dercon S. (2008). Fate and Fear: Risk and Its Consequences in Africa. *Journal of Africa Economics* 17 (2): 97- 127 doi: 10.1093/jae/ejn019

Dercon, S. (2004). "Risk, insurance, and poverty: a review". In: Dercon, S., (Ed.), Insurance Against Poverty. Oxford University Press, Oxford

De Pinto, A., Magalhaes, M. and Ringler, C. (2010), 'Potential of Carbon Markets for Small Farmers: *A Literature Review,' in IFPRI Discussion Paper* (1004):1 – 36

Develtere, P., Pollet, I. and Wanyama, F. (2008). Cooperating out of Poverty: the Renaissance of the African Cooperative Movement. ILO/The World Bank Institute, Geneva.

Diagne, A., Simtowe, F. and Zelle, M. (2009), 'The impact of credit constraints on the adoption of hybrid maize in Malawi,' in *Review of Agricultural and Environmental Studies - Revue d'Etudes en Agriculture et Environnement*, 90(1): 5-22.

Diagne, A., and Zeller, M.(2001). Access to Credit and Its Impact on Welfare in Malawi. IFPRI press, Washington, DC.

Dixon, R., Ritchie, J. and Siwale, J. (2007), Loan officers and loan delinquency in microfinance: a Zambian case', *Accounting Forum*, 31: 47–71. Doi. 10.1016/j.accfor.2006.11.005

Dorward, A., Poole, N., Morrison, J.A., Kydd, J. and Urey, I. (2003). Markets, Institutions and Technology: Missing Links in Livelihoods Analysis. *Development Policy Review*, 21(3): 319–32.

Dudek, D., Joseph, G., Sarah,W., (1997). Emissions Trading in Non-attainment Areas: Potential**,** Requirements, and Existing Programs," in Richard F. Kosobud and Jennifer M. Zimmerman, eds., *Market-Based Approaches to Environmental Policy: RegulatoryInnovations to the Fore*, Toronto: Van Nostrand Reinhold

Dumanski, J., Peiretti, R., Benetis, J., McGarry, D. and Pieri, C.(2006) "The paradigm of conservation tillage," Proceeding World Association of Soil and Water conservation, P1: 58-64.

Dutschke, M., Schlamadinger, B., Wong, J. and Rumberg, M. (2005). Value and risks of expiring carbon credits from afforestation and reforestation projects under the CDM *Climate Policy*, 5(1): 109 – 125

Ecosystem market place (2008), ´Forests: Taking Root in the Voluntary Carbon Market available at: http://ecosystemmarketplace.com/documents/cms_documents/ForestCarbonBooklet%2008-0908%203%5B1%5D.pdf (Accessed 14 April 2012)

Eicher, K. (1989). Sustainable Institutions for African Agricultural Development Working Paper No. 19ISNAR, the Hague: Netherland

Eijck, V. (2007). 'Transition towards Jatropha biofuels in Tanzania? An analysis with Strategic Niche Management,' Leiden: African Studies Centre

EP (2011). Members and Reporting, Equator Principle, June 9. Available at: http://www.equator-principles.com/index.php/members-reporting (Accessed 27 April 2013).

Evenson, E., and Mwabu, G. (1998). The effects of agricultural extension on farm yields in Kenya. *Economic Center Discussion Paper* No.708.

FAO (2007). The state of food and agriculture: Paying farmers for environmental services Available at: ftp://ftp.fao.org/docrep/fao/010/a1200e/a1200e00.pdf (Accessed 27 April 2014).

FAO (2011a). Factors influencing the adoption of conservation agriculture http://www.fao.org/docrep/004/y2781e/y2781e04.htm (Accessed 17 January 2014)

FAO (2011b). "*Socio-Economic Analysis of Conservation Agriculture in Southern Afri*ca," Network No. 2. Rome: FAO

FAO (1989). 'Sustainable development and natural resources management', Twenty-Fifth Conference, Paper C 89/2 - Sup. 2, Food and Agriculture Organization, Rome.

Feder, G., and Umali, D. (1993). The Adoption of Agricultural Innovations: A Review, in *Technological Forecasting and Social Change,* 43: 215-239

Feder, G., Just, R., and Zilberman, D. (1982). Adoption of agricultural innovation in developing countries. World Bank Staff Working Paper No. 542. Washington, DC: World Bank

Feder, G., Just, E. and Zilberman D. (1985). Adoption of Agricultural Innovations in Developing Countries: A survey. *Econ Dev Cult Change,* 33: 255–295.

Feder, G. and Umali D (1993). The adoption of agricultural innovations: A review. *Technol. Forecast. Soc. Change,* 43: 215–239

Fernandez-Cornejo, J., and McBride, D. (2002).'Adoption of Bioengineered Crops,' in *Agriculture economic report* No. 810. Washington, D.C: U.S. Department of Agriculture.

Fernando, N. A. (2008). 'Managing Microfinance Risks: Some Observations and Suggestions,' in *Asian Journal of Agriculture and Development,* 4(2):1-22

Flamini, V., McDonald, C. and Schumacher L. (2009). 'The Determinants of Commercial Bank Profitability in Sub-Saharan Africa,' in IMF Working Paper 09(15): 1 - 32

Fletschner, D., and Kenney, L. (2011). Rural Women's Access to Financial Services: Credit, Savings, and Insurance. Rome: Food and Agriculture Organization of the United Nations.

Foster, A., and Rosenzweig, M. (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. *The Journal of Political Economy*, 103: 1176-1209.

Foster, K., Neufeldt, H., Franks, P., Diro, R., Munden, L., Anand, M. and Wollenberg, E. (2013). Climate Finance for Agriculture and Livelihoods. ICRAF Policy Brief 15. Nairobi, Kenya. World Agroforestry Centre (ICRAF).

Franzel, S. (1999). Socioeconomic factors affecting the adoption potential of improved tree fallows in Africa *Agroforestry Systems,* 47: 305–321

Fraser, E. (2004). Land tenure and agricultural management: Soil conservation on rented and owned fields in Southwest British Columbia. *Agric Human Values* 21:73–79

Furrer, B., Hoffmann, V., and Swoboda, M. (2009). Banking & Climate Change:Opportunities and Risks An Analysis of Climate Strategies in more than 100 banks worldwide. *ETH Zurich and SAM,* June 9. Available at: http://ec.europa.eu/enterprise/policies/sustainable- business/corporate-social-responsibility/reporting-disclosure/swedish-presidency/files/surveys_and_reports/banking_and_climate_change_-_sam_group_en.pdf (Accessed 27April 2012).

Gakiru, M., Winters, K., and Stepman F. 2009. Inventory of Innovative Farmer Advisory Services using ICTs. The Forum for Agricultural Research in Africa, Accra, Ghana.

Garbach, K., Lubell, M., and DeClerck, F. (2012). Payment for Ecosystem Services: The roles of positive incentives and information sharing in stimulating adoption of silvopastoral conservation practices Agriculture, *Ecosystems and Environment* 156: 27– 36

Garbach, K., Mark, L., and DeClerck F.(2012). Payment for Ecosystem Services: The roles of positive incentives and information sharing in stimulating adoption of silvo pastoral conservation practices. *Agriculture, Ecosystems & Environment*, 156 (1): 27–36. Doi.10.1016/j.agee.2012.04.017

Garnett, T., Appleby, Balmford, A., Bateman, I., Benton,T., Bloomer, P., Burlingame, B., Dawkins,M., Dolan, M., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton,P., Toulmin,C., Vermeulen, S. and Godfray, H., (2013). Sustainable Intensification in Agriculture: *Premises and* Policies Science, 341(6141): 33-34

Garrity, P. (2004). Agroforestry and the achievement of the Millennium Development Goals Volume. *Agroforestry Systems,* 61-62: (1 – 3):5-17

Gebremedhin, B., and Swinton, M. (2003). Investment in soil conservation in northern Ethiopia: the role of land tenure security and public programs. *Agricultural Economics* 29: 69–84

Ghazoul, J., Garcia, C., and Kushalappa, C. (2011). Landscape labelling approaches to PES: Bundling services, products and stewards In: Ottaviani, D.and Scialabba, N. (Eds), Payments for Ecosystem Services and Food Security, FAO, Rome

Giller, K., Witter, E., Corbeels, M. and Tittonell, P. (2009). "Conservation agriculture and smallholder farming in Africa: *The heretics' view*, Field Crops Research 114: 23–34

Godquin, M., and Sharma, M. (2005). If only I could borrow more! Production and consumption credit constraints in the Philippines. IFPRI, Washington, DC

Gold, M. (1999). Sustainable agriculture: definitions and terms. Sustainable agriculture Terminology Beltsville, Md.: National Agricultural Library

Goldberg, M., and Palladini, E. (2010). Managing Risk and Creating Value with Microfinance. Washington D.C.: The World Bank.

Gondo, P. (2012). A review of forest financing in Africa. Southern Alliance for Indigenous Resources (SAFIRE), Zimbabwe. 129 p.

Gonzalez-Vega, C. (1993). 'From Policies, to Technologies, to Organizations: The Evolution of The Ohio State University Vision of Rural Financial Markets,' in Economics and Sociology Occasional Paper No. 2062, Columbus, Ohio: The Ohio State University.

Gonzalez-Vega, C., and Graham, H. (1995). 'State – Owned agricultural Development Banks: Lessons and Opportunities,'in Economics and Sociology Occasional Paper No. 2245 Columbus, Ohio: The Ohio State University.

Gössling, S., Broderick, J., Upham, P., Ceron, J., Dubois, G., Peters, P. and Strasdas, W. (2007). Voluntary carbon offsetting schemes for aviation: efficiency, credibility and sustainable tourism. *Journal of Sustainable Tourism*, 15(3): 223–248

gov.mb (2008). Next steps: 2008 Action on Climate Change. Agriculture: climate friendly farms http://www.gov.mb.ca/asset_library/en/beyond_kyoto/agriculture.pdf (Accessed 17 June 2014)

Green Markets International (2007). 'The Voluntary Carbon Market: Status & Potential to Advance Sustainable Energy Activities'. *Greenmarkets,* June 9. Available at: http://www.green-markets.org/Downloads/vCarbon.pdf (Accessed 27April 2012).

Greenresources (2014). Carbon offsets market – market overview http://www.greenresources.no/Carbon/CarbonMarkets.aspx (Accessed 27 April 2012).

Guirkinger, C., and Boucher, S. (2008). Credit Constraints and Productivity in Peruvian Agriculture. *Agricultural Economics,* 39: 295-308.

Gupta, S. (2008). "Microfinance in Africa: Harnessing the potential of a continent" *Microfinance Insights*, Vol. 9 Nov/Dec 2008, pp. 12-15.

Hall, A., Janssen W., Pehu E. and Rajalahti R. (2006). Enhancing agricultural innovation: how to go beyond the strengthening of research systems. Washington, D.C.: The World Bank;

Hamilton, K., Sjardin, M., Marcello, T. and Xu, G. (2008). Forging a frontier: State of the voluntary carbon markets 2008. Ecosystem Market Place and New Carbon Finance, Washington, D.C.

Han, L., Fraser, S., and Storey, D. (2009). The Role of Collateral in Entrepreneurial Finance. *Journal of Business Finance & Accounting*, 36: 424–455. doi:10.1111/j.1468-5957.2009.02132.x

Harrison, R., Jesusco, J., Sevare, M. and Mangaoang, E. (2009). 'Agroforestry farming practices of smallholders in Leyte and implications for agroforestry systems design,' Queensland: The University of Queensland

Hartemink, E. (2006). Soil fertility decline: denitions and assessment. In: Lal R (ed) Encyclopedia of soil science, vol 2, 2nd edn. CRC Press, Boca Raton, FL, USA, p 1923. Doi:10.1081/E-ESS-120041235

Hattingh, H., and Herzberg, A. (1980). "Ownership or leasing of agricultural land; production economics aspects", *Agrekon*, 19 (2):1-7

Havemann, T. (2011). Financing mitigation in smallholder agricultural systems: issues and opportunities', in E. Wollenberg, A. Nihart, M-L. Tapio-Biström and M. Grieg-Gran (eds.), Climate Change Mitigation and Agriculture, London: Earthscan.

Havemann, T., and Muccione, V. (2011). Mechanisms for agricultural climate change mitigation incentives for smallholders. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security; 2011. Available online at: www.ccafs.cgiar.org (Accessed September 15, 2013)

Hellings, B., Romijn, H. and Franken, Y.(2012). 'Carbon storage in Jatropha curcas trees in Northern Tanzania,' in *Fuels from Agriculture in Communal Technology (FACT)*, (1):1– 25

Henning, R. (2004). 'Jatropha curcas L. in Africa: Assessment of the impact of the dissemination of "the Jatropha System" on the ecology of the rural area and the social and economic situation of the rural population (target group) in selected countries in Africa,' *GFU*, June 9. Available at: http://www.underutilized-species.org/documents/publications/jatropha_curcas_africa.pdf (Accessed 27April 2012).

Hishigsuren, G. (2006). 'Information and Communication Technology and Microfinance: Options for Mongolia,' in *ADB Institute Discussion Paper*, (42):1 – 33

Honohan, P., and Beck, T. (2007). Making Finance Work for Africa. Washington, D.C.: The World Bank:

Hughes, P., and Mester, J. (1998). Bank capitalization and cost: Evidence of scale economies in risk management and signaling. *Review of Economics and Statistics* 80(2): 314-325

Huffman, W. (2001). Human capital: Education and agriculture. Handbook of Agricultural Economics, 1: 334-381.

Huffman, W., and Orazem, P. (2007). Agriculture and human capital in economic growth: Farmers, schooling and nutrition. Handbook of Agricultural Economics, 3: 2282-2341.

Hull, C. (2009). "*Risk Management and Financial Institutions*." New Jersey: Pearson

IEG World Bank (2011).**"**Climate Change and the World Bank Group: Climate Adaptation" Avaialable at: http://ieg.worldbankgroup.org/content/dam/ieg/climatechange/ccIII_approach_paper.pdf (Accessed 27 April 2012)

IFAD (2003). Agriculture marketing companies as a source of smallholder credit in Eastern and Southern Africa: Experiences, insights and potential donor role. Eastern and Southern African division, Available online at: http://www.ifad.org/ruralfinance/policy/pf.pdf (Accessed 15 September 2013)

IFAD (2013) Enabling poor rural people to overcome poverty in Kenya. Available at: http://www.ifad.org/operations/projects/regions/pf/factsheets/kenya.pdf (accessed 21 March 2014)

IFC (2007). Banking on sustainability: Financing Environmental and Social Opportunities in Emerging Market http://firstforsustainability.org/media/IFC%20Banking%20on%20Sustainability.pdf (Accessed 22 June 2014)

IFC. Doing Business (2013). Smarter regulations for small and medium scale enterprise. Washington D.C.: IBRD press; 2013 *(*doi: 10.1596/978-0-8213-9615-5) Available online at:http://www.doingbusiness.org/~/media/GIAWB/Doing%20Business/Documents/Annual-Reports/English/DB13-full-report.pdf (Accessed September 15, 2013)

Isham, J. (2000). The effect of social capital on technology adoption: evidence from rural Tanzania. Department of Economics and the Program in Environmental Studies, Middlebury College, Middlebury.

Jack, K., Kousky, C. and Sims, K. (2008). Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. Proc Natl Acad Sci USA 105:9465–9470.

Jama, B., and Pizarro, G. (2008). Agriculture in Africa: strategies to improve and sustain smallholder production systems. Ann N Y Acad Sci 1136: 218–232

Jamison, D., and Lau, L. (1982). Farmer education and farm efficiency. Johns Hopkins University Press; Baltimore.

Jarecki, M., and Lal, R. (2003). Crop Management for Soil Carbon Sequestration *Critical Reviews in Plant Sciences*, 22(5):471–502

Jayne T., Yamano T., Weber M., Tschirley D., Benfica R., Chapoto A. *and* Zulu B. (2003). Smallholder income and land distribution in Africa: Implications for poverty reduction. *Food Policy*, 28: 253–275

Jayne, T., Mathe, D. and Mghenyi, E.(2010). " Principal Challenges Confronting Smallholder Agriculture in Sub-Saharan Africa." *World Development,* 38(10):1384–1398.

Jensen, R., and Emily O. (2009). "The Power of TV: Cable Television and Women's Status in India with Robert Jensen." *Quarterly Journal of Economics*, 24(3): 1057-1094

Jessop, R., Diallo, B., Duursma, M., Mallek, A., Harms, J. and Manen,V. (2012). Creating Access to Agricultural Finance Based on a horizontal study of Cambodia, Mali, Senegal, Tanzania, Thailand and Tunisia. Agence Française de Développement (AFD) http://www.afd.fr/webdav/shared/PUBLICATIONS/RECHERCHE/Scientifiques/A-savoir/14-VA-A-Savoir.pdf (Accessed 25 October 2013)

Jimenez, G., and Saurina, J. (2004). "Collateral, type of lender and relationship banking as determinants of credit risk," *Journal of Banking and Finance,* 28: 2191-2212.

Jindal, R., Swallow, B. and Kerr, J. (2008). “Forestry-based carbon sequestration projects in Africa: Potential benefits and challenges.” *Natural Resources Forum*, 32 (2): 116 – 130 Doi. 10.1111/j.1477-8947.2008.00176

Johnston, Jr. D., and Jonathan Morduch (2007). “The Unbanked: Evidence from Indonesia.”*World Bank Economic Review*, 22 (3): 517-537

Jones, W., and Hiller, T. (2010). ‘Achieving Scale in Investment Global Risk and Opportunity from Climate Change, *UK's First Climate Change Risk Assessment (CCRA)*, June 9. Available at: http://www.foresight.gov.uk/index.asp (Accessed 25 October 2013)

Kaaria S., Njuki, J., Abenakyo, A., Robert, D. and Sanginga, C. (2009). Enabling rural innovation: empowering farmers to take advantage of market opportunities and improved livelihoods. In Sanginga, et al. (ed)., Innovation Africa: enriching farmers' livelihoods. Earthscan: London.

Kabamba, H., and Muimba-Kankolongo, A. (2009). Adoption and impact of conservation farming on crop productivity among smallholder farmers in Kapiri Mposhi District of Zambia. *Journal of Animal & Plant Sciences*, 3(2): 205 - 214

Kabwe, G., Bigsby H, Cullen R (2009). Factors influencing adoption of agroforestry among smallholder farmers in Zambia. Paper presented at the 2009 NZARES conference, Tahuna Conference Centre, Nelson, 27–28 Aug 2009

Kagwiria, J. (2013). Karama cluster growing strong. The international small group and tree planting program (TIST). Available at: https://www.tist.org/i2/docs/NL/2013.03.March.Mazingira%20Bora.6%20Languages.pdf (Accessed 25 July 2013)

Katchova, A., and Barry, P. (2005). ‘Credit Risk Models and Agricultural Lending.’ In *American Journal of Agricultural Economics*, 87(1): 194-205.

Khandker, R., and Faruqee, R. (2003). The Impact of Farm Credit in Pakistan. *Agricultural Economics*, 28:197–213.

Kiptot, E., Hebinck, B., Franzel, S. and Richards, P. (2007). Adopters, testers or pseudoadopters? Dynamics of the use of improved tree fallows by farmers in western Kenya. *Agric Syst.*, 94:509–519.

Kiptot, E., and Franzel, S. (2011).Gender and agroforestry in Africa: are women participating? ICRAF Occasional Paper No. 13. Nairobi: World Agroforestry Centre

Kiptot, E., and Franzel S. (2012). Gender and agroforestry in Africa: Who benefits? In Ramachandran N. and Garrity D. ed. Agroforestry - the future of global land use. Dordrecht; Springer

Kiyota, H. (2009). Efficiency of Commercial Banks in Sub-Saharan Africa: A Comparative Analysis of Domestic and Foreign Banks,' paper presented at the CSAE conference, 22 - 24th March, University of Oxford, U.K

Kloeppinger-Todd, R. and Sharma, M. (2010). Innovations in rural and agriculture finance. Wahington, DC: The World Bank.

Kodongo, O., and Kendi, L. (2013). Individual lending versus group lending: An evaluation with Kenya's microfinance data. Development Finance, 3: 99-108.

Kollmuss, A., Zink, H and Polycarp, C. (2008). Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards. Berlin: WWF Germany

Kossoy, A., and Guigon, P. (2012). 'State and Trends of the Carbon Market 2012'. Washington, D.C.: Westland Printers

Kreibich, N., Arens, C. and Hermwille, L. (2013). Quo Vadis, Africa? Update on the uptake of the CDM in Africa. JIKO Policy Paper 03/2013. Wuppertal; Wuppertal Institut für Klima, Umwelt, Energie

Knowler, D., and Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. *Food Policy*, 32:25–48

Lafourcade, A., Isern, J., Mwangi, P. and Brown M. (2005). 'Overview of the Outreach and Financial Performance of Microfinance Institutions in Africa.' Microfinance Information exchange (MIX), Nov. 10. Available at: http://www.ruralfinancenetwork.org/pubs/MIX%20Africa_Data_Study.pdf (Accessed 27 March 2011).

Lambrecht, B. (2009). Discussion of The Role of Collateral in Entrepreneurial Finance. *Journal of Business Finance & Accounting*, 36: 456–460. Doi: 10.1111/j.1468-5957.2009.02139.x

Lambert, O., and Ozioma, A.(2011). Adoption of Improved Agroforestry Technologies among Contact Farmers in Imo State Nigeria, *Asian Journal of Agriculture and Rural Development* 2(1): 1-9

Landell-Mills, N., and Porras, I. (2002). Silver Bullet or Fools' Gold? A Global Review of Markets for Forest Environmental Services and their Impact on the Poor, Instruments for Sustainable Private Sector Forestry Series, International Institute for Environment and Development (IIED), London

Lapenu, C., and Zeller M. (2001). "Distribution, growth and performance of microfinance institutions in Africa, Asia and Latin America," *FCND discussion paper 114,* Washington, DC: International Food Policy Research Institute (IFPRI)

Laura, S. (2010). "Conservation Agriculture and Sustainable Crop Intensification in Lesotho." Rome: FAO

Ledgerwood, J. (1999). Microfinance handbook: An institutional and financial perspective. World Bank: Washington, D.C.

Lehner, M. (2009). Group Lending Versus Individual Lending in Microfinance. University of Munich. Discussion paper 299 available at: http://www.sfbtr15.de/uploads/media/299.pdf (Accessed 27 August 2011).

Li, F., Wang, X., Zhang, Y. and Kou, Q. (2014). The economic impact of carbon pricing with regulated electricity prices in China :An application of a CGE approach – presented at the 17th Annual Conference on Global Economic Analysis "New Challenges in Food Policy, Trade and Economic Vulnerability": Foreign Investment in Land and Microfinance; Regulation of Food and Energy Markets June 18-20, Dakar, Senegal

Lipper, L., Neves, B., Wilkes, A., Tennigkeit, T., Gerber, P., Henderson, B. Branca, G. and Mann, W. (2011). 'Climate Change Mitigation Finance for Smallholder Agriculture*: A guide book to harvesting soil carbon sequestration benefits,'* Rome: FAO

Locatelli, B., and Pedroni, L. (2006). Will simplified modalities and procedure make more small-scale forestry projects viable under the clean development mechanism. *Mitigation and Adaptation Strategies for Global Change*, 11: 621–643

Louis, B. (2011).“Climate Change Financing What Are the Challenges and the Opportunities for Financing Agriculture in Africa?” Rome: FAO

Lubwama, B. (1999). Socio-economic and gender issues affecting the adoption of conservation tillage practices. P.G. Kaumbutho and T.E. Simaleng (ed.), Conservation Tillage with animal traction. A resource book of Animal traction Network for Eastern and Southern Africa (ATNESA).Harare; Zimbabwe.

Luedeling, E., Sileshi, G., Beedy, T. and Dietz, J.(2011). Carbon Sequestration Potential of agroforestry Systems in Africa In Kumar B.M. and Nair P.K.R. (eds.), Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges, Springer; Dordrecht. DOI 10.1007/978-94-007-1630-8_13

Lybbert, T., and Sumner, D. (2010). Agricultural technologies for climate change mitigation and adaptation in developing countries: policy options for innovation and technology diffusion. ICTSD –IPC Platform on Climate Change, Agriculture and Trade. Issue Brief No.6, International Centre for Trade and Sustainable Development, Geneva, Switzerland and International Food & Agricultural Trade Policy Council, Washington DC

Mahieux, T., Zafar, O. and Kherallah M. (2011). “Financing Smallholder Farmers and Rural Entrepreneurs through IFAD supported Operations in the Near East and North Africa”Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture 24-25 January, 2011, Rome

Manzeke, M., Mapfumo, P., Mtambanengwe, F., Chikowo, R., Tendayi, T. and Cakmak I. (2012). Soil fertility management effects on maize productivity and grain zinc content in smallholder farming systems of Zimbabwe. *Plant Soil* 361: 57–69

Marenya, P., and Barrett, C. (2007). Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya, *Food Policy,* 32: 515–536

Masiga, M., Yankel, C., and Iberre, C. (2012). Institutional innovation in African smallholder carbon projects. Case Study: The International small group tree planting program (TIST) Kenya. Copenhagen: Denmark CCAFS.

Mazvimavi, K., and Twomlow, S. (2009). Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. *Agricultural Systems,* 101 (1–2): 20–29

McCloskey, D.N., and Ziliak, S.T. (1996). The standard error of regressions. J. Econ. Lit. 34, 97 – 114.

McNeely, J., and Scherr S. (2006). Agroforestry and biodiversity conservation – traditional practices, present dynamics, and lessons for the future. *Biodiversity and Conservation,* 15:549–554

McIntyre, B., Herren, H., Wakhungu, J., and Watson, R. (2008). "Agriculture at a Crossroads: Sub-Saharan Africa (SSA) Report: International Assessment of Agricultural Knowledge, Science and Technology for Development" Island Press: Washington, DC

McNeely, A., and Scherr, S. (2006). Agroforestry and biodiversity conservation – traditional practices, present dynamics, and lessons for the future. *Biodiversity and Conservation,* 15:549–554

Mercer, D. (2004). Adoption of agroforestry innovations in the tropics: *A review Agroforestry Systems,* 204411: 311–328

Mercer, D. and Pattanayak, S. (2003). Agroforestry adoption by smallholders. In: Sills E. and Abt K. (eds) Forests in a Market Economy. Kluwer; Dordrech

Mhlanga, N. (2010). 'Private sector agribusiness investment in sub-Saharan,' Rome: FAO

Milde, H., and Riley, J. (1988). Signaling in Credit Markets. *The Quarterly Journal of Economics,* 103: 101-129. Doi:10.2307/1882644

Mitra, K., Reiss,C. and Capella, M. (1999). "An examination of perceived risk, information search and behavioral intentions in search, experience and credence services", *Journal of Services Marketing,*13(3): 208–228

MIX (2008). 'Sub-Saharan Africa Microfinance Analysis and Benchmarking Report,' *Microfinance Information eXchange (MIX),*' June 9, Available at: http://www.themix.org/sites/default/files/2008%20Africa%20Microfinance%20Analysis%20and%20Benchmarking%20Report%20-%20English.pdf (Accessed 27 April 2011).

MIX (2010). 'Sub-Saharan Africa Microfinance Analysis and Benchmarking Report,' *Microfinance Information eXchange (MIX)*,' June 9, Available at: http://www.themix.org/sites/default/files/096_MIX_Africa%20Report_05-05-2011.pdf (Accessed 27April 2011).

Miyazawa, I. (2012). What are Sustainable Development Goals? In IGES Rio+20 Issue Brief; Institute for Global Environmental Strategies: Hayama; Japan,

Mizrach, B. (2010). Does a Common Trend Exist Between EUA and CER prices? http://snde.rutgers.edu/pubs/%5B44%5D-2010_EUACER.pdf (Accessed 27April 2012).

Mohapatra, A. (2007). 'Stimulating small business for sustainable livelihoods of poor through urban micro-finance'. *Microfinance Focus*, 2: 9–14.

Montagnini, F., and Nair, P. (2004). Carbon sequestration: An underexploited environmental benefit of agroforestry systems. *Agroforestry Systems*, 61: 281-295.

Morton, J.F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proc Natl Acad Sci USA* 104(50):19680–19685

Muayila, K., and Tollens, E. (2012). Assessing the Impact of Credit Constraints on Farm Household Economic Welfare in the Hinterland of Kinshasa, Democratic Republic of Congo. *Africa Journal of Food, Agriculture, Nutrition and Development*. 12, 6095 – 6109.

Mucavele, F. G. (2009). True Contribution of Agriculture to Economic Growth and Poverty Reduction: Malawi, Mozambique and Zambia Synthesis Report. Paper presented at the meeting of the The 9th Annual Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN) policy dialogue, 31th Aug. – 4 Sept. Maputo, Mozambique

Mugagga F., and Buyinza M. (2013). Land tenure and soil conservation practices on the slopes of Mt Elgon National Park, *Eastern Uganda Journal of Geography and Regional Planning*, 6(7): 255-262

Mugwe, J., Mugendi, D., Mucheru-Muna, M., Merckx, R., Chianu, J. and Vanlauwe, B. (2009). Determinants of the decision to adopt integrated soil fertility management practices by smallholder farmers in the central highlands of Kenya. *Exp. Agric*, 45: 61–75.

Murdiyarso, D., and Herawati, H. (2005). "Carbon forestry: who will benefit? Proceeding of workshop on carbon sequestration and sustainable livelihoods". Jakarta: Inti Prima karya

Musara, J., Chimvuramahwe, J. and Borerwe, R. (2012). Adoption and Efficiency of Selected Conservation Farming Technologies in Madziva Communal Area, Zimbabwe: A Transcendental Production Function Approach. Bulletin of Environment. *Pharmacology & Life Sciences* 4(1): 27 - 38

Nair, P., Kumar, B. and Nair, D.(2009). Agroforestry as a strategy for carbon sequestration. *J. Plant Nutr. Soil Sci.*, 172: 10–23.

Ndayambaje, J., Heijman,W., Godefridus M. and Mohren, G.(2013). Farm woodlots in rural Rwanda: purposes and determinants. *Agroforestry Systems*, 87(4):797-814

Nicoll, C., Achim, A., Mochan, S. and Gardiner, B. (2005). Does steep terrain influence tree stability? A field investigation. *Can. J. For. Res*., 35: 2360 – 2367

Niemack, A., and Chevallier, R. (2010). An Overview of the Carbon Trading Landscape: Possibilities and Pitfalls for South Africa. South African Institute of International Affairs, Occasional paper 70. Johannesburg

Nyanga, P.H. (2012). "Food Security, Conservation Agriculture and Pulses: Evidence from Smallholder Farmers in Zambia" *Journal of Food Research*, 1(2): 120 – 138

Nyangena, W. (2008). Social determinants of soil and water conservation in rural Kenya *Environ Dev Sustain*, 10:745–767 DOI 10.1007/s10668-007-9083-6

Obi, A. (2006). "Trends in South African agricultural land prices." Publish doctoral dissertation, University of the Free State, Bloemfontein, South Africa available at: http://etd.uovs.ac.za/ETD- db/theses/available/etd-09252007-134444/unrestricted/ObiA.pdf (Accessed 27April 2012).

Oduol ,A., Binam, M., Olarinde, L., Diagne, A. and Adekunle, A.(2011). Impact of adoption of soil and water conservation technologies on technical efficiency: Insight from smallholder farmers in Sub-Saharan Africa. *Journal of Development and Agricultural Economics*, 3(14): 655-669

Ogada, J. (2012). Forest management decentralization in Kenya: effects on household farm forestry decisions in Kakamega, 2012 Conference, August 18–24, 2012. Foz do Iguacu, International Association of Agricultural Economists, Brazil.

Ogunlela, Y., and Mukhtar, A. (2009). 'Gender Issues in Agriculture and Rural Development in Nigeria: The Role of Women,' in *Humanity & Social Sciences Journal*, 4(1): 19-30.

Oke, A. (2007). "An empirical analysis of microcredit repayment in southwestern Nigeria. *Humanity & Social Sciences Journal*, 2(1): 63–74.

Oluoch- Kosura,, W., and Sikei, G. (2013). Africa agriculture status report: focus on staple crops. Alliance for a green revolution in Africa (AGRA), Nairobi: Kenya

Ottaviani, D. (2011). The role of PES in agriculture. In: Ottaviani, D.and Scialabba, N. (Eds), Payments for Ecosystem Services and Food Security, FAO, Rome,

Orodho, A. (2006). The role and importance of Napier grass in the smallholder dairy industry in Kenya. Available at: http://wwww.fao.org/AG/AGP/AGPC/doc/newpub/napier/napier_kenya.htm. (Accessed 27April 2012).

Paal, B., and Wisemann, T. (2006). Group insurance and lending with endogenous social collateral: Department of Economics University of Texas at Austin https://webspace.utexas.edu/wisemant/www/PaalWiseman.pdf (Accessed 27 April 2012).

Pagiola, S., Arcenas, A. and Platias, G. (2005). Can Payments for Environmental Services Help Reduce Poverty? An exploration of the Issues and the Evidence to Date from Latin America, *World Development* 33(2): 237–253 Doi:10.1016/j.worlddev.2004.07.011

Pandey, V. (2007). 'Urban microfinance: efforts towards a lasting impact', *Microfinance Focus* 2: 1–9.

Patel, A. (2010). Agricultural Credit by Commercial Banks in India: Need for Creating Enabling Environment available at: www.microfinancegateway.org/gm/document-1.9.49819/Agricultural%20Credit.pdf (Accessed 27April 2012)

Pattanayak, K., Mercer, E., Sills, E. and Yang, J. (2003). Taking stock of agroforestry adoption studies. *Agroforestry Systems*, 57: 173–186

Paulais, T., and Pigey, J. (2009). Adaptation and Mitigation: What Financing is Available for Local Government Investments in Developing Countries? Fifth Urban Research Symposium 2009.

Pederson, G. (2003). 'Rural finance institutions, markets and policies in Africa', paper presented at the Pre-IAAE Conference on African Agricultural Economics, 13–14 August 2003 Bloemfontein, South Africa.

Perez, C., Roncoli, C.,Neely C. and Steiner, L. (2007). 'Can carbon sequestration markets benefit low-income producers in semi-arid Africa? Potentials and challenges,' in *Agricultural Systems*, (94): 2–12.

Persson, A. (2011), Institutionalising climate adaptation finance under the UNFCCC and beyond: could an adaptation 'market' emerge? SEI Working Paper No. 2011-03, Stockholm

Peskett, L., Brown, J. and Schreckenberg, K. (2010). Carbon offsets for forestry and bioenergy: researching opportunities for poor rural communities. London: ODI

Peters-Stanley, M., and Hamilton, K. (2012). State of the Voluntary Carbon Markets 2012 available at http://www.forest-trends.org/documents/files/doc_3164.pdf (Accessed 21 February 2014)

Pfeifer, G., and Stiles, G. (2008). "Carbon Finance in Africa." Policy Paper presented at the "Africa Partnership Forum," November 17-18 Addis Ababa, Ethiopia

Place, F., Ajayi, C., Torquebiau, E., Detlefsen, G., Gauthier, M. and Buttoud, G., (2012). Improved Policies for Facilitating the Adoption of Agroforestry. *Biodiversity and Ecosystem Services - Science and Practice*, 4 : 113-128

Pollak, A. (1985). Approach to Families and Households. *Journal of Economic Literature*, 23( 2) : 581-608

Porteous, D. (2006). The Enabling Environment for Mobile Banking in Africa. London: DFID

Poulton, C., Dorward, A. and Kydd, J. (1998). The revival of smallholder cash crops in Africa: Public and private roles in the provision of finance. *Journal of International Development*, 10(1): 85–103

Poulton, C., Kydd, J. and Dorward A. (2006). Overcoming market constraints on pro-poor agricultural growth in Sub-Saharan Africa. *Development Policy Review*, 24 (3):243–277

Prakash, A., and Stigler, M. (2012). Part 1- People and demography. Available at: http://www.fao.org/docrep/015/i2490e/i2490e00.htm (Accessed 21 February 2014)

Pretty, J. (1999). Can Sustainable Agriculture Feed Africa? New Evidence on Progress, Processes and Impacts. *Environment, Development and Conservation*, 1: 253 – 274.

Pu, C., and Willi, S. (2013). Discount Rates, Default Risk and Asset Pricing in a Regime Change Model. In , When, C.S., , Hoppe, C and Gregoriou G.N (ed) Rethinking Valuation and Pricing Models: lessons Learned from the Crisis and Future Challenges Academic Press; Oxford

Rahm, M., and Huffman, W., (1984). The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables, *American Journal of Agricultural Economics* 66:405-413

Randhawa, B. and Gallardo, J. (2003). "Microfinance Regulation in Tanzania: Implications for Development and Performance of the Industry," The World Bank - Africa Region Working Paper Series 51:1- 48

Robert, C., Demirgüç-Kunt, A., and Morduch, J. (2009). Microfinance Meets the Market. *Journal of Economic Perspectives* 23: 167-192. doi 10.1257/jep.23.1.167

Rodrigues de Aquino, A., Aasrud, A. and Guimarães, L.(2011). Can Forest Carbon Finance Influence Land Tenure Security in Project Areas? Preliminary Lessons from Projects in Niger and Kenya. In Kumar B.M. and Nair P.K.R. (eds.), Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges, Springer; Dordrecht. DOI 10.1007/978-94-007-1630-8_13

Rogers, E. (2003). Diffusion of Innovations. Pp. 14 Free Press, New York, NY

Rondinelli, A. and Berry, M.(2000). Environmental citizenship in multinational corporations. S*ocial Responsibility and Sustainable Development*, 18(1): 70–84

Roshetko. M., Lasco, R. and de los Angeles, M. (2005). Smallholder agroforestry systems for carbon storage. *Mitigation and Adaptation Strategies for Global Change*, 12: 219–242

Rossi, A., and Lambrou Y. (2009), Making sustainable biofuel work for smallholder farmers and rural households: issues and perspectives. Rome: FAO.

Ryan, B., and Gross, N. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology*, 8: 15-24.

Sacerdoti, E. (2005). Access to Bank Credit in Sub-Saharan Africa: Key Issues and Reform Strategies, IMF Working Paper 5/166 : 1–38, Washington, DC

Sadoulet, E., de Janvry, A., and Benjamin, C. (1998). "Household Behavior with Imperfect Labor Market ". *Industrial Relations*, 37(1): 85-108

Sahan, E., and Mikhail, M. (2012). Private investment in agriculture . Oxfam Discussion paper. 26th September. Oxfam International. Available at: http://ageconsearch.umn.edu/bitstream/25121/1/wp787.pdf (Accessed 27April 2012).

Salami, A., Kamara, B. and Birxiova, Z. (2010). Smallholder Agriculture in East Africa: Trends, constraints and opportunities. African Development Bank Group Working Paper Series, No. 105, Tunisia; AfDB

Saliu, O., Alao, J. and Oluwagbemi, T. (2010). An Evaluation of Farmers' Participation in Afforestation Programme in Kogi State, Nigeria. *Journal of Agricultural Science*, 2:(3) 248 – 257 doi: 10.5539/jas.v2n3P248

Samek, H., Skole, D., Klinhom, U., Butthep, C., Navanugraha, C., Uttaruk, P. and Laosuwan. T. (2011). Inpang Carbon Bank in Northeast Thailand: A Community Effort in Carbon Trading from Agroforestry Projects. In Kumar B.M. and Nair P.K.R. (eds.), Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges, Springer; Dordrecht. Doi 10.1007/978-94-007-1630-8_13

Sanchez, P., Buresh, R. and Leakey, R. (1997). Trees, soils, and food security. *Philosophical Transactions of the Royal Society of London*, 352 (1356) : 949–961

Sanginga, P., Water-Bayer, A., Kaaria, S., Njuki, J. and Wettasihna, C. (2009). Innovation Africa: enriching farmers' livelihoods. London: Earthscan

Schick, A., and Steckel, R.H. (2010). Height as a proxy for cognitive and non-cognitive ability. NBER Working Paper No. 16570.

Schneider, H., Semenov, S., Patwardhan, A., Burton, I. , Magadza, D., Oppenheimer, M., Pittock, B., Rahman, A., Smith, B., Suarez, A. and Yamin, F. (2007). 'Assessing key vulnerabilities and the risk from climate change. Impacts, Adaptation and Vulnerability,' in Parry, Canziani, Palutikof, van der Linden and Hanson (eds.), Intergovernmental Panel on Climate Change, Cambridge University Press; Cambridge

Scherr, S. (1995). Economic analysis of agroforestry systems: the farmers´ perspective. In Current D., Lutz E., and Scherr S. Cost, Benefit and adoption of Agroforestry: project experience in Central America and Caribbean. Washington D.C.; The World Bank

Scherr, S. (1995b). Economic factors in farmer adoption of agroforestry: patterns observed in western Kenya, *World Development*, 23 (1995):787–804

Schipper, L., and Pelling, M. (2006). Disaster risk, climate change and international development: scope for and challenges to, integration. *Disasters*, 30 (1):19–38

Scholz, M. (2009). Rural Development through Carbon Finance: Forestry Projects under the Clean Development Mechanism of the Kyoto Protocol. Frankfurt; Peter Lang

Seeberg-Elverfeldt, C. (2010).'Carbon finance possibilities for Agriculture, Forestry and Other Land Use Projects in a Smallholder Context,' in *Environmental and natural resources management working paper 34*. Rome: FAO

Seeberg-Elverfeldt, C., and Gordes, A. (2013). Agriculture, forestry and other land use mitigation project database. Second assessment of the current status of land-based sectors in the carbon markets. Rome; FAO

Segrado, C. (2005). Case study: The involvement of commercial banks in microfinance: the Egyptian experience. University of Torino. Available at: http://www.saa.unito.it/meda/pdf/Case%20study_downscaling.pdf (Accessed 27April 2012).

Senkondo, E. (2000). Risk attitude and risk erception in agroforestry decisions: the case of Babati, Tanzania PhD thesis Wageningen University, Wageningen; CABI

Sewamala, F., Sperber, E., Zimmerman, J. and Karimli, L. (2010). 'The potential of asset-based development strategies for poverty alleviation in sub-Saharan Africa', *International Journal of Social Welfare*, 19: 433–43. Doi. 10.1111/j.1468- 2397.2010.00738.

Shames, S. and Scherr, J. (2010). Institutional models for carbon finance to mobilize sustainable agricultural development in Africa. Available at: http://www.ecoagriculture.org/documents/files/doc_335.pdf (Accessed 27 April 2012)

Shames, S. (2013). How can small-scale farmers benefit from carbon markets? Policy brief 8. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: *www.ccafs.cgiar.org* (Accessed 27 April 2012)

Shames, S., Wollenberg, E., Buck, L.E., Kristjanson, P., Masiga, M. and Biryahaho, B. (2012). Institutional innovations in African smallholder carbon projects.CCAFS Report no. 8. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: www.ccafs.cgiar.org. (Accessed 27 February 2011)

Sielhorst, S., Molenaar, W. and Offermans D. (2008), 'Biofuels in Africa: An assessment of risks and benefits for African wetlands,' *international*, June 9. Available at: http://www.wetlands.org/LinkClick.aspx?fileticket=vPIIvbwvqTs%3D&tabid=56 (Accessed 27 April 2012)

Silici, L. (2010). Conservation agriculture and sustainable crop intensification in Lesotho. Rome: FAO

Simtowe, F., Zeller, M. and Phiri, A., (2006). Determinants of Moral Hazard in Microfinance: Empirical Evidence from Joint Liability Lending Schemes in Malawi, International Association of Agricultural Economists, Annual meeting, August 12-18, 2006, Queensland, Australia.

Simtowe, F., Manfred, Z., Alexander, P., and Mburuong-run, J. (2007), "Determinants of moral hazard in microfinance: a study of group lending programs from Malawi using panel data" *Quarterly Journal of International Agriculture* ,46 (1): 69-84

Simtowe, F., Zeller, M., *and* Diagne, A. (2009). The impact of credit constraints on the adoption of hybrid maize in Malawi. *Review of Agricultural and Environmental Studies* 90: 5-22.

Sirrine, D., and Shennan, C. (2010). Comparing agroforestry systems *ex-ante* adoption potential and ex-post adoption : on-farm participatory research from southern Malawi, *Agroforestry Systems*, 79(2):253 - 266

Skees, R., and Barnett, J. (2006). "Enhancing microfinance using index-based risk-transfer products", *Agricultural Finance Review*, 66 (2): 235 – 250

Smith, J., and Scherr, S. (2002). "Forest carbon and local livelihoods: Assessment of opportunities and policy recommendations" *CIFOR Occasional Paper 37*, Jakarta; Indonesia.

Smith, J. (2002). Afforestation and reforestation in the clean development mechanism of the Kyoto Protocol: implications for forests and forest people. *Int. J. Global Environmental Issues*, 2(3- 4): 322 – 343

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Ric,e C., Scholes, B, and Sirotenko O. (2007). Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice,C., Scholes, R., Sirotenko, O., Howden, M., McAllister, T., Pan, G., Romanenkov, V., Schneider, U., Towprayoon. S., Wattenbach. M. and Smith, J. (2008). Greenhouse gas mitigation in agriculture. *Philosophical Transactions of the Royal Society*, 363:789–813

Solís, D., Bravo-Ureta, B. and Quiroga, R. (2007).Soil conservation and technical efficiency among hillside farmers in Central America: a switching regression model. *The Australian Journal of Agricultural and Resource Economics*, 51: 491–510

Soule, J., Tegene, A., and Wiebe K. (2000). Land tenure and the adoption of conservation practices, *American Journal of Agricultural Economics*, 82 (4): 993–1005

Speranza, I., Kiteme, B., and Opondo, M. (2009). Adapting public agricultural extension services to climate change: Insights from Kenya. Paper presented at the Conference on Human Dimensions of Global Environmental Change, 2nd – 4th December Panel 9: Vulnerability and Adaptation in Agricultural and Food Systems, Amsterdam; Netherland

Steckel, R.H. (1995). Stature and the standard of living. *J Econ Lit* 33: 1903-1940.

Steel, W. F and Andah, D.O (2003). 'Rural and microfinance regulation in Ghana: Implications for development and performance of the industry,' The World Bank Africa Regional Working paper Series No. 49, Washington, DC.

Stewart, R., van Rooyen C., Dickson, K., Majoro, M. and de Wet, T. (2010), "What is the impact of microfinance on poor people? A systematic review of evidence from sub-Saharan Africa." London: EPPI-Centre,

Stiglitz, J.E. and Weiss, A. (1981). Credit rationing in markets with imperfect information, *American Economic Review*, 71: 393–410

Streck, C., Burns, D. and Guimaraes, L. (2012). Incentives and benefits for climate change mitigation for smallholder farmers CCAFS Report no. 7. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org (Accessed 27 April 2012)

Su, X. (2012). A Re-Examination of Credit Rationing in the Stiglitz and Weiss Model."NHH Dept. of Finance & Management Science Discussion Paper 10. Bergen, Norway: Norwegian School of Economics.

Swinnen, J., and Gow, H. (1999). Agricultural credit problems and policies during the transition to a market economy in Central and Eastern Europe. *Food Policy*, 24: 21–47.

Syampungani, S., Chirwa,W., Akinnifesi, K. and Ajayi, C. (2010). The Potential of Using Agroforestry as a Win-Win Solution to Climate Change Mitigation and Adaptation and Meeting Food Security Challenges in Southern Africa. *Agricultural Journal*, 5(2):80-88. DOI: 10.3923/aj.2010.80.88

Tamazian, A., Chousa, J.P, and Vadlamannati, K.C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy*, 37:246–253

Tenywa, M., Rao, K., Buruchara, R., Kashaija, I., Majaliwa, J., Tukahirwa, J., Adekunle, A., Fatunbi, A., Mugabe, J., Wanjiku, C., Mutabazi, S., Pali, P., Mapatano, S., Lunze, L., Mugabo J and Ngaboyisonga, D.(2011). Institutional Innovations for Building Impact Oriented Agricultural Research, Knowledge and Development Institutions. *Journal of Agriculture and Environmental Studies*, 2(1): 24 - 55.

Tham-Agyekum, E., Appiah, P. and Nimoh, F. (2010). Assessing Farm Record Keeping Behaviour among Small-Scale Poultry Farmers in the Ga East Municipality. *Journal of Agricultural Science,* 2: 52 – 62.

Thangata, P., Mudhara, M., Grier, C. and Hildebrand, P. (2008). Potential for agroforestry adoption in Southern Africa: A comparative study of improved fallow and green manure adoption in Malawi, Zambia and Zimbabwe. *Ethnobotany Research & Applications*, 5:67-75.

The World Bank (2006). 'Africa Region: Making Finance Work for Africa,' Washington D.C: The World Bank

The World Bank (2007a). "Impact Evaluation for Microfinance: Review of Methodological Issues." Washington D. C: The World Bank

The World Bank (2007b). 'World Bank Assistance to Agriculture in Sub-Saharan Africa: an IEG review,' Washington, D.C: The World Bank.

The World Bank (2011a). "Congo community to use carbon payments to put kids through school: Reforestation project is DRC's first registered under Kyoto

Protocol.” News Release No. 2011/359/SDN available at: http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/Ibi_Bateke_registration_DRC_final.pdf (Accessed 27April 2012)

The World Bank (2011b). ‘First African Emission Reductions Purchase Agreement For Soil Carbon Signed In The Hague’ *Press Release No:2011 /165/SDN*, June 9. Available at: http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22753334~pagePK:34370~piPK:34424~theSitePK:4607,00.html (Accessed 27 April 2012)

The World Bank, (2011c), ‘Triple Win of Climate-Smart Agriculture put into Practice,’ June 9. Available at: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSDNET/0,,contentMDK:22842518~menuPK:64885113~pagePK:7278667~piPK:64911824~theSitePK:5929282,00.html (Accessed 27 April 2012)

Thierfelder, C., Cheesman,, S., & Rusinamhodzi, L. (2012). Benefits and challenges of crop rotations in maize-based conservation agriculture (CA) cropping systems of southern Africa. *International Journal of Agricultural Conservation*, 11:1–17 doi:10.1080/14735903.2012.703894

Thiombiano, L. and Meshack, M. (2009). “Scaling-up Conservation Agriculture in Africa: Strategy and Approaches,” Addis Ababa: FAO

Thomas, P., Dargusch, S., Harrison, S. and Herbohn, J. (2009). Why are there so few afforestation and reforestation Clean Development Mechanism projects? *Land Use Policy*, 27: 880–887

Thonabauer, G. and Nosslinger, B. (2004). ‘Rating Models and Validation: Guidelines on Credit Risk Management, Vienna: Oesterreichische Nationalbank.

Thorp, R., Stewart, F., and Heyer, A. (2005). When and how far is group formation a route out of chronic poverty? *World Development*, 33 (6): 907-920.

Tschakert, P. (2004). ‘Carbon for farmers: Assessing the potential for soil carbon sequestration in the old peanut basin of Senegal,’ in *Climatic Change*, 67(2-3): 273–290.

Tschakert, P. (2007). Environmental services and poverty reduction: Options for smallholders in the Sahel. *Agricultural Systems*, 94 (1): 75-86.

Tschirley, D. and Benfica. R. (2001). Smallholder Agriculture, Wage, Labour and Rural Poverty Alleviation in Land-Abundant Areas of Africa: Evidence from Mozambique. *Journal of Modern African Studies*. 39(2): 333-58.

Tubiello, F.N. (2011). Linking Climate Change Financing and Sustainability. Natural Resources Management and Environment Department, Rome; FAO

TIST (2012). "Planting Trees and Improving Agriculture for Better Lives." The International small group and tree planting program, April, 21 2010. http://www.tist.org/ (Accessed 27April 2012)

Udo de Haes, H.A., Snelder, D.J., and de Snoo G.R., The Potential of Sustainable Forestry Certification for Smallholder Tree Growing in Snelder and Rodel (ed.) Smallholder Tree Growing for Rural Development and Environmental Services: Lessons from Asia. Netherland; springer

Unruh, D., Houghton, A. and Lefebvre, P. (1993). Carbon storage in agroforestry: An estimate for sub-Saharan Africa. *Climate Research*, 3:39-52

UCB (2010). 'Uganda's Experience in Regulating Microfinance Deposit-taking Institutions,' Paper presented at the International Conference on Microfinance Regulation – Who Benefits? Conference, 15th - 17th March, Dhaka, Bangladesh

UNEP (2004). 'Sustainability Banking in Africa,' available at: http://www.unepfi.org/fileadmin/documents/sustainable_banking_africa_2004.pdf (Accessed 02 July 2011)

UNEP (2007). A New Approach to Credit Risk in Africa http://www.unepfi.org/fileadmin/documents/banking_on_value.pdf (Accessed 22 July 2014)

UNEP (2007a). 'Africa's Banks Starting to Rise to Challenge of Wider Environmental, Social and Governance Concerns,' *UNEP News Release 2007/22* June 9. Available at: http://www.unep.org/Documents.Multilingual/Default.Print.asp?DocumentID=512&ArticleID=5613&l=en (Accessed 27 March 2013)

UNEP (2007b). 'Banking on Value: A New Approach to Credit Risk in Africa,' Available at: http://www.unepfi.org/fileadmin/documents/banking_on_value.pdf (Accessed 27 March 2013)

UNFCC (2003). Simplified modalities and procedures for small-scale afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol and measures to facilitate their implementation. Available at: https://unfccc.int/files/meetings/cop_11/application/pdf/cmp1_20_simplified_modalities_small_scale_a_and_r_project.pdf (Accessed 27 May 2013)

UNFCCC (2005). Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol on its first session, held at Montreal from 28 November to 10 December 2005. Available at: http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=3 (Accessed 27 October 2012)

UNFCCC (2006)."Further guidance to an entity entrusted with the operation of the financial mechanism of the Convention, for the operation of the Special Climate Change Fund". Available at: http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/1_cp.12.pdf (Accessed 27April 2012)

UNFCC (2014). Approved simplified baseline and monitoring methodology for small-scale afforestation and reforestation project activities under the clean development mechanism. Available at: http://cdm.unfccc.int/methodologies/DB/7O930NO6FCXTRZI6WIVTF54TTWJM6I (Accessed 27 October 2012)

UKFG (2012). 'More Aid for African Agriculture Policy implications for small-scale farmers,' UK Food Group, June 9. Available at: http://www.ukfg.org.uk/docs/More_Aid_for_African_Agriculture_MAIN_REPORT.pdf (Accessed 27 October 2012)

Valdivia, C., M. Gold, M.,. Zabek. L., Arbuckle, J., Flora, C. (2009) Human and institutional dimensions of agroforestry in H.E. Garrett (ed.) North American

Agroforestry: An Integrated Science and Practice,. American Society of Agronomy, 677 S. Segoe Rd., Madison, WI 53711, USA.

Van der Horst, D. (2011). Adoption of payments for ecosystem services: An application of the Hägerstrand model. *Applied Geography*, 31: 668 - 676

Van Rooyen, C., Stewart, R. and De Wet, T. (2012). The Impact of Microfinance in Sub-Saharan Africa: A Systematic Review of the Evidence. *World Development*, 40: 2249–2262.

Verhoef, G. (2005). 'Globalization, concentration and regulation: Trends in the globalization of South African banking, 1990 – 2005,' University of Johannesburg, June 9. Available at: http://ehsanz.econ.usyd.edu.au/papers/Verhoef.pdf (Accessed 27 April 2012)

VCS (2007). 'The Voluntary Carbon Standard'. Available at http://www.v-c-s.org/ (Accessed 27 October 2012)

VCS, (2012). 'The VCS Project Database,' Voluntary carbon standard, June 9. Available at: http://www.vcsprojectdatabase.org/ (Accessed 27 March 2013)

VCS (2012b). AFOLU Non-Permanence Risk Tool. http://www.v-c-s.org/sites/v-c-s.org/files/AFOLU%20Non-Permanence%20Risk%20Tool,%20v3.2.pdf (Accessed 27 March 2013)

Waterford, S. (2008) Carbon credit prospectus http://swsecurities.co.za/files/carbon/Carbon%20Credit%20Note%20prospectus.pdf (Accessed 17 July 2014)

Wagner, D. (2004). Promoting Conflict Responsibility in the Developing World —The Role of Project Finance and Insurance in UNEP and IISD (ed) Investing in Stability: Conflict Risk, Environmental Challenges, and the Bottom Line. Geneva; witzerland

Wagstaff, P. and Harty, M.(2010). "The Impact of Conservation Agriculture on Food Security in three low veldt districts of Zimbabwe" *Trócaire Development Review*, 67-84

Webersik, C. and Wilson, C. (2009). Achieving environmental sustainability and growth in Africa: the role of science, technology and innovation. *Sustainable Development*, 17: 400–413. doi: 10.1002/sd.411

Wejnert, B. (2002). Integrating models of diffusion of innovations: A Conceptual Framework, *Annual Review of Sociology* (28): 297-326. DOI: 10.1146/annurev.soc.28.110601.141051

West, T. and Post, W.(2002). Soil Organic Carbon Sequestration by Tillage and Crop Rotation: *A Global Data Analysis Soil Science Society of America Journal,* 66: 1930-1946

Wette, H. (1983).Collateral in credit rationing in market with imperfect information. *American Economic Review*, 73: 442 – 445.

Wiebe, D., Soule, J. and Schimmelpfennig ,E. (2001). Agricultural productivity for sustainable food security in sub-Saharan Africa. In Lydia Zepeda (ed.) Agricultural Investment and Productivity in Developing Countries. Rome: FAO

Winchester, N. and Reilly,J.(2014).Contribution of biomass to emissions mitigation under a global climate policy. – presented at the 17th Annual Conference on Global Economic Analysis "New Challenges in Food Policy, Trade and Economic Vulnerability": Energy - Economy Interactions June 18-20. Dakar, Senegal.

Winters, P., Crissman, C. and Espinosa, P. (2004). Inducing the adoption of conservation tech-nologies: lessons from the Ecuadorian Andes, *Environment and Development Economics*, 9(5): 695 - 719

Wisniwski, S. (1998). 'Savings in the Context of Microfinance –Lessons Learned from Six Deposit-Taking Institutions,' *Paper presented at the Interamerican Microenterprise forum*, 26th -28th March,. Mexico-City, Mexico

Wollenberg, E., Higman, S., Seeberg-Elverfeldt, H., Neely, C., Tapio-Bistrom, M-L. and Neufeldt, H. (2012). Helping smallholder farmers mitigate climate change. CCAFS Policy Brief 5. Copenhagen, Denmark.

World Bank (2012). Adaptation trust fund-Update on Status of Resources and CER Monetization Program. Available online https://www.adaptation-fund.org/sites/default/files/AFB.B.20.Inf_.4%20Trustee%20Presentation%20on%20CER.pdf (Accessed 03 March 2012)

World Bank (2014). BioCarbon Fund: carbon finance unit of the World Bank https://wbcarbonfinance.org/docs/BioCarbon-Fund-Brochure-WebReady.pdf (Accessed 22 July 2014)

World Bank (2010). Carbon finance at the World Bank http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/For_Web_CF_at_ WB-web.pdf (Accessed 27 March 2013)

WSBI (2008). Microfinance services by savings banks in Africa: The sleeping giants have started moving, but where are they going? World savings banks and institute, June 9. Available at: http://www.wsbi.org/uploadedFiles/Publications_and_Research_%28WSBI_only%29/microfinance%20leadership%20of%20WSBI%20African%20members%20GB%20screenview5.pdf (Accessed 27 March 2013)

Wunder, S. (2007). The efficiency of payments for environmental services in tropical conservation. *Conservation Biology*, 21 (1): 48–58

Wunscher ,T., Engel, S. and Wunder, S. (2011). Opportunity Costs as a Determinant of Participation in Payments for Ecosystem Service Schemes paper presented at the European Association of Agricultural Economists Conference, 30$^{th}$ Aug. – 24$^{th}$ Sept. 24, Zurich, Switzerland.

Young, R., Curran, L. and Natilson, N.(2005), "Case Study on Profitability of Microfinance in commercial banks: Hatton National Bank, USAID. Available at: http://pdf.usaid.gov/pdf_docs/PNADD679.pdf (Accessed 27 April 2012)

Young, A. (1989). Agroforestry for soil conservation. CAB lnternational, Wallingford, UK, and International Center for Research in Agroforestry, Nairobi

Yesuf, M., and Kohlin, G. (2006). Market imperfections and farm technology adoption decisions: case study from the highlands of Ethiopia. Department of Economics, Goteborg, Sweden. Available at: http://www.rff.org/Events/Documents/Academic%20Seminar%20Series/Sustainable_Land_Management.pdf (Accessed 27.02.2014)

Zahidul Islam, K., Sipiläinen, T. and Sumelius, J. (2011). Influence of Credit Constraints on Technical, Allocative and Cost Efficiency in Peasant Farming in Bangladesh. *European Journal of Scientific Research*, 56: 229-243.

Zbinden, S., and Lee D., (2005). Paying for Environmental Services: An Analysis Of Participation in Costa Rica's PSA Program. *World Development*, 33( 2): 255–272 doi:10.1016/j.worlddev.2004.07.012

Zeller, M. (2001). On the safety net role of micro-finance for income and consumption smoothing. In: Lustig, N. (ed.). 2001. Shielding the poor: Social protection in developing countries, Washington, D.C.; The Brookings Institution and Interamerican Development Bank,

Zepeda, L. (2001). Agricultural investment production capacity and productivity. Rome; FAO

Zilberman, D., Lipper, L., and Mccarthy, N. (2008). When could payments for environmental services benefit the poor? *Environment and Development Economics*, 13: 255–278