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ESSAYS ON THE EFFECTS OF CLIMATE AND WEATHER VARIABILITY ON SUSTAINABLE LAND MANAGEMENT, CROP BIODIVERSITY AND POVERTY IN KENYA

PHD POST-FIELD WORK REPORT

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NOVEMBER 2013

ESSAY ONE

EFFECTS OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES ON POVERTY

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Developing countries are faced with various developmental challenges. Some of these challenges are increasing agricultural productivity, reducing poverty and increasing food security among others. In particular, agriculture sector plays a key role in the economic development of African countries. Most of the vulnerable groups in Africa depend on agriculture for their livelihood thus making agriculture development an important sector for poverty reduction (Salami et al., 2010; World Bank, 2008). However, with the current and the predicted trend of climate variability and weather variability, agriculture sector is at great risk (IPCC, 2007, 2012).

Agriculture is recognized as the backbone of the Kenyan economy. The sector directly contributes 24.5 percent of the Gross Domestic Product (GDP) and 27 percent indirectly. The sector is also a means of livelihood for many Kenyans since it employs 60 percent of the labor force and contributes 65 percent of the total exports as of year 2012 (Government of Kenya, 2013). Most of the poor people rely on agriculture as the source of livelihood thus making agriculture development a key sector for poverty reduction (Government of Kenya, 2007, 2010a). Further, majority of the Kenyan farmers are small scale and face a lot of challenges which include, limited productive land, climate and weather variability among others (Government of Kenya, 2010b).

Having recognized the importance of agriculture sector in poverty reduction, the Kenyan government formulated various strategies aimed at not only increasing agricultural productivity but also raising farmers’ income. Immediately after independence, the Kenyan government outlined the need to have proper management of land resources by adopting technologies that conserve productive land and water supplies (Government of Kenya, 1965). Land management practices were also emphasized in the development plan of 1964-1970 and that of 1994-1996 (Government of Kenya, 1964, 1994). The government through Swedish International Development Agency (SIDA) developed a National Soil and Water Conservation Project (NSWCP) in Machakos in 1974 with the aim of increasing food security and raising the living standards of rural population (Critchley, 1991). This project was widely accepted and promoted for adoption in various parts of the country.

Once the National Alliance of Rainbow Coalition (NARC) government took power in 2002, it recognized the continued decline in agriculture productivity and formulated an economic recovery strategy for wealth and employment creation which emphasized on revitalizing agriculture sector. The strategy recognized the use of inappropriate technologies as one of the causes of low agriculture productivity (Government of Kenya, 2003). Further, the government developed a land policy in 2009 which aimed at facilitating sustainable land management (SLM). This policy outlined the need for the government to promote the use of soil conservation technologies, use of traditional land conservation methods, controlling inappropriate land practices and establishing institutions that promote environmental conservation in order to increase agriculture productivity, ultimately raising the incomes of farmers' (Government of Kenya, 2009).

However, agriculture productivity still remains low even after the introduction of various SLM technologies (Government of Kenya, 2010b). Over the period of 2004 to 2009, productivity of various crops remained either constant or was on the decline. The cause of this low agricultural productivity could be explained by low adoption of modern technologies and adoption of inappropriate SLM techniques among other factors (NEMA, 2011). The continued trend in low agricultural productivity will be a hindrance to achieving the goals set out in Kenya's vision 2030 of improving farmers' welfare and alleviating poverty. Already, the country is lagging behind in terms of halving the population living in poverty by the year 2015 as outlined in the Millennium Development Goals (MDGs) (AUC et al., 2009).

Though poverty rate in Kenya is declining, majority of the rural people who highly depend on rain-fed agriculture as their main source of livelihood are still poor. The government views agriculture led growth as the most effective way of reducing poverty as compared to other sectors. The government recognizes the need to promote sustainable land management among the farmers' in order to stimulate rural economies, increase agriculture productivity and reduce food insecurity (Government of Kenya, 2010a).

Sustainable land management is defined as “the use of land resources, including soils, water, animals and plants, for production of goods to meet changing human needs, while simultaneously ensuring their environmental functions”. Further, Soil and Water Conservation (SWC) is defined as, “activities at the local level which maintain or enhance the productive capacity of the land in areas affected by, or prone to, degradation”. Finally, SWC technologies are defined as, “agronomic, vegetative, structural and/or management measures that prevent and control land degradation and enhance productivity in the field” (WOCAT, 2007, p.10). Some of these SWC technologies include: terracing, manuring /composting, crop residue, afforestation and mulching among others. Although the definitions SLM differ[1], there is a general consensus that SLM technologies are beneficial to farmers and to society at large. The benefits of adoption of these technologies ranges from increasing crop productivity (Kassie et al., 2010), mitigating the effects of climate change through carbon sequestration and adaptation to climate change through use of mulch in places where precipitation is erratic (Woodfine, 2009).

Adoption of SLM technologies in Kenya is still low due to various factors such as; inadequate social capital (Nyangena, 2008), absence of tenure security, household assets, characteristics of the farm, village institutions (Kabubo-Mariara et al., 2010a) and credit facilities (Alufah et al., 2012). However, these studies did not consider assessing the sensitivity of SLM technologies to climate and weather variability. Other studies (Arslan et al., 2013; Di Falco et al., 2013; FAO, 2011) sought to estimate how SLM technologies are sensitive to climate change but did not take into account the short term effects caused by weather variability. Therefore, it is still unclear how sensitive SLM technologies are to both climate and weather variability. Finally, since farmers adopt multiple SLM packages it is of great essence to understand how each particular technological package affects farmers’ welfare in order to promote adoption of high impact packages.

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[1] TerrAfrica defines sustainable land management (SLM) as the adoption of land use systems that, through appropriate management practices, enable land users to maximize the economic and social benefits from land while maintaining or enhancing the ecological support functions of the land resources.

1.2 Statement of the Problem

As illustrated in the background section, agriculture is the backbone of the Kenyan economy. The sector is a means of livelihood for many Kenyans who directly or indirectly depend on agriculture. Therefore, the development of agriculture sector plays an important role in poverty alleviation in the country. However, the sector is faced with increasing land degradation, low productivity (Government of Kenya, 2010b), climate and weather variability (Funk et al., 2010; IPCC, 2007). Among other factors, inappropriate land management technologies are attributed to low productivity and degradation of environment in Kenya (Muchena & Julie, 1997). To overcome these challenges, the Kenyan government has been promoting adoption of sustainable land management technologies among farmers' (Critchley, 1991; Government of Kenya, 2010a).

Though adoption of sustainable land management technologies is beneficial in increasing crop productivity, food security, mitigating and adapting to climate change (Kassie et al., 2010; WOCAT, 2007), the uptake of these practices is very low due to various constraints (Arslan et al., 2013; Di Falco et al., 2013; Kabubo-Mariara et al., 2010a; Nyangena, 2008; Teklewold et al., 2013). This study builds on (Kabubo-Mariara et al., 2010; Nyangena, 2008; Alufah et al., 2012) to assess the sensitivity of SLM technologies (terracing, crop rotation and grass strips) on climate and weather variability. It is important to understand the sensitivity of SLM technologies to climate and weather variability in order to know where a particular SLM technology is best suited given the increasing climate and weather variability.

Further, most of the previous studies (Arslan et al., 2013; Di Falco et al., 2013; Teklewold et al., 2013; Alufah et al., 2012; Nyangena, 2008; Kabubo-Mariara et al., 2010a) did not take into account that farmers adopt a combination of various SLM technologies technology at a point in time. Therefore, this study fills this research gap by estimating factors that determine adoption of a combination of SLM technologies. Further, the study estimates the effects of adoption of various combinations of SLM technologies on poverty. Understanding the effects of various combinations of SLM technologies comes in handy in promoting packages that have higher impact on farmers' welfare.

1.3 Objectives of the Study

1.3.1 General Objective of the Study

The general objective of this study is to estimate the effects of SLM technologies on poverty in Kenya.

1.3.2 Specific Objectives of the Study

The specific objectives include:

i. To analyze factors that determines adoption of a combination of SLM technologies (terracing, crop rotation and grass strips) in Kenya.
ii. To analyze the effects of different combinations of SLM technologies (terracing, crop rotation and grass strips) on poverty.

1.4 Research Questions

iii. What are the determinants of adoption of a combination of SLM technologies (terracing, crop rotation and grass strips) in Kenya?
iv. What are the effects of different combinations of SLM technologies (terracing, crop rotation and grass strips) on poverty?

1.5 Contribution of the Study

Agriculture sector is the main driver of the Kenyan economy but is experiencing low productivity. This low productivity has negative effect on poverty alleviation since majority of the rural poor are small scale farmers. Therefore, the need to have sustainable agriculture is paramount in order to reduce food insecurity and improve farmers' welfare (Government of Kenya, 2010a). This study contributes to the understanding of the determinants of adoption of combinations of SLM technologies (terracing, crop rotation and grass strips) and their specific impacts on poverty in Kenya. The knowledge of the determinants and the impacts of these technologies will enable policy makers device targeted strategies that would increase agriculture productivity, reduce poverty and conserve environment given the increasing climate and weather variability.

The contribution of this study is twofold. The first one is that previous studies on adoption of SLM technologies (Kabubo-Mariara et al., 2010a; Kassie et al., 2010; Nyangena, 2008; WOCAT, 2007) did not analyze the sensitivity of these practices to climate and weather variability. The exception are Arslan et al. (2013) and Teklewold et al. (2013) who focused on how SLM technologies are sensitive to rainfall variability and weather risks in Zambia and Ethiopia respectively. Thus this study assesses the sensitivity of SLM technologies (terracing, crop rotation and grass strips) to climate and weather variability. Understanding the sensitivity of these technologies to climate and weather variability is important given the changing climate. The study findings will be useful to both policy makers and farmers by providing information on which SLM technology packages best fits where given climate and weather variability.

The second contribution is based on the fact that previous studies (Kabubo-Mariara et al., 2010a; Kassie et al., 2010; Nyangena, 2008; Teklewold et al., 2013) investigated adoption of single SLM technologies without taking into account that farmers may adopt a combinations of packages at a point in time. This study therefore considers adoption of SLM packages/ combinations rather than single SLM technology since farmers make several adoption decisions simultaneous.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents both theoretical and empirical literature review on adoption of SLM technologies and on the relationship between poverty and SLM technologies. Section 2.2 presents theories on adoption of SLM technologies and on poverty and SLM technologies. Section 2.3 presents empirical literature review on adoption of SLM technologies and the effects of SLM technologies on poverty while section 2.4 presents the overview of the reviewed literature.

2.2 Theoretical Literature Review

This section presents theoretical literature review on adoption of SLM technologies and on poverty and SLM technologies.

2.2.1 Theories on Adoption of SLM Technologies

A number of theories have been developed to explain technology adoption in agriculture. Some of these theories include; induced technical and institutional innovations, collective action, market and institutional development and finally agricultural household models. Boserup (1965) developed the theory of induced institutional innovation where she argues that as population increases, natural resources become scarce leading to agricultural intensification. Thus population growth stimulates agricultural productivity and development leading to induced institutional innovations which affect farmers' decisions to adopt agricultural technologies.

Ruttan & Hayami (1984) developed the theory of institutional innovations and argues that institutional innovations are induced by resource endowments and technical change (new technologies). Further, the theory illustrates how property rights and non market institutions are induced by changes in resource endowment, new technologies and knowledge advances in social sciences.

Singh and Strauss (1986) developed Agricultural Household Model (AHM) that assumes that an agricultural household maximizes utility. Agricultural households are assumed to maximize their utility from consumption of farm produced goods and market purchased goods subject to farm production, budget and time constraints. This model further assumes that agricultural households make consumption decisions subject to agricultural production given that all markets exist. In the production decisions, agricultural households take into account both the external environment and social economic constraints. Pender et al. (2006) hypothesizes that adoption of SLM technologies depends on agro ecological condition of a certain area. The paper alludes to the fact that adoption of vegetative SLM technologies will be higher in areas that receive higher rainfall while adoption of SLM technologies will be higher in low rainfall areas.

2.2.2 Theories on Poverty and SLM Technologies

In the study of poverty, population and the environment, Mink (1993) argues that poor farmers have a short time horizon due to their high rate of pure time preference. The high rate of pure time preferences leads to high rate of resource extraction to meet today’s consumption needs and low investments in natural resources to meet the future consumption needs. Therefore, due to this short time horizon, poor farmers will have low chances of making natural resource investments whose returns are expected after a number of years. These natural resource investments may include investment in soil conservation and water harvesting technologies.

Following the debate on poverty-environment nexus, Reardon and Vosti (1995) developed a framework for analyzing the links between rural poverty and environment in developing countries where they introduced the concept of investment poverty. To establish the links between rural poverty and environment, the paper considers poverty in the context of asset categories and various categories of change in environment. The paper argues that the strength and direction of the poverty-environment links depend on composition of assets and the type of environmental problem that the rural poor face. Some households may have poverty levels above the poverty line but may lack key assets which are useful in enhancing adoption of land use practices. Thus investment poverty is considered to affect enhancement of natural resource base and that enhancing natural resource base can reduce poverty. Therefore, the level, distribution and type of poverty and the environmental problem under consideration determines the direction of causality between poverty and environment.

2.3 Empirical Literature Review

This section presents empirical review on adoption of SLM technologies and on poverty and SLM technologies.

2.3.1 Empirical Literature on Adoption of SLM Technologies

There is a huge literature on determinants of adoption of sustainable land management technologies. Arellanes and Lee (2003) investigated the determinants of adoption of Labranza minima (type of minimum tillage) in hillsides of Honduras using logistic regression found that household income and household characteristics of the farmer did not influence the decision to adopt minimum tillage. However, land tenure, slope of the land and whether farmer practiced irrigation were the main determinants of adoption of minimum tillage.

In Ethiopia, factors that determine the decision to adopt terracing and manure application as SLM technologies were investigated by (Heyi & Mberengwa, 2012). The paper found that access to extension services determined the adoption of both terracing and manure application. Livestock ownership was found to determine manure application but not terracing while access to credit had a negative influence on adoption of terracing. In the highlands of Tigray, Ethiopia, Pender and Gebremedhin (2007) found that access to credit, extension services, small landholdings and population pressure affected the intensity of crop production but had little effect on land management and agricultural production.

In Kenya, Ogada et al. (2010) analyzed the effects of production risk on smallholder farmers adoption of farm technology. The paper found that yield variability and risk of crop failure influenced adoption of farm technology. Specifically, the paper found that downward risk was an incentive to adopt terracing and increased the use of manure. Social capital was also found to influence the decision to adopt sustainable land management technologies (Nyangena, 2008).

Kabubo-Mariara et al. (2010a) investigated the effect of tenure security on SWC investments in Kenya. The paper employed factor analysis and reduced form models to analyze the adoption of SWC technologies. Land tenure security was found to be an important determinant of the choice and intensity of SWC investments while household assets, farm characteristics, village institutions and market access were found to influence adoption of SWC investments. Further agro ecological diversity and soil quality were found to influence adoption of SWC investments.

Mahmud and Pender (2006) investigated factors that determine adoption of SLM in the Ethiopian highlands and their impacts. Secure and easily transferable land tenure rights were found to be a key element in promoting long-term investment and facilitating the reallocation of factors of production in ways that maximized efficiency in their use. Based on nationally representative survey data, Deininger et. al. (2008) found that the impact of tenure insecurity on adoption of land management technologies varied across different types of investments. Transferable rights and more secure tenure significantly increased investment incentives on SLM technologies.

Bezabih et al. (2013) noted that the adoption of new farming technology through sustainable land management practices enabled farmers and communities to adapt to climate change by increasing food production and conserving soil and water thus enhancing food security and restoring productive natural resources. They further allude to the fact that complementary factors to soil conservation in the face of climate change aids in the design, implementation and adoption of sound conservation practices.

A growing body of literature identifies a strong link between climate change and soil conservation. For instance, Kassie et al. (2007) indicates that the effect of mean annual rainfall on the adoption of stone terracing varies based the on agro-ecology type of a place. Their findings show that there is significantly higher productivity benefit of the technology in conserving moisture in drier areas compared to higher rainfall areas. Similarly, based on a study of a sample of farmers in the Nile basin, Deressa et al. (2009) indicate that the probability of adopting soil conservation practices in drier regions is higher than that of wetter regions. The research shows a direct link between an increase in temperature and increasing the probability of using soil conservation by about 2.6%.

Access to credit and extension, and farmers’ awareness of climate change are some of the important determinants of farm-level adaptation of SLM and SWC technologies. In Tigray region of Ethiopia, insecure land tenure and the absence of local food-for-work projects are associated with short-term investments in soil bunds which are an SLM technology that helps to prevent soil erosion were employed. The use of drought resistant seed varieties, changing of planting dates, water management and irrigation, tree planting and SWC practices, are some of the adaptation options which have been suggested and used to counteract the negative consequences of climate change (Hengsdijk et al., 2005).

Jagger and Pender (2000) investigated the role of trees (Eucalyptus) for sustainable management of the less favored lands in Ethiopia and came to the conclusion that it was an ecologically appropriate species for sustainable land management in the Ethiopian highlands. They emphasize the complexities associated with the factors that determine the ecological impact of eucalyptus trees both on adjacent crops as well as on soil and water conditions in general. There was a notable decrease in crop output in some areas, however, the benefits derived in terms of slowing erosion and retaining soil moisture over the entire plot of land may compensate for the losses in crop production experienced within the zone affected by the presence of the trees. Such positive impacts encouraged the adoption of SLM.

Education plays a key role in the adoption of SLM such as the use chemical fertilizer under the different socioeconomic environments in Ethopia. It is hypothesized to affect agricultural productivity by enabling farmers to produce surplus from the available resources and enhancing their ability to acquire and evaluate information. Asfaw and Admassie (2004) conducted a research in which they considered education a key factor that affects decision on adoption. They investigated its impact on adoption decisions under the diverse socio-economic settings. The results indicated that the decision making process is decentralized and learned mature members of the family unit actively took part in the deciding process. Results from the study undertaken for the research implied that the expansion of education in countryside areas would be more appealing than in urban areas since knowledge is the only means to enhance the capability of farmers to attain, synthesize and respond to innovations such as chemical fertilizer. Educated people are more likely to achieve certain goals and function with higher competence and are more likely to take up new technologies in a less period of time than those who are uneducated. Skilled people can acquire, process, and construe available information, and be able to distinguish between potential and unpromising investments and make decisions more simply with relatively minimal errors.

In Haiti, the economics of implementation and managing of alley cropping as SLM technologies were investigated by (Bayard et al., 2007). Haitian people were facing serious problems of environmental degradation which threatened the economic livelihoods of many poor farmers. The paper found that the factors that influenced the adoption and management of alley cropping are such as membership to neighborhood peasant societies and training in soil management practice which favorably influenced taking up of SLM. Socio-economic aspects such as per capita income, gender and relations between education and per capita income also considerably influence adoption of alley cropping. Alley cropping improves soil fertility and controlled soil erosion. Field research documented positive response of crops such as maize, cassava and beans and indicated that the adoption of alley cropping was profitable in tropical regions. They noted that the decision to use an innovation is a process where different factors interact. It was indicated that the innovations perceived by farmers as having greater relative advantage, compatibility with past practices and the particular needs of the farmers and less complexity were adopted more rapidly than other innovations.

In Malawi, tenure security was investigated in relation to soil conservation by (Lovo, 2013). The sources of tenure insecurity range from lack of land titles (Bezabih et al., 2012), short-term tenancy contracts (Bandiera, 2007), lack of transferability and risk of expropriation (Deininger et al., 2008). The paper found that tenure security had important consequences on the conservation of natural resources. The paper shows that land titling alone cannot induce great investment in soil conservation under the existing customary inheritance systems which was insecure. Tenure insecurity is documented to account for a third of the long term loss in land productivity. According to the paper, in as much as insecure tenure decreases investment, investment itself could lead to higher tenure security if it can be claimed by the land user.

According to the sourcebook on SLM by the World Bank, SLM procedures help to integrate land, water, biodiversity, and environmental management so as to meet the rising food and fiber demands while sustaining ecosystem services and livelihoods. The book indicates that it is necessary to adopt SLM so as to meet the requirements of the rapid growing population. Improper land management can lead to land degradation and a significant reduction in the productive and service functions (World Bank, 2006) . Adoption of SLM includes measures to stop and reverse degradation or at least mitigate the effects of earlier misuse. Farmers who adopted SLM technology noted a significant increase per capita food increase.

In Eastern Uganda, SLM and technology adoption was investigated by (Woelcke et al., 2000). According to the paper, land degradation is a major factor contributing to declining agricultural productivity as well as to poverty and food insecurity. To address the issue of declining agricultural productivity the government adopted modernized agriculture as a poverty eradication plan and sustainable use of land. The key priority areas of the government were increasing research and technology development, promoting sustainable natural resource utilization, and providing opportunities for management and educational training in agriculture. Households in Eastern Uganda faced challenges in the adaptation of new technologies. These challenges include financial constraints and imperfect market conditions that compel farm households to adopt livelihood strategies that contribute to nutrient depletion. Sustainable agriculture is not pursued. SLM technologies should be made affordable and adoptable, especially to poor farmers.

In Western Kenya, Smeds (2012) investigated the factors influencing the level of adoption of sustainable agricultural land management (SALM) among farmers. The paper found that adoption of SALM provided a solution to land degradation and biodiversity losses. It also increases soils productivity, ensures food security for small-scale farmers and assists in climate change adaptation. The key factors affecting the adoption of SALM in Western Kenya are: access to money, land ownership and household decision making structures. Spread of knowledge on SALM, gender equality and resource mobilization are some of the suggestion that were put across in the paper as the ways of strengthening the adoption of farmers groups.

Kessler (2006) investigated the key factors influencing farm households’ investment in SWC. The paper found that the economic stratum of a family was a key factor influencing the adoption of SWC. The more the income a family generated from agriculture the higher the investment they were likely to put in SWC technology. The practices were easily adopted in fields that required the least efforts and were likely to yield more impact. The paper goes ahead to give recommendations on strategies that are aimed at motivating farmers to adopt SWC practices such as enhancing the profitability of agriculture and investing in satisfying households’ basic needs.

Bekele and Mekonnen (2010) investigated investment in land conservation in the Ethiopian highlands. In this research paper, they explored the factors that affect the farm households' decision at the plot level to spend in land conservation and how much of an investment theory are willing to commit, focusing on the roles of scarcity, tenure security and access to market. They found that the decisions to adopt land conservation and the amount of investment to make were explained by the fact that poverty-related factors had a varied effect on adoption and intensity decisions. The amount of conservation is determined by prospects of farming the land for a long term period and the farmer's belief of land ownership.

Lee (2005) investigated agricultural sustainability and adoption of technology. According to the United Nations, sustainable agriculture (SA) is resource conserving, environmentally non-degrading, technically appropriate, and economically and socially acceptable. These are the key aspects that SLM technology tries to achieve. The paper notes that there is consensus that the adoption of SA and natural resource management (NRM) practices uses less off-farm inputs, has improved management techniques and practices, and utilizes the locally available natural resources sustainably and purchased inputs more efficiently. It is a complementary and synergistic fashion that farmers are quickly embracing.

Alufah et al. (2012) did an analysis of factors influencing adoption of SWC technologies in Ngaciuma Sub-Catchment, Kenya. It was found that terracing, tree planting, agro forestry, cover cropping, mixed cropping and contour vegetation strip were major SWC technologies in the area. Household size, perception of soil erosion problem, training in soil erosion control, land ownership and access to institutional credit had significant effects on adoption of SWC technologies. In order to achieve sustainable watershed management, institutional and economic factors should be given special attention. It was also noted that there is need for sensitization of farmers so that they could form groups in order to access credit facilities which would enhance adoption of SWC technologies.

In Ethopia, Belay (2012) assessed the role of social learning institutions and social capital for soil conservation. According to his findings, for sustainable soil conservation measures to be adopted it requires the understanding of knowledge co-production. This kind of knowledge can be acquired through social learning. Social learning, social capital and institutions in soil conservation studies play a key role in the adoption of soil conservation innovations. This is because it creates opportunities for broader understanding on soil conservation and for the emergence of trust and mutual understanding among the actors. The paper recommends that soil conservation strategies should consider investing in social learning and the establishment of effective institutions in order to strengthen or create social capital which encourages voluntary adoption of soil conservation innovations.

Mackenzie et al. (2005) in their research paper summarized the factors that influence the uptake of sustainable land management practices by private and leasehold landholders with specific regard to wetland conservation on private land. It also makes recommendations concerning currently available incentive programmes so as to improve their efficiency. Some of the factors that influence the uptake of SLM include; land holder factors such as the financial stability of the land holder, program factors which include the financial incentives offered or the duration and continuity of the program and other external factors that influence the land owner's decision on the participation in SLM. Some of the recommendations that were made are inclusive of, education and extension and provision of incentives.

Waithaka et al. (2004) focused on farmers' perception towards technology and the impact that the perception has on the uptake of technology in central Kenya highlands. The paper employed ordered probit model to analyze the importance of technology attributes to adoption and the Tobit model to analyze the effects of perception on adoption of technology. The paper found that the most important characteristics of adoption of fodder legumes were dry season tolerance and economy on land. Therefore, in adoption of technology researchers should analyze those factors that farmers themselves perceive as important in their decision to adopt the technologies.

Paudel and Thapa (2004) analyzed the factors influencing the adoption of land management practices in two mountain watersheds of Nepal. Farmers in both watersheds have adopted several types of structural and biological land management practices to control land degradation. Some variables were also found to be significant in influencing the adoption of land management technologies. These variables included; extension service, class affiliation of farmers, household agricultural labor force, training on land management, schooling period of the household head, participation in joint land management activities and landslide density in farmlands.

Belay and Bewket (2013) investigated the influence of household's possession of livelihood assets on the use of manure for soil fertility replenishment in the highlands of Ethiopia. The investigation revealed that farmers' ownership of livelihood assets influence their use of manure to improve soil fertility. Number of livestock owned, plot distance from home, land to man ratio, maize-vegetable-fruit intercropping and using dung for household fuel were found to significantly influence farmers manure use as soil fertilizer. It was therefore recommended that the agricultural extension system should promote manure use for soil fertility improvement.

In a report on the best practices in SWC practices on cultivated land, Taye (2006) evaluates the performance of SWC practices that had been adopted and were used on cultivated land. Findings of the research indicate that farmers considered a range of criteria in the choice of SWC practices that they adopted, as opposed to control on soil erosion only. The criteria in the choice of alternative depended on attributes of the cultivated land such as the slope and soil type. Farmers made trade-offs between the efficacy of the measures and the investment associated with their preference of conservation practices. It was also noted that farmers had relevant knowledge and experience regarding suitability of the conservation measures, which can be used in conservation planning. The report recommended that farmers should be involved in conservation activities so to utilize their knowledge and experiences, and in turn facilitate wider acceptance SLM by the reluctant farmers.

In Burkina Faso and Guinea West Africa, Adesina and Baidu-Forson (1995) conducted a research on farmers' perception to agricultural technologies and how it affected their adoption behavior. The findings of the research indicate that the subjective preferences for characteristics of new agricultural technologies affect farmers' adoption decisions. The paper further argues that new farming technologies can be viewed as new products thus their demand is greatly influenced by individual consumer subjective preferences.

2.3.2 Empirical Literature on Poverty and SLM Technologies

In Uganda, Birungi and Hassan (2010) analyzed the effects of poverty, social capital and property rights on soil fertility management and conservation technologies found that poverty level, land tenure security and social capital determines adoption of land management technologies. The soil fertility management and conservation technologies considered in this study were fallowing, terracing and inorganic and organic fertilizers. Specifically, the study found that poverty level reduced the chances of adoption of organic and inorganic fertilizers and terracing but increased the chances of non adoption of land management technologies. On the other hand, social capital and land tenure security were found to increase the chances of adopting sustainable land management technologies. Adoption of fallowing and organic fertilizer was found to be positively influenced by land tenure security.

In Ethiopia, Pender and Gebremedhin (2007) investigated the determinants of land management practices and their impact on household income. The paper found that land management practices such as stone terracing, reduced tillage and reduced burning lead to increase in agricultural production ultimately increasing household incomes. Access to roads, population pressure, small farm size, extension services, irrigation and credit programs were found to have minimal impact on incomes and agricultural production.

Scherr (2000) investigated the relationship between poverty and natural resource degradation. The paper indicates that previous researches posited a ‘downward spiral’ of poverty and ecological dilapidation. In this model, the poor people placed an increasing pressure on the natural resource base which resulted from rapid population increase, inaccessibility to land or access to only poor or sensitive lands and limited resources for investment on sustainable resource management. This in turn resulted in environmental degradation that led to a decline in consumption, human health and food security. However, more recent studies reveal that although the poor may have inadequate resources, they have capacity to acclimatize to environmental degradation. This is either by mitigating its effects on their livelihoods or by rehabilitating degraded resources. Over time the local poor have developed practical and institutional innovation in natural resource management (NRM) to minimize risks and adapt to or mitigate degradation, even as pressures increase.

The local impact of population and market pressure resulting in community- level changes induces response in agriculture and NRM strategies at household and collective level. Such changes include: land use changes, investment in land, use intensity, input mix, management practices and collective action. Public policies and investments can influence poverty–agriculture–environment dynamics. For instance, public agricultural research investments and food price policies affect shift factors, while technical assistance influences response patterns. The most effective action for reducing poverty and environmental degradation depends on the dynamics of the local change process. Poor farming communities will certainly intensify in the coming decades and although the relationship between poverty and environment is highly variable, the ‘downward spiral’ is both avoidable and reversible in many circumstances. Poor people have an unrecognized potential for adaptation and innovation. Public policies can positively influence the micro-scale factors that determine how farmers adapt to environmental pressures. However, more pro-active policies are required to achieve environmental and anti-poverty objectives simultaneously, enhancing the access to and productivity of poor people’s natural resource assets and engaging them as partners in public resource management (Scherr, 2000).

In Zambia, Kabamba and Muimba-Kankolongo (2009) investigated the taking up and effect of conservation farming (CF) on crop productivity among small-scale farmers. Majority of the small scale farmers in Zambia are poor as a result of soil degradation due to persistent low input agriculture and poor farming systems over a long period of time. The paper found that crop productivity among small scale farmers is constantly low due to the poor and unsustainable farming systems. To offer a solution, conservation farming practices was adopted. This involves cropping with using least amount tillage or conservation tillage (CT), incorporating legumes in rotation and diversification of crops resulting in reduced soil erosion and better rain water infiltration. It also involved dry-season least land tillage, no burning and retention of crop residues, fixed planting stations and rotating with nitrogen-fixing crops for fertility re-compensation to soils. Conservation farming was adopted as a strategy among small scale farmers so as to increase soil organic carbon and organic matter levels. Efforts to extend the CF technology for general use among smallholder farmers have attracted strong support and interest from various institutions, such as government, private companies and nongovernmental organizations (NGOs). As a result, CF has been embraced as one of the official policies leading to more efforts towards expanding its adoption in order to achieve SLM. There was also a notable increase in the yields and generated profits for small-scale farmers, and enhanced their ability to withstand recurrent drought impact.

In Ethiopia, Kassie et al. (2007) noted that land degradation in the form of nutrient depletion and soil erosion presents a threat to food security and sustainability of agricultural production in the third world countries. Governments and development agencies invested considerable resources to promote soil conservation practices as part of an effort to enhance environmental condition and reduce poverty. This paper investigated the effect of stone bunds as an SWC technology. Plots with stone bunds were more fruitful than those without such technology in arid and semi arid land (ASAL) areas. This is because the benefits of conserving moisture by this technology are beneficial in dry areas.

According to World Bank (2009a) report on measuring the impacts of sustainable land management, it was noted that improvement in land management plays an important role in securing food and other services such as water supplies. The report recognizes that minimum attention has been given the monitoring and evaluation of SLM for its global benefits and long term impacts. Therefore, a project on 'Ensuring Impacts from SLM - Development of a Global Indicator System' was designed to address this shortcoming. The project came up with a suite of global and project-level indicators to measure global environmental benefits and local livelihood benefits of SLM. The indicators were used to measure impacts of their respective strategies to combat land degradation. The project addressed the knowledge management gaps in land degradation by providing the scientific-technical basis for selecting indicators to demonstrate the benefits, impacts and good practices of SLM projects. Some of the indicators that we formulated sought to establish the impact of SLM on poverty.

In a paper prepared by FAO (2009) on policy and financing for SLM in sub-Saharan Africa; SLM is at the centre of Africa's development challenges. According to the paper, land degradation impedes agricultural growth, increases poverty and vulnerability. It also contributes to social tensions as well as threatening biodiversity and the release of carbon through deforestation. SLM is increasingly recognized in national development plans and poverty reduction strategies. It has enabled land users to maximize the economic and social benefits from land while maintaining or enhancing the ecological support functions of the land resources. The dominance of land as a source of wealth in African economies makes land policy especially politically sensitive. The elites have a strong incentive to manipulate the land system to secure control of land resources, normally at the expense of the poor.

In Kenya, Kabubo-mariara et al. (2010b) investigated the importance of tenure security and investment in soil and water conservation strategies on household welfare. Household welfare was measured in terms of livestock wealth, property ownership rights and the willingness to invest in conservation structures. The impact of soil and water conservation as well as agro-ecological potential on household welfare suggested the existence of a poverty-environment link. Attempts at poverty alleviation have failed to bring adequate progress and development despite decades of development assistance. Population increase, poor initial resource endowments and policies against agriculture have failed to alleviate poverty. They have also led to the detriment of the natural resources on which the rural livelihoods depend on. According to the paper, agricultural stagnation and resource degradation are interlinked. Resource degradation results in declining agricultural productivity and reduced livelihoods options, while poverty and food insecurity in turn contribute to worsening resource degradation by households. The paper indicates that, poverty is not a direct cause of land degradation, but is a constraining factor on the rural households' ability to avoid land degradation or to invest in mitigating strategies since poor households are unable to compete for resources and are confined to unproductive areas, a situation that further perpetuates poverty. In Kenya, conservation and sustainable utilization of the environment and natural resources now form an integral part of national planning and poverty reduction efforts. Weak environmental management, unsustainable land use practices and depletion of the natural resource base have resulted in severe land degradation. This impedes increases in agricultural productivity and must be addressed in order to check its impact on poverty.

Haggblade et al. (2011) investigated the productivity impact of conservation farming (CF) on smallholder cotton farmers in Zambia. They noted that smallholder farmers faced shortages in labor, land, animal traction and financing that limited their access to improved technologies. The paper evaluates CF technology packages as possible means of increasing productivity and incomes among poor households and ensuring SLM. Some of the strategies employed in CF practiced in Zambia include: dry-season land preparation using minimum tillage methods; crop residue retention; seeding and input application in fixed planting stations; nitrogen-fixing crop rotations; and reduced but precise doses of mineral fertilizer. These practices reduce land degradation. They also improve soil fertility, soil structure and soil organic matter which has resulted in higher yield among the small-scale farmers. CF enables even the smallest, poor

Zambian farm households to achieve yield gains of about 40% over conventional tillage. This has helped to significantly reduce the poverty levels and land degradation and promote the adoption of conservation farming techniques.

In his research paper, Jalal (1993) recognized that Asia and the Pacific are the fastest growing region in the world. It is the home to large numbers of the poor and faces a major challenge in striking a balance between economic growth, poverty reduction and protection of the environment. In dealing with environmental problems of Asia and the Pacific as well as the promotion of environmentally sound and sustainable development, the key features of the region were noted. The region is home to 54 per cent of the world's total population and contains some of the world's most productive and ecologically sensitive areas, such as tropical forests, mangroves, and small islands and coral reefs. The region is also lacking in development and the process of development has caused and continues to cause environmental degradation. It is also noted that the poor people who earn less than a dollar exert tremendous pressure on the region's resources. The existing developments also continue to be unmindful of their negative consequences on the environment. In this paper, the researcher notes that environmental degradation, rapid population growth and stagnant production are closely linked with the fast spread of acute poverty in many countries of Asia. Some of the measures employed in Asia to address poverty and ensure sustainable land management are: the poor who were dependent on fragile lands, improved the management of natural resources and combined traditional wisdom with modern science and technology while the poor in areas of good agricultural potential, employed sustainable use of water resources and methods of pest and soil fertility management.

Holden (2006) investigated sustainable land management and poverty alleviation in the Ethiopian Highlands. In his research paper, he was investigating why farmers degrade the environment and the adoption of a sustainable green revolution for the Ethiopian highland. Increased land scarcity, fragmentation and landlessness among the poor have been the leading causes of land degradation. Peasants are generally unaware of the consequences of their land practices and the existence of better technologies. They are also too poor to afford investment required in conservation. The sustainable green revolution introduced a production system that can sustain its productivity level over time with existing technology, input levels and constraints that the system is facing especially the poor farmers. Farmers did not embrace SLM since the short term returns from conservation technologies are low and negative. This is because land was lost to the structures that were put up for CF and they made ploughing more cumbersome.

In Zimbabwe, Wagstaff and Harty (2010) studied the impact of conservation agriculture (CA) on food security. They noted that for substantial and equitable progress towards food security, there is need for investment in agricultural development with focus on poverty reduction, resilience to the effects of climate change and the rights and education of women farmers. CA is founded on three basic principles, which are: minimal soil disturbance, permanent soil cover and crop rotations. Its aim is to achieve sustainable and profitable agriculture which will improve the livelihood of farmers. Based on the research, investment in CA by the national government and donors has the potential to meet the above needs and greatly contribute towards poverty reduction and increased food supply while at the same time improve soil fertility and provide a range of environmental goods.

Kwazira et al. (2009) investigated the role of CA in increasing crop productivity for small holder farmers in Zimbabwe. The authors established that most small holder farmers apply unsustainable soil and crop management practices. More often, land preparation is at a low standard, planting is delayed and the crops are not well managed. Also there has been a notable increase in water supply and degradation of soil resources which greatly affect the sustainability of food production. This paper suggests that CA as an intervention can increase and sustain crop yield for the small holder farmers. It analyzes the factors that negatively affect crop productivity and address ways that CA can address them. Some of the solutions offered by CA for sustainable land management, increased crop production and reduced poverty are: reduced surface run-off through increased infiltration, efficient use of organic material and soil cover as manure, crop rotation with legumes and agro forestry and finally reduces pressure on marginal areas with farmers focusing on smaller land units.

In Ethiopia, Holden et al. (2003) assed the impact of planting trees as a strategy to reduce poverty in the less favored highlands. In the paper, the authors noted that poverty, low agricultural production and natural resource degradation are severe problems that are inter-related. Land degradation, population increase, outdated technology and drought threaten food security. There is need for urgent intervention to improve land quality and household welfare.

Tree planting (Eucalyptus) was noted to increase household income and was found to be a better way of using land sustainably. It provided a suitable technology for the less favored highlands since it had minimum negative effects on agricultural activities. Finally, the paper revealed that the areas that were unsustainable for crop production were suitable for tree planting.

In Niger, the government devised programs that promoted adoption of SLM and other activities with the aim of reducing poverty and vulnerability. Given this background, the World Bank (2009b) sought to evaluate the impact that these SLM programs had on land management and poverty in Niger. The paper established that there was interlink-age in the problems of poverty, vulnerability, land degradation and low agricultural productivity in Niger. Land degradation was found to be a major contributing factor to low agricultural productivity, poverty, and other social and environmental problems. SLM was an important measure and priority in Niger since it promoted water harvesting, SWC, tree planting and other measures to rehabilitate lands. The reported outcomes of these investments in SLM are: increased vegetation, reduced erosion, rehabilitation and increased use of degraded land, increased agricultural yields, more fodder for livestock, improved water availability, improved food security, improved welfare of vulnerable groups and reduce poverty. Tree plantations were the most common community land management investment promoted by the SLM program and the trees were valued for wood and fodder. This provided a source of income and substantially reduced poverty among those that embraced the technology. Adoption of many land management practices was inhibited by aspects of poverty since the poor farmers were limited by their minimal incomes and lack access to credit facilities.

According to Taye (2006) land degradation in the Ethiopian highlands is linked to population pressure and poverty in a complex web of cause and effect. Though population pressure could increase the intensity of labor and capital investment, intensification in agriculture is not well developed in the country, due to the influences of poverty. Hence, increasing rural population causes land shortage and lower yields. With shrinking land holding size, traditional systems of soil fertility maintenance (fallowing and crop rotations) could not stand anymore and artificial amendments using chemical fertilizers became expensive for resource-poor farmers. This has led to cultivation without sufficient technology, which often accentuates the processes of degradation.

Inappropriate policies and many years of political instability in the country have provided additional dimensions to the problem and thus have contributed to the vicious spiral of poverty and land degradation (Holden et al., 2003). The implications of land degradation are extremely important, since the livelihoods of many Ethiopians are entwined with land resources. Degradation reduces the production potential of land, making it difficult to produce enough to feed the growing population. It also increases farmers' vulnerability to food shortages and becomes a threat to the mere survival of the people. The looming food insecurity in the country is mainly linked to the prevailing degradation problem. Land conservation is therefore badly needed and SLM technologies ought to be adopted to alleviate the situation.

Deininger et al. (2008) in their research paper encouraged the planting of trees which was a cheaper investment than terraces to address the problem of soil erosion and reduced fertility. They identified resource poverty as the main factor leading to underinvestment in tree crops as poor farmers preferred to engage in subsistence farming for their daily livelihood with minimal surplus for sale. Finally, insecure land tenure was found to be a disincentive for farmers to invest in land improvements and conservation and therefore decreases agricultural productivity.

2.4 Summary of the Literature Review

This study focused on reviewing relevant theoretical and empirical literature on adoption of agricultural innovations and their impacts on poverty. It is evident that there are a number of theories that seek to explain adoption of agricultural innovations while others seeks to link poverty and improvement of natural resource base. The empirical literature reveals that various factors influence adoption of SLM technologies. Some of these factors include; household characteristics, village and farm characteristics among others. However, there is scanty information of how environmental factors, such as climate and weather variability affect the adoption of SLM technologies.

Findings from the literature review suggest that the adoption of SLM technology can result in a wining situation, where there is a simultaneous increase in agricultural productivity, reduced poverty and reducing land degradation. As it emerged in the literature review, some of the strategies that can be used to achieve this include promoting investment in SWC and agro forestry. Some strategies contribute to positive outcomes such as the adoption of SLM practices without offering any significant substitution. An example of these strategies are such as; road development, off-farm activities, education and the decision making process on adoption of SLM. However, other strategies involved substitution. For instance, investing in livestock may appear to improve household income but is also associated with the tendency to deplete more soil nutrients and a decreased tendency to fallow. The need to increase agricultural production so as to reduce the levels of poverty among the poor farmers is likely to cause more environmental degradation while promoting higher incomes. This is the case more often unless effort is made to restore soil nutrients. Presence of substitutions is not an argument to avoid these strategies. However, it demonstrates that there is need to recognize and find ways to mitigate such negative impacts where they are likely to occur. For instance, provision of education on the principles of sustainable land management and NRM in community is an important measure to address this challenge.

Further, empirical literature review on poverty and SLM technologies reveal the bicausality relationships between poverty and SLM technologies. Therefore, this paper seeks to analyze the effects of climate and weather variability on SLM technologies and assess the impacts of these SLM technologies on poverty taking into account the possible endogeneity problems.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the theoretical framework of the study, model specification, diagnostics and sources of data.

3.2 Theoretical Framework

To analyze factors that influence adoption of SLM technologies we follow the induced technical and institutional innovations theory developed by (Boserup, 1965) and the Agricultural Household Model (AHM) developed by (Singh & Strauss, 1986). The AHM assumes that farm households maximize their utility from consumption of farm produced goods and market purchased goods subject to budget constraints. Therefore, a farm household makes production decisions regarding what to produce, how to produce (technology choice) and when to produce. These production decisions are not only influenced by resource constraints but also by external factors such as agro ecological and social economic factors.

In making production decisions such as choice of technology, farmers take into account the external environment and social economic factors. Some of these technologies include SLM technologies that increases productivity, improves well being and have impact on sustainability. Therefore, combining farm household framework developed by Singh and Strauss (1986) with induced technical and institutional innovations theories, this study analyzes the determinants of adoption of SLM packages in Kenya. To analyze determinants of technology adoption by farmers we follow the Random Utility Theory (McFadden, 1981).

Random Utility theory assumes that individuals are rational decision makers who seek to maximize utility relative to their choices. As outlined by Cascetta (2009) consumer i, considers m_i mutually exclusive alternatives that are contained in choice set I^i. The consumer assigns perceived utility to each alternative j and chooses the alternative that maximizes his or her utility.

This utility depends on the attributes of the consumer and the alternative itself. Thus utility can be expressed as shown in Equation 3.1.

$$U_j^i = U^i \ X_j^i \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

Where; U_j^i is the utility of individual i derived from alternative j, X_j^i is a vector of characteristics of both the decision maker and the alternative j. However, the analyst does not observe utility U_j^i thus the utility is represented as a random variable. Therefore, the choice that an individual makes can be expressed as the probability of choosing alternative j conditional to the choice set. Thus an individual will choose alternative j if it gives higher utility than all other available alternatives as presented in Equation 3.2. Using Equation 3.2 it is possible to derive a statistical model by specifying a particular distribution of the disturbances. The two commonly used distributions for the disturbances are normal and logistic distributions which result to probit and logit models respectively (Greene, 2008).

$$P^i(J|I^i) = \Pr\{U_j^i > U_k^i \forall_k \neq j, k \in I^i\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

3.3 Model Specification

Based on the Random Utility Theory, the decision maker in this case a farmer, will choose from a number of SLM technologies, a package that gives the highest utility at a particular decision occasion t. Therefore, utility U_{ijt} of farmer i resulting from adoption of SLM package j at decision occasion t is composed of deterministic component (V_{ijt}) and stochastic error component that is assumed to follow Gumbel distribution (ε_{ijt}) as shown in Equation 3.3.

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.3$$

Farmers are assumed to adopt multiple SLM technologies, therefore using terracing, crop rotation and grass strips the study developed eight combinations/packages that farmers' could choose from. Since the decision to adapt a package is observable but farmers' utility is unobservable, the study uses latent variable, Y_{ijt}^*. Therefore, $Y_{ijt}^* = m$ if and only if $U_{ijt}^m > U_{ijt}^l$ for every $m \neq l$. Using the Generalized Linear Latent and Mixed Models (GLLAMM) estimation technique we can specify the utility differences as shown in Equation 3.4.

$$U^{m}_{ijt} - U^{l}_{ijt} = V^{m}_{ijt} + \varepsilon^{m}_{ijt} - \varepsilon^{l}_{ijt} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3.4)}$$

Equation 3.4 can be expanded to get Equation 3.5 as shown.

$$Y^{*}_{ijt} = U^{m}_{ijt} - U^{l}_{ijt} = \propto^{m} + \beta^{m\prime} X_{ijt} + \gamma^{m}_{j} + \delta^{m}_{ijt} + [\varepsilon^{m}_{ijt} - \varepsilon^{l}_{ijt}] \dots\dots\dots\dots\dots\dots \text{(3.5)}$$

From Equation 3.5 utilities from adopting SLM package are nested in fields that are nested in households. Y^{*}_{ijt} denotes utility differences and takes eight categories thus forming a multinomial logit model. The study will use stata package GLLAMM to estimate the model specified in Equation 3.5. Estimating Multinomial Logit model in GLLAMM relaxes the assumption of Independence of Irrelevant Alternatives (IIA) and accounts for the repeated nature of the decision choices made by farmers (Skrondal & Rabe-Hesketh, 2004).

From Equation 3.5, Y^{*}_{ijt} denotes the eight SLM packages adopted by farmer in a plot of land at decision occasion t, X is a vector of variables which include; land size, household size, land tenure system, highest level of education of the household head, age of the household head, gender and marital status of the household head, livestock ownership, distance to nearest motorable road, access to extension services, credit access, group membership, income, asset value, climate variability (measured by the coefficient of variation of both rainfall and temperature for the period ranging from 1960 to 2010) and weather variability (measured by the coefficient of variation of both rainfall and temperature for the year 2007 and 2010).

To estimate the effects of SLM technologies on poverty we follow endogenous switching regression analysis. In this specification we estimate the effects of adopting a certain SLM package on poverty by estimating the counterfactual of adopters and non adopters of SLM package. Thus in the first stage estimation the study specifies a probit model for decision to adopt SLM package. The study specified the probit model as shown in Equation 3.6.

$$\mathrm{A}^{*}_{\mathrm{i}} = \mathrm{Z}_{\mathrm{i}}\pi + \mu_{\mathrm{i}} \ \text{ where } \mathrm{A} = \begin{matrix} 1 \text{ if } \mathrm{A}^{*}_{\mathrm{i}} > 0 \\ 0 \text{ otherwise} \end{matrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3.6)}$$

From Equation 3.6, $\mathrm{A}^{*}_{\mathrm{i}}$is a latent variable that captures the expected net benefits from adopting SLM package, $\mathrm{Z}_{\mathrm{i}}$is a vector of factors that determine adoption of SLM package, π are parameters to be estimated and μ_{i} is error term. To estimate the effects of adopting SLM package on poverty we specify the following poverty Equations (Maddala, 1983).

Regime 1 (Adopter): $LnP_{1i} = X_{1i}\beta_1 + \varepsilon_i \qquad if\ A_i = 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3.7a)$

Regime 2 (Non Adopter): $LnP_{2i} = X_{2i}\beta_2 + \varepsilon_i \qquad if\ A_i = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots\ldots..(3.7b)$

Where $LnP_{1i}$and LnP_{2i} are poverty levels for adopters and non adopters, β is a vector of parameters to be estimated.

Using the endogenous switching regression procedure the study compares the observed and the counterfactual. Specifically the study calculates the effects of the treatment on the treated (TT) and effects of the treatment on the untreated (TU) where treatment is the adoption of SLM package. The study follows Heckman et al. (2001) and Di Falco et al. (2011) to estimate Equation 3.8.

$$TT = E\ \ LnP_{1i}\ A_i = 1\ \ - E\ \ LnP_{2i}\ A_i = 1\ \ = X_{1i}\ \ \beta_1 - \beta_2\ \ +\ \ \sigma_{1n} - \sigma_{2n}\ \ \lambda_{1i} \ldots\ldots.\ldots\ldots(3.8a)$$

$$TU = E\ \ LnP_{1i}\ A_i = 0\ \ - E\ \ LnP_{2i}\ A_i = 0\ \ = X_{2i}\ \ \beta_1 - \beta_2\ \ +\ \ \sigma_{1n} - \sigma_{2n}\ \ \lambda_{2i} \ldots\ldots\ldots\ldots(3.8b)$$

Where LnP denotes the logarithm of poverty, X denotes determinants of poverty which include: household size, land tenure system, highest level of education of the household head, age of the household head, gender and marital status of the household head, credit access, group membership, income, asset value, land size, distance from the household to the nearest motorable road, distance from the household to the nearest health centre, distance from the household to the nearest piped water source, dummy for weather household head earned cash from informal business/activities, dummy for whether household head earned income from salaried employment or wage activities.

3.4 Diagnostic Tests

Diagnostic tests are conducted to test for the violation of assumptions of classical linear regression model (CLRM). Therefore, to run Equation 3.5 we need to ensure that the CLRM assumptions are not violated. If any of the assumptions are violated we need to account for this violation in order to get unbiased, efficient and consistent estimates. Based on Gujarati (2003) the study will test for the presence of severe Multicollinearity and for serial correlation in the data. Further the study will test for Heteroskedasticity among other panel diagnostics (Greene, 2008).

3.5 Data Sources

The study used panel data for year 2007 and 2010 collected by Tegemeo Institute of Agricultural Policy and Development, Egerton University. Climate data (precipitation and temperature) for 1960 to 2010 was from Kenya Meteorological Department while data on inflation rates was from Africa Development Indicators.

CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the findings of the study and discusses the results. Specifically section 4.2 presents the descriptive statistics, section 4.3 presents the diagnostic test results and finally section 4.4 presents the regression results and their interpretation.

4.2 Descriptive Statistics

From Appendix 1, it is evident that the first three most popular SLM technologies are terracing, crop rotation and grass strips. Specifically, terracing was the most popular SLM technology adopted by farmers for both year 2007 and 2010, this was followed by grass strips and finally crop rotation. This study investigated the factors that determine adoption of these three SLM technologies and further assessed the effects of these SLM technologies on poverty. Out of these three SLM technologies, the study formulated eight packages/combinations that a farmer could choose from as shown in Table 4.1.

Table 4.1: Sustainable Land Management Technologies

Package	Terracing	Crop Rotation	Grass Strips
0	No	No	No
1	Yes	No	No
2	No	Yes	No
3	No	No	Yes
4	Yes	Yes	No
5	Yes	No	Yes
6	No	Yes	Yes

7	Yes	Yes	Yes

Yes denotes adoption of SLM technology while No denotes non adoption of SLM technology

From these eight packages, we investigated how they are distributed in 2007 and 2010. As shown in Table 4.2, the percentage of farmers who did not adopt any of the packages fell from 25.95 to 23.10 percent implying that there was an increase in adoption of SLM packages in 2010. However, there is mixed trend in adoption of various packages, for instance the package (2) that comprised of crop rotation, no terracing and no grass strip was adopted by 2.43 percent of farmers in year 2007 but in year 2010 the same package was adopted by 14.71 percent of farmers. On the other hand, package (5) that comprised of terracing, grass strips and no crop rotation was adopted by 31.77 percent of farmers in year 2007 but in year 2010 the same package was adopted by 15.03 percent of farmers. The distribution of these packages is spread across various fields that farmers cultivate. The distribution of the fields that farmers cultivate is presented in Appendix 2.

Table 4.2: Distribution of Packages in 2007 and 2010

	2007		**2010**	
Package	**Frequency**	**Percent**	**Frequency**	**Percent**
0	2,425	25.95	2,438	23.10
1	1,963	21.00	2,084	19.75
2	227	2.43	1,552	14.71
3	1,411	15.10	901	8.54
4	209	2.24	1,384	13.11
5	2,969	31.77	1,586	15.03
6	98	1.05	354	3.35
7	44	0.47	254	2.41
Total	9,346	100.00	10,553	100.00

This study defines a household to be composed of people who work together, farm together, sleep together, spend income together and eat from the same pot. In this regard, and as shown in Table 4.3, the mean of household size fell by 0.2 for the period 2007 to 2010. This reduction could be due to mortality or reduction in the number of children born in a particular household. The value of the logarithm of agricultural assets increased from a mean of 11.61 to a mean of 11.75 while that of income increased by 0.32 for period 2007 to 2010.

This implies that over the years, households were accumulating agricultural assets and that their total income was also increasing. The value of agricultural asset is calculated by summing the value of all agricultural assets and then adjusting the same for inflation. On the other hand, total income is calculated by summing net farm and net off farm income of a household and then adjusting for inflation. It is evident in Table 4.3 that the mean of land size fell by 0.56 for the period 2007 to 2010. This could be explained by high fragmentation of parcels of land. This study defines land size as the total land holding in acres that a household owns.

Further, the study calculated poverty level for each household. The study used income poverty rather than consumption poverty since the surveys capture little information on consumption expenditures. As noted by Tschirley and Mathenge (2003) there is little difference between studies that estimated poverty using household income data collected by Tegemeo Institute and studies that use expenditure data collected by Kenya National Bureau of Statistics (KNBS). Thus the study estimated poverty for each household by using inflation to deflate nominal household income to real income. Additionally to standardize real income, the study divided it by household size so as to get real income per capita.

More so, the study used linear extrapolation of KNBS rural poverty lines for year 2006 to compute the values of poverty lines for year 2007 and 2010. The KNBS nominal rural poverty line for 2006 was Kshs 1562 per month and the resulting linear extrapolated nominal poverty lines for 2007 and 2010 were Kshs 1598 and Kshs 1706 per month respectively. The study used inflation rate for year 2007 and 2010 to deflate these nominal poverty lines. Finally, the study divided real income per capita with real poverty lines and transformed this value into logarithm to get a proxy for poverty. From Table 4.3 the mean of poverty rose from 0.16 in 2007 to 0.46 in 2010 implying that there was a slight reduction in the levels of rural poverty.

The study calculated climate and weather variability using coefficient of variation. Specifically, the study used temperature and precipitation data for 26 weather stations located across the country for the period between 1980 and 2010. Monthly total precipitation was summed for each year and its average and standard deviation computed. To calculate climate variability in terms of precipitation, the study used coefficient of variation for 30 years period while for weather variability (precipitation) the study used coefficient of variation for year 2007 and 2010 respectively.

On the other hand, maximum and minimum temperature data was collected for each weather station. The study used maximum and minimum temperature to calculate the average temperature per month and further the average temperature per year. Using the average temperature per year, the study computed the coefficient of variation for a period of 30 years[2] and for year 2007 and 2010[3] for each weather station.

Given the GIS coordinates of the 26 weather stations, the values of climate and weather variability at each weather station and the GIS coordinates of each household, the study used inverse distance weighting interpolation method to compute climate and weather variability for each household. As shown in Table 4.3, the mean of climate variability in terms of precipitation and temperature was 0.24 and 0.04 respectively. The mean of weather variability in terms of precipitation and temperature for year 2007 were 0.81 and 0.19 respectively while that of 2010 was 0.85 and 0.17 respectively. It is evident that weather variability which is measured by variability in temperature decreased by 0.02 while weather variability which is measured by variability in precipitation increased by 0.04.

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[2] This gives a measure of climate variability in terms of temperature

[3] This gives a measure of weather variability in terms of temperature

Table 4.3: Descriptive Statistics for variables used in the Analysis

Variable	2007				2010			
	Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Household Size	6.99	3.05	1	24	6.79	3.15	1	27
Age of the household head	58.40	13.00	23	107	60.24	12.93	20	98
Gender of the household head (1 for female and 0 for male)	0.21	0.41	0	1	0.25	0.43	0	1
Marital Status1 (Dummy variable for single)	0.01	0.11	0	1	0.01	0.10	0	1
Marital Status2 (Dummy variable for married)	0.76	0.42	0	1	0.73	0.45	0	1
Marital Status3 (Dummy variable for divorced and separated)	0.01	0.11	0	1	0.01	0.12	0	1
Marital Status4 (Dummy variable for Widowed)	0.21	0.41	0	1	0.24	0.43	0	1
Highest education1 (Dummy variable for Primary Level)	0.53	0.50	0	1	0.53	0.50	0	1
Highest education2 (Dummy variable for Secondary Level)	0.22	0.41	0	1	0.21	0.41	0	1
Highest education3 (Dummy variable for Advanced Level)	0.02	0.13	0	1	0.02	0.13	0	1
Highest education4 (Dummy variable for College Level)	0.05	0.22	0	1	0.06	0.24	0	1
Highest education5 (Dummy variable for University Level)	0.01	0.09	0	1	0.01	0.10	0	1
Natural Logarithm of value of Agricultural Asset (Kshs)	11.61	1.23	7.6	17.3	11.75	1.29	8.0	16.7
Natural Logarithm of household Income (Kshs)	11.86	0.91	3.9	16.1	12.18	1.00	7.3	16.2
Land Tenure1 (Dummy variable for owned land with title deed)	0.52	0.50	0	1	0.56	0.50	0	1
Land Tenure2 (Dummy variable for owned land without title deed)	0.41	0.50	0	1	0.37	0.48	0	1
Land Tenure3 (Dummy variable for rented land)	0.05	0.22	0	1	0.05	0.21	0	1
Land Tenure4 (Dummy variable for land owned by parents)	0.02	0.13	0	1	0.02	0.14	0	1
Land Tenure5 (Dummy variable for land owned by government)	0.00	0.01	0	1	0.01	0.08	0	1
Credit Access (1 for household accessed credit and 0 otherwise)	0.93	0.25	0	1	0.29	0.45	0	1
Owned Livestock (1 for own livestock credit and 0 otherwise)	0.99	0.11	0	1	0.98	0.14	0	1
Extension Serv (1 for accessed extension service and 0 otherwise)	0.63	0.48	0	1	0.57	0.50	0	1
Group membership (1 for member of group and 0 otherwise)	0.81	0.39	0	1	0.76	0.43	0	1
Distance from the household to the nearest motorable road (Km)	0.46	0.76	0.01	10	0.42	0.83	0	15
Distance from the household to the nearest health centre (Km)	2.95	3.00	0.03	47	2.83	2.36	0.01	18
Distance from the household to the nearest piped water (Km)	3.82	5.76	0	51	3.94	6.27	0	52
Total land holding in acres that a household own	6.21	12.99	0	300	5.65	10.98	0	157

Household head earned cash from informal business/activities	0.48	0.50	0	1	0.37	0.48	0	1
Household head earned income from salaried employment	0.46	0.50	0	1	0.50	0.50	0	1
Ln Poverty (Measured by household income)	0.16	0.91	-8.15	4.03	0.46	1.01	-4.85	3.83
Climate variability (precipitation)	0.24	0.11	0.11	0.54	0.24	0.10	0.1	0.5
Climate variability (Temperature)	0.04	0.04	0.02	0.17	0.04	0.04	0.02	0.2
Weather variability (Temperature)	0.19	0.36	0.03	1.34	0.17	0.36	0.03	1.4
Weather variability (precipitation)	0.81	0.32	0.49	1.46	0.85	0.32	0.4	1.6

4.3 Diagnostic Results

The study conducted various diagnostic tests to ensure that we fit the correct model. It was evident that climate variability measured in terms of variability in precipitation was the only variable that was causing severe multicollinearity. To account for multicollinearity we dropped climate variability which is measured by variability in precipitation.

4.4 Regression Results

To analyze the determinants of adoption of a combination of sustainable land management practices (terracing, crop rotation and grass strips) in Kenya, the study specifies a panel Multinomial Logit model. Specifically the study employs the Generalized Linear Latent And Mixed Models (GLLAMM) in order to take into account the repeated nature of the choice of SLM packages and the effects of clustering (Skrondal & Rabe-Hesketh, 2004). However, before running GLLAMM in Stata, the study estimated the determinants of adoption of SLM packages using pooled multinomial logit regression and the results are presented in Table 4.4. The results from pooled multinomial logit regression shows that gender, highest level of education, income, tenure system, credit access, group membership, distance to motorable road, land size and weather variability in terms of precipitation and temperature were significant determinants of adoption of a package (1) that was composed of terracing, no grass strips and no crop rotation.

Further, adoption of a package (2) that was composed of crop rotation, no terracing and no grass strips was influenced by household size, age, gender, highest level of education, income, tenure system, credit access, distance to motorable road, climate variability (temperature) and weather variability in terms of precipitation and temperature. Adoption of package (3) that comprised of grass strip, no terracing and no crop rotation was influenced by household size, age, gender, highest level of education, income, tenure system, credit access, group membership, land size, climate variability (temperature) and weather variability in terms of precipitation and temperature.

The results further shows that adoption of package (4) that comprised of terracing, crop rotation and no grass strips was influenced by household size, age, gender, highest level of education, income, tenure system, credit access, distance to motorable road, land size, climate variability (temperature) and weather variability in terms of precipitation and temperature while package (5) that comprised of terracing, grass strips and no crop rotation was determined by household size, gender, highest level of education, income, tenure system, credit access, access to extension services, group membership, distance to motorable road, land size, climate variability (temperature) and weather variability in terms of precipitation and temperature.

Household size, age, gender, highest level of education, income, tenure system, credit access, livestock ownership, access to extension services, group membership, distance to motorable road, land size, climate variability (temperature) and weather variability in terms of precipitation and temperature were found to significantly influence adoption of package (6) that is composed of crop rotation, grass strips and no terracing. Finally, adoption of package (7) which is comprised of terracing, crop rotation and grass strips was found to be determined by household size, gender, highest level of education, income, tenure system, credit access, group membership, land size, distance to motorable road, climate variability (temperature) and weather variability in terms of precipitation and temperature in Kenya as shown in Table 4.4.

Table 4.4: Pooled Multinomial Logit Regression

Variable	**Packages**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Household size	0.995	0.97**	0.954*	0.959*	0.958*	0.869*	0.660*
Age of the household head	0.999	0.99*	0.991*	0.993*	1.003	0.972*	0.994
Gender of the household head	0.588*	0.68*	0.639*	0.802*	0.743*	0.302*	0.10*
Highest education2	1.47*	2.11*	1.061	2.343*	1.589*	0.323*	0.695
Highest education3	0.956	1.7***	1.064	1.217	2.068*	1.095	0.000
Highest education4	1.4**	1.97*	1.041	1.911*	0.984	0.49**	0.33**
Highest education5	0.6***	0.00	1.478	7.625*	2.524*	0.43***	0.000
Natural Logarithm of household Income	1.16*	1.26*	1.1**	1.23*	1.243*	1.21**	2.9*
Land Tenure2	1.29*	0.73*	1.33*	1.218*	1.403*	0.73**	1.5**
Land Tenure3	1.00	0.90	1.37*	1.170	0.903	3.97*	1.505
Land Tenure4	0.44*	0.17*	0.57*	0.101*	0.442*	0.594	0.401
Land Tenure5	2.61**	3.8*	0.00	0.000	0.000	0.000	0.000
Credit Access	1.14*	2.5*	0.84*	2.328*	0.739*	3.066*	1.708*
Owned Livestock	0.76	1.43	0.88	0.699	0.857	8.865*	0.000
Extension Service	1.05	0.95	1.03	0.970	0.676*	0.77**	1.092
Group membership	0.61*	0.90	0.71*	1.1***	0.361*	0.138*	0.7***
Distance from household to nearest motorable road (km)	1.1***	0.68*	0.98	0.89**	0.9***	0.70**	1.050
Land size in acres	1.01*	1.00	0.98*	0.984*	0.976*	1.016*	0.902*
Climate variability (Temperature)	0.58	3677*	7374*	10151*	18942*	293600*	5770*
Weather variability (Temperature)	0.8***	6.09*	4.5*	1.733*	1.469*	19.1*	1.61**
Weather variability (precipitation)	5.0*	0.22*	1.4**	0.632*	5.639*	1.63***	1.95**

Reference category package 0, highest education1, land tenure1, (*), (**) and (***) denotes 1%, 5% and 10% level of significance, Number of obs = 17870, LR chi2 (154) = 7700.27, Prob > chi2 = 0.0000 Log likelihood = -28550.92, Pseudo R2 = 0.1188.

To analyze the effects of different combinations of SLM technologies on poverty we use endogenous switching regression analysis. The study chose this methodology in order to account for endogeneity and sample selection bias. The endogenous switching regression results are presented in Table 4.5. The results in Table 4.5 are the preliminary analysis for the treatment effects thus the study will further estimate predicted outcomes in order to compute treatment effects of each SLM package.

Table 4.5: Endogenous Switching Regression for Package Two

	Coefficient	Std. Err.	z	P>z
Lnpoverty0				
Household size	-0.150*	0.0004	-330.5	0.000
Age of the household head	0.003*	0.0001	25.69	0.000
Gender of the household head	0.049*	0.0037	14.62	0.000
Natural Logarithm of value of Agricultural Asset (Kshs)	-0.003**	0.0014	-2.47	0.013
Natural Logarithm of household Income (Kshs)	0.983*	0.0019	510.19	0.000
Credit Access	-0.023*	0.0020	-11.74	0.000
Group membership	0.032*	0.0034	9.28	0.000
Distance from the household to the nearest motorable road (Km)	-0.001	0.0017	-0.84	0.401
Total land holding in acres that a household own	0.001*	0.0001	5.83	0.000
Distance from the household to the nearest health centre (Km)	-0.002*	0.0005	-3.43	0.001
Household head earned cash from informal business/activities	-0.014*	0.0029	-4.98	0.000
Household head earned income from salaried employment	-0.027*	0.0028	-9.74	0.000
Constant	-10.62*	0.0260	-408.05	0.000
Lnpoverty1				
Household Size	-0.156*	0.0017	-90.07	0.000
Age of the household head	0.003*	0.0004	6.79	0.000
Gender of the household head	0.121*	0.0114	10.67	0.000
Natural Logarithm of value of Agricultural Asset (Kshs)	-0.024*	0.0051	-4.74	0.000
Natural Logarithm of household Income (Kshs)	0.997*	0.0066	151.00	0.000
Credit Access	-0.003	0.0102	-0.33	0.744
Group membership	0.032*	0.0115	2.81	0.005
Distance from the household to the nearest motorable road (Km)	0.070*	0.0087	8.13	0.000
Total land holding in acres that a household own	-0.0004	0.0004	-0.92	0.358
Distance from the household to the nearest health centre (Km)	0.008*	0.0029	2.74	0.006
Household head earned cash from informal business/activities	-0.056*	0.0109	-5.12	0.000
Household head earned income from salaried employment	-0.041*	0.0105	-3.87	0.000
Constant	-10.578*	0.0983	-107.64	0.000

Selection Equation

Package2				
House size	-0.012**	0.0050	-2.43	0.015
Age of the household head	-0.002***	0.0011	-1.89	0.058
Gender of the household head	0.024	0.0343	0.71	0.475
Natural Logarithm of value of Agricultural Asset (Kshs)	0.019	0.0150	1.28	0.201
Natural Logarithm of household Income (Kshs)	0.019	0.0194	0.99	0.323
Credit Access	0.434*	0.0182	23.89	0.000
Group membership	0.115*	0.0344	3.33	0.001
Distance from the household to the nearest motorable road (Km)	-0.090*	0.0246	-3.64	0.000
Total land holding in acres that a household own	0.003*	0.0011	2.76	0.006
Distance from the household to the nearest health centre (Km)	-0.053*	0.0074	-7.15	0.000
Household head earned cash from informal business/activities	0.092*	0.0304	3.04	0.002
Household head earned income from salaried employment	0.010	0.0294	0.34	0.737
Distance from the household to the nearest piped water (Km)	-0.007**	0.0026	-2.52	0.012
Owned livestock	0.129	0.1112	1.16	0.248
Climate variability (Temperature)	-0.117	0.6818	-0.17	0.864
Weather variability (Temperature)	0.455*	0.0511	8.91	0.000
Weather variability (precipitation)	-1.070*	0.0737	-14.51	0.000
Constant	-1.552*	0.2986	-5.20	0.000
/lns0	-1.739*	0.0053	-326.41	0.000
/lns1	-1.673*	0.0185	-90.61	0.000
/r0	0.009	0.0644	0.14	0.891
/r1	-0.089	0.1016	-0.88	0.380
sigma0	0.176	0.0009		
sigma1	0.188	0.0035		
rho0	0.009	0.0644		
rho1	-0.089	0.1008		

(*), (**) and (***) denotes 1%, 5% and 10% level of significance, LR test of indep. eqns. : chi2(2) = 0.71 Prob > chi2 = 0.7023, Number of obs = 19364, Wald Chi2 (13) = 515405.32, Log likelihood = 915.85704, Prob > chi2 = 0.0000.

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APPENDICES

Appendix 1: Distribution of SLM Technologies

	2007		2010	
Terracing	**Frequency**	**Percent**	**Frequency**	**Percent**
0	4,161	44.52	5,245	49.70
1	5,185	55.48	5,308	50.30
Total	9,346	100.00	10,553	100.00
Crop Rotation				
0	8,768	93.82	7,009	66.42
1	578	6.18	3,544	33.58
Total	9,346	100.00	10,553	100.00
Grass Strips				
0	4,824	51.62	7,458	70.67
1	4,522	48.38	3,095	29.33
Total	9,346	100.00	10,553	100.00
Waterpans				
0	9,301	99.52	10,369	98.26
1	45	0.48	184	1.74
Total	9,346	100.00	10,553	100.00
Afforestation				
0	7,296	78.07	8,740	82.82
1	2,050	21.93	1,813	17.18
Total	9,346	100.00	10,553	100.00
Reafforestation				
0	9,186	98.29	10,300	97.60
1	160	1.71	253	2.40
Total	9,346	100.00	10,553	100.00
Agroforestry				
0	8,797	94.13	8,736	82.78
1	549	5.87	1,817	17.22
Total	9,346	100.00	10,553	100.00
Gabions				
0	9,326	99.79	10,469	99.20
1	20	0.21	84	0.80
Total	9,346	100.00	10,553	100.00

Cutoffdrains				
0	8,458	90.50	9,515	90.16
1	888	9.50	1,038	9.84
Total	9,346	100.00	10,553	100.00
Fallows				
0	9,191	98.34	10,476	99.27
1	155	1.66	77	0.73
Total	9,346	100.00	10,553	100.00

Where 1 denotes adoption of the SLM technology and zero otherwise

Appendix 2: Field Distribution

	2007		**2010**	
Field Number	**Frequency**	**Percent**	**Frequency**	**Percent**
1	2,435	26.07	3,173	30.08
2	2,039	21.83	2,704	25.64
3	1,561	16.71	1,794	17.01
4	1,142	12.23	1,202	11.40
5	797	8.53	755	7.16
6	540	5.78	442	4.19
7	364	3.90	244	2.31
8	222	2.38	123	1.17
9	127	1.36	56	0.53
10	61	0.65	27	0.26
11	29	0.31	11	0.10
12	18	0.19	6	0.06
13	3	0.03	4	0.04
14	1	0.01	3	0.03
15	0	0	3	0.03
Total	9,339	100.00	10,547	100.00