FACTORS INFLUENCING ADOPTION OF SOIL CONSERVATION PRACTICES IN KAPLAMAI DIVISION OF TRANS NZOIA COUNTY, WESTERN KENYA

BY

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DECLARATION

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This thesis is dedicated to treasured memory of my late father Mr. Samson Asatsa and my brother Joseph Mbai, my mentor and sponsor, who spared his meagre resources to pay for my education.

ABSTRACT

Land is key input into agriculture production in Kenya. However, soil degradation coupled with an increasing human population has a negative effect on increasing and sustaining agricultural productivity and the environment. This study was conducted in Kaplamai division, Trans Nzoia County in Western Kenya with the aim of assessing the level of adoption of soil conservation practices among the local farmers. The specific objectives of the study were to determine the household perceptions of soil conservation and its effects, the socio-economic factors influencing adoption of soil conservation technologies and to establish the reasons for farmers' willingness to pay for soil conservation activities on their farms. Random sampling was used to identify 232 farmers who were engaged in agriculture. Primary data was collected by administering a structured questionnaire, personal observation and informal interviews. Secondary data was obtained from official government documents and other relevant materials. The findings show that major perceptions on soil conservation technologies are not significantly different between the sexes and adoption is constrained by lack of finance (51%); too labour intensive (21%) and limited labour availability (20%). The practice is also perceived to result in low soil fertility leading to poor crop yields (93 %), sedimentation due to uphill land users (19%) and the carrying away of planted or sown seed (50%). Farmers adoption rates are contour ploughing 99%, bare terraces 58%, tree lines/hedge 56%, cut of drains 40%, infiltration ditches 7% and stone lines 2%. The Logit model result show that education level significantly influenced the adoption of bare terraces ($p = 0.004$), contour ploughing ($p = 0.012$) and cut off drains ($p \leq 0.001$). Decision making significantly influenced the adoption of bare terraces ($p \leq 0.05$), stone lines ($p = 0.015$) and cut off drains ($p = 0.016$). Crop growing significantly influenced the adoption of bare terraces, ($p \leq 0.001$), contour ploughing ($p \leq 0.001$), cut off drains ($p \leq 0.007$) and infiltration ditches ($p = 0.023$). Household size significantly influenced the adoption of bare terraces ($p \leq 0.001$), contour ploughing ($p \leq 0.001$), stone lines ($p \leq 0.002$), cut off drains ($p \leq 0.001$) and infiltration ditches ($p = 0.021$). Farm income ($p = 0.05$); crop growing ($p< 0.001$); family involvement ($p = 0.002$); and highest level of education achieved ($p< 0.001$) are positive and significant explanatory variables of willingness to pay for improved soil conservation practices. On the contrary mode of working on the farm is negative and significant predictor of willingness to pay for improved soil conservation practices. Crop growing $t = 4.012$ is the main predictor of willingness to pay. The farm income, crop growing, level of education and family involvement had a positive and statistically significant impact on willingness to pay for improved soil conservation practices. At the household level, it is important to involve both male and female in soil conservation decision making: from public awareness through technology adoption to evaluation. It is recommended that policies that create environment that facilitate conservation of soil, minimize labour and financial constraints as well as improve formal education will encourage adoption of soil conservation measures. Further research is needed on how to measure the efficiency of the adopted soil conservation practices.

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ABBREVIATIONS AND ACRONYMS

ALDEV	African Land Development Board
CBS	Central Bureau of Statistics (of Kenya)
CVM	Contingent Valuation Method
DAEO	Divisional Agriculture Extension Officer
DAO	District Agriculture Officer
DIVSCO	Divisional Soil Conservation Officer
DPTs	Divisional Planning Teams
FAO	Food and Agriculture Organisation (UN)
GDP	Gross Domestic Product
GOK	Government of Kenya
ICRAF	International Centre for Research on Agro forestry
IGBP	International Global Biosphere Programme
ILO	International Labour Organisation
KARI	Kenya Agricultural Research Institute
KECG	Kaplamai Environmental Conservation Group
MoA	Ministry of Agriculture
MUSAWCOP	Mutomo Soil and Water Conservation Project
NSWCWP	National Soil and Water Conservation Programme
NDDP	Nakuru District Development Plan
NDP	National Development Plan
NEAP	National Environmental Action Plan
OECD	Organisation for Economic Cooperation and Development.
NTF	National Task Force in Agro forestry (of Kenya)
PPCSCA	Permanent Presidential Commission on Soil

	Conservation and A forestation
SCC	Soil Conservation Committee
SCO	Soil Conservation Officer
SIDA	Swedish International Development Authority
SRA	Strategy for Revitalisation of Agriculture
UNEP	United Nations Environment Programme
USLE	Universal Soil Loss Equation
RoK	Republic of Kenya
WRI	World Resource Institute
WTP	Willingness to pay

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agriculture is the backbone of the Kenya's economy contributing directly 27% of the GDP and 65% of the export earnings (SRA, 2008). The sector provides 25% of the total national output and employs 75% of the total labour force, while providing 65% of the foreign exchange earnings and providing livelihood to 80% of the population with an average acreage of two hectares per person (RoK,1994a). Land available for agriculture and related uses that is, per capita holding has been decreased due to increasing human population (ASDS, 2010). Kenya’s economy is characterised by many economic and social problems found in many developing countries of the world, with a majority of people making their livelihood in agriculture and having inadequate incomes (ERS, 2003). The increased population exerts tremendous pressure on the available agricultural land. As a result of high population pressure land parcels have been fragmented into small holding scattered on the available land. The smallholders form more than 80% of the farming community; produce most of food and cash crops in the country. Because of the increasing demand for crop land, farming activities have encroached into river banks, steep slopes and on hill tops which are not suitable for cultivation. Such areas, when farmed, are known to be seriously affected by run-off erosion leading to rapid land degradation.

All farm land under continuous cropping is at a risk of fertility decline unless adequate conservation practices are included as part of farming activities. Also, grazing areas are affected by erosion due to overstocking and over utilisation. It is therefore important that farming and pastoral communities are properly educated, directed and guided on proper land use practices that emphasise resource conservation for improved productivity. It is also important that soil and water conservation is seen by the community as one of the environmental issues whose effect is not confined to individual land holding. Uncoordinated conservation efforts will result in scattered and disjointed conservation structures that are less effective. For example, damage from water erosion is not limited to the loss of productivity on the land where it occurs alone but the bulk of eroded soil from hill side comes to rest a distance away at the foot of the slope or a nearby flood plains where it may bury crops or reduce the fertility of the bottom lands. Whenever it is deposited soil erosion is unwelcome since it creates an external diseconomy.

Odendo, (1999) shows that economic factors influencing soil erosion and conservation can be subsumed under three broad categories; farm households' economic characteristics, policy and land tenure system. Low adoption rates of soil conservation among smallholder farmers in Kenya are attributed to technical, socio- economic and farm management decisions (Kipsat, 2007, Diagana, 2003). Kessler, 2006 and Tenge et al. 2004 show that several factors determine adoption of soil conservation technologies among smallholder farmers, especially female. These factors include education level of the farmer, social status, social influence, estimated skills and resource endowment and their objectives in farm management.

The first step in soil conservation should be to identify why soil erosion occurs and factors that influence the farmers' efforts towards soil conservation (Kabii et al., 2006). This should however be the beginning point in explaining farmers' perception of soil conservation in a given area. To improve adoption of soil conservation at household level, there is need to identify the gaps and problem areas that need special identification to redefine the issues of soil erosion. Soil conservation is important to productive farming system (FAO, 2010; Kabii et al., 2006). Policy makers and development planners however perceive soil conservation as a separate tool on the farm. Poor infrastructure and limited number of agriculture extension officers in the field have limited the number of contacts between the agriculture officers and farmers (Davis et. al., 2003).

1.2. Brief History of Soil Conservation in Kenya

The soil conservation service in Kenya was started in the 1930s and was made compulsory for farmers to practice by the colonial government from 1937 to the end of colonial era in 1963 (RoK, 1955; Thomas et al., 1986; Thompson and Pretty, 1996; Thomas, 1997). At the time, the land which was occupied by the European settlers and the former nature reserves, or African lands, already had serious erosion problem that wanted immediate attention. In 1930s the emphasis was on introduction of simple slope barriers such as trash lines, rows of stones and vegetative strips. African farmers on the other hand employed conservation measures such as shifting cultivation, trash lines and simple terracing.

Shifting cultivation was wide spread and effective since Kenya's population was low and land was not intensively cultivated and grazed. But as both population of humans and livestock grew, the pressure on the land increased. As a result a number of policies such as discouraging ploughing of steep land, stopping cultivation along the river courses, encouraging terracing, tree planting on hillsides, controlling forest clearing and promoting restocking were introduced and vigorously enforced. Administrative and agricultural extension personnel were employed to ensure that policies were observed and those who did not comply were punished (SIDA, 1993; Thomas,1997).

Throughout the late 1940s and the 1950s soil and water conservation initiatives in the areas occupied by Africans were promoted through the African Land Development Board [ALDEV] (1946-1955) and the Swynnerton plan (1953-1957). The Swynnerton plan emphasised the need to substantially improve the economy of the country by developing sound and intensive systems of farming.

Resulting from the initiative of Sywnnerton plan, most of the settled high and medium potential areas were terraced with the aid of labour from the local community, but usually without local sanction, and sometimes through coercion. Conservation works were occasionally carried out as a punishment for disobeying the local chiefs or for poll tax evasion resulting in wide spread resistance. Kenyans saw the enforcement of conservation structures as part of the colonial plan to distract them from real political and economic issues that needed immediate attention (Thomas et al., 1986; SIDA, 1993). Large section of the country was eventually terraced, despite the open resistance against the enforcement as was reflected in a spate of riots. Soil conservation at independence was seen as a form of colonial oppression since it had been tainted the connotation of forced labour and few administrators and politicians dared address it. Soil conservation was rejected as part of the colonial legacy (SIDA, 1993). For about ten years after independence little attention was given to soil conservation. Few terraces were constructed, steep slopes under good vegetation cover were cleared for cultivation and forests were cut down for timber, building material and fuel wood (Pretty et al.. 1995; Thomas, 1997). Erosion accelerated to alarming levels and there were signs of decline in soil fertility. As population continued to increase, and the shortage of good available land became acute, Kenya resolved to address the problem of increasing soil erosion as a step towards increasing food production. The soil conservation activities were revived in 1974 when the government realised the grave implications of soil erosion in predominantly agricultural economy (Pretty et al., 1995). The nation-wide soil conservation programme was launched by the Government with the assistance of the Swedish International Development Authority (SIDA) as a new effort to reinforce and expand soil conservation activities.

The program steps from the Kenyan Declaration during 1972 world conference on the Environment and Development held in Stockholm that soil erosion which slowly undermines the country's survival by lowering the soils production potential can only be prevented by mass implementation of soil and water conservation. During the first 13 years of its existence, emphasis was placed on working with those farmers who were willing to accept technical assistance from the Ministry of Agriculture agents, who promoted farm soil conservation through use of a variety of physical and biological measures.

In 1981 the president initiated Permanent Presidential Commission on Soil Conservation and a forestation (PPCSCA) in Kenya Anyieni, 1986; Kilewe and Thomas 1992). The commission was charged with the responsibility to propagate and create awareness of the problem of soil erosion, deforestation and water conservation in all sections of the community. It therefore became the commissions conviction that every member of the population must participate in implementing various conservation measures to combat soil degradation problems. In 1987, it had become clear that the approaches to soil and water conservation were failing to meet the massive environmental challenge, even though the achievements had been impressive. The techniques of soil and water conservation measures were scattered all over the country, and did not necessarily provide complete local or regional conservation (Mwenda, 1991; Pretty et al., 1995). The Kenyan government introduced the "Catchment approach" to soil and water conservation in 1986, with the objective to concentrate resources and efforts within a specific catchment area (typically 200-500 hectares) for a limited period of time, so conserving all farms and leaving small adjustments and maintenance to be carried out by local extension agents and the community itself (Mwenda, 1991; Pretty et al., 1995). The local communities are now more involved in the analysis of their own soil and water conservation problems, discussions and decisions are made with their active participation. The government through the ministry of agriculture extension agents provides technical advice (Davis 2003, McMillan 2001, Hassan 2001,), surveys the layout of terraces and organises farmers. In some instances, it provides tools such as hoes, spades and shovels to the farmers in the catchment areas.

1.3 Statement of the Problem

Smallholder farming in Kenya is widely affected by soil erosion. This undermines the ability of many households to produce enough food for both subsistence and income generation. Farmers in Kaplamai division and Trans Nzoia County at large face Soil erosion as a major problem due to various reasons. These include historical perceptions dating back to the forced erosion control measures such as terracing during colonial period. Increasing population pressure on land has resulted in utilization of land not suited for agriculture with little regard to adoption of better soil conservation technologies. Consequently, Kaplamai division is losing a large share of soil especially during the long rains. Meanwhile many of the soil conservation programs designed to address the problems have fallen short of expectations, with farmers often abandoning the soil conservation practices once the project ended.Despite the intervention by many agents to develop and popularize adoption of soil conservation technologies there is little or no adoption of soil conservation practices in Trans Nzoia County especially Kaplamai division. In addition factors influencing adoption of soil conservation technologies like gender perceptions, economic factors and institutional factors including farmers' willingness to pay for soil conservation practices is not fully documented in Kaplamai, Trans-Nzoia County, Kenya. This study was designed to bridge this information gap.

1.4 Research Objectives

1. To establish economic factors influencing adoption of selected soil conservation practices.
2. To establish social factors influencing adoption of selected soil conservation practices.
3. To estimate household willingness to pay for improved soil conservation practices

1.5 Study Hypotheses

Three null hypotheses were tested in the study.

1. The adoption of selected soil conservation practices by farmers of Kaplamai is not influenced by any prevailing social factors.
2. The adoption of selected soil conservation practices by farmers of Kaplamai is not influenced by any prevailing economic factors.
3. The willingness by female farmers at Kaplamai to pay for improved soil conservation is not significantly different from that of male farmers at 5% significance level.

1.6 Justification for the study

The research work hopes to contribute greatly towards the existing body of knowledge on soil conservation practices in Kenya that will enhance adoption of identified technologies by farmers in Kenya and Kaplamai ward in particular. The identification of economic factors that influence the adoption of soil conservation practices will be useful in aiding decision making among various stakeholders (farmers, extension providers, planners/policy makers, trainers, etc.) with regard to better soil management for improved agricultural production (Bai and Dent, 2006; Tenge, et al.2004). The reasons for the farmers' willingness to pay for appropriate soil conservation technologies will help policy makers and extension providers demystify the false gender based and historical perceptions among farmers regarding implementation of soil conservation activities and to encourage adoption of these practices (NASWCWP, 1998; 1999; Marenya, 2007, Wunders, 2007). Overall, this work will contribute to Kenya's initiatives in complying with local, regional and global declarations on better soil conservation for improved agricultural production, food security and the management of the natural resource base for agriculture (FAO, 2010; NALEP, 2009;Okalebo, 2005;GoK, 2001).

1.7 Scope of study

The study covered116 households in Kaplamai division who practice soil conservation in their farms, the local agricultural extension officers and personal observations. The guiding assumption was that each interviewee was as trustworthy as possible in responding to the questions asked so that accurate and credible data was collected.

1.8 Limitation of the Study

The anticipated threats to validity in this study included intervening or confounding variables which might have been beyond researchers control such as honesty of the respondents and personal bias. To minimize such conditions, the researcher requested the respondents to be as honest as possible and to be impartial/ unbiased when answering the questionnaires.

The research environments are classified as uncontrolled settings where extraneous variables may influence the data gathered such as comments from other respondents, anxiety, stress, motivation on the part of the respondents while on the process of answering the questionnaires. Although these were beyond the researcher's control, effort was made to request the respondents to be as objective as possible in answering the questionnaires.Limitation of the data collected included lack of the measures on slopes of the farms, soil loss or runoff. Such data was useful in assessing whether there was need for any soil conservation practices and hence determined the willingness to pay for improved soil and water conservation practices. There was need to know whether the respondents were willing to pay for the practices in case the project (SIDA) withdrew from the area. The study relied on survey data and voluntary information that was bound to have a myriad of errors for some respondents may have deliberately distorted the truth and failed to recall the past events accurately due to lack of farm records and illiteracy. Farm income in most households was received in piece-meal and fluctuated between seasons and the respondents were unwilling to openly discuss issues related to it.

The farm household that was taken as a unit of analysis made more sense if it consisted only of the male and female that were interviewed but not in multi-person household as seen in most households in Kaplamai division. The responses obtained from both male and female of the household, were assumed to represent a joint utility function of all the household members. This may not have been true since the information given may not have taken into consideration tastes and preferences of other family members.

1.9 Organization of the Study.

This thesis consists of five chapters. The introductory chapter deals with background to the study, a brief history of soil and water conservation in Kenya, statement of the problem, study objectives, research questions and hypotheses. It also discusses justification for the study, limitations and presents definitions of some operational terms used in the study. Next chapter (Chapter two) presents the literature that shows related work on the study area with their implications to environmental management in general. The conceptual framework deals with concepts of household decisions making and adapts the farm household model as the basis for identifying socio-economic factors warranting soil conservation. Chapter three describes the methods used to meet the study objectives through various data collection and analysis procedures. Chapter four handles data analysis, discussion and presentation of results. Chapter five provides summary, conclusions and recommendations based of the findings of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Practice of Soil Conservation

Soil conservation measures are generally classified into three types: agronomic or biological techniques that use plants and ground cover to hold soil in place. Soil management techniques that focus on improving soil structure to make it more resistant to erosion include mechanical measures such as cut off drains, artificial water ways, terracing and contour furrowing. The structural measures include construction of check dams, riprap gabions or masonry to control erosion (Ecborm, 2006). Reasons for erecting structural measures include diverting runoff water where it is safely deposited, to reduce velocity runoff of water and pressure of land, and to provide an effective barrier or sieve for moving soil (Kato, 2009; MOA, 2009; Jasmine et al., 1984). Another highly effective method is to reserve the highly eroded soil for agricultural production and this does not involve tillage or ploughing. The conservation Reserve Programme in the United States used this approach successfully with 14.5 million hectares between 1986 and 1993 (Roberts, 2003; Ryan, 2001). This last practise is not applicable in Kaplamai, as most parts of Kenya have high population pressure. As pointed out by (Kato et al.2009), the most productive and effective soil conservation technologies occur when different techniques are combined.

Soil degradation result more likely from demographic, socio-economic, and political factors that force farmers to utilise the land the way they do or not utilise the appropriate soil conservation technologies, resulting in erosion (Kipsat, 2007). Socio-economic explanation is often left out in model building and causal explanation of soil degradation in the classic approach to soil conservation policy formulation.

An effort was made to address this in the current study.

2.2 Economics of Soil Erosion and Conservation

Many governments are concerned with soil conservation problem and have since 1930s implemented programmes to ease economic burden of soil conservation on individual farms or groups of farms (Bekele, 2003). There is insufficient understanding of the economic and social factors that determine incentives for soil conservation in most developing countries (Chinnappa, 2004). Analyses by Kessler (2006) and Kipsat (2007) throw light on economic factors affecting household's perception of the need for soil conservation and decisions to conserve or deplete the soil. They outlined the economic factors that influence the farmer's decision to invest in soil conservation to include, inadequate finance and labour, capital endowments, levels of technical assistance and availability of incentives. The degree of access to alternative employment and income earning opportunities, tenure security, user rights and delivery systems also influence farmers' decision to invest in soil conservation measures (Goldstein, 2008).

The ultimate price for failure to control soil erosion is high for this leads to failure of agricultural systems, followed by starvation and can culminate into the toppling of the nation. An example here is the once powerful Mayan civilisation probably disappeared because of not controlling soil erosion (Brown and Wolf, 1984). Studies on calculating the cost for not correcting erosion, manifested in cases such as reduced yields, extra cost of fertilizer and energy, exist (Kipsat, 2006). The 'Do Nothing Approach' is thought to drive the food prices up over the long run as soil productivity declined.

Other studies support the fact that issues regarding soil erosion and conservation require a complex assessment of both physical and human environment (Adhikari, and Nadella, 2011; Cohen, et.al. 2006). These issues include social economic and institutional arrangements upon which farmers operate.

The government of Kenya through the Sessional Paper No.1 of 1986 on "Economic Management for Renewed Growth targeted to have agriculture provide food security , generate income for farm families that grow by at least 5.3% per annum and absorb farm workers 3% per annum. The sector directly contributes 24% of the Gross Domestic Product (GDP) and 27% of GDP indirectly through linkages with manufacturing, distribution and other service related sectors. Approximately 45% of the Government revenue is derived from agriculture and the sector contributes over 75% of industrial raw materials and more than 50% of the export earnings. The sector is the largest employer in the economy, accounting for 60% total employment. Over 80% of the population, especially living in rural areas, derive their livelihoods mainly from agricultural related activities (GOK, 2007). Most of the Kenyan population is concentrated in the high to medium potential areas, practising small scale agriculture. Small scale farming accounts for 75% of the total agricultural output and 70% of the marketed agriculture produce. Small scale farmers produce 70% maize, 65% coffee, and 50% tea (MoA, 2004).

2.3 Economic factors influencing soil degradation and conservation in Kenya

2.3.1 Insecure land tenure

Land tenure is a set of laws and customs which establish rights and duties relating to land use (Goldstein, 2008; Hagos et al., 2006; Soule et al., 2000). Regimes of rights, the structure of rights to resource and the rules under which these rights are exercised are mechanisms people use to control the use of environment, Hagos, 2006; Huggins, 2004; Otsuka, 2001). Where property rights are well defined, decision makers will take all consequences of their decision. Farmers will not invest their limited capital in conservation programmes without assurance of capturing benefits from the investments (Abdulai et al. 2011; Gabremedhin, 2003). Like in Trans Nzoia East Sub-county, farmers without title deeds would be unwilling to implement costly soil conservation measures.

The length of time it takes for an investment to be repaid, for example, can indicate whether tenure issues are likely to pose investment problems. If the investment is repaid, insecurity of tenure is unlikely to affect adoption. Studies have shown that farmers' decision to invest in soil conservation is influenced by the nature of land ownership (Gabremedhin, 2003). Where ownership is unclear, farmers are unlikely to participate in effective farm management (Goldstein, et al. 2008; Othuka et al., 2003). Swynerton's plan of privatisation of land ownership in favour of men resulted in women being marginalised in land ownership and general farm management Swynnerton, (1955). This led to reduction in land available for production of food crops in favour for cash crops. Women's rights to use land were also constrained by the size of land owned by their husbands. The growing of cash crops, however, led to reduction in available land for production of food crops (FAO 2009).

2.3.2 Gender disparities in soil conservation

Evidence from Africa and Asia has shown that securing women's access and tenure to land and resources is crucial to improving their productivity and economic wellbeing (World Bank, 2007). Although data is scarce, there is evidence that if given the same land, input, education and technology, females can equal or surpass males in agricultural output. A study in Kenya showed that by holding constant most of the factors, female farmers out produce men by 66% in maize yields per hectare (ILO, 2009; Susana, 2006). Studies have also shown that women try to direct their labour towards activities under their control that are more profitable. The report indicated that the presence or absence of clearly defined property rights makes all the difference between men and women active interest in soil conservation investment or apparent indifference to land degradation at household level.

Land tenure is an important factor that influences farmers' response to soil erosion (Brasselle, 2002). Lack of rights to own land by women in most communities is hence considered as an impediment to their perception and response to soil erosion (Gabreselassie, 2006; Askale, 2005). Land shortage affects women especially where women have no tenural hold on land and this may affect their willingness to invest in soil conservation. Formulation of social and economic policies is appropriate to the needs of smallholder farmers and is considered a priority in rural areas where women provide the bulk of agricultural labour and management with respect to soil conservation (OECD, 2009b). This includes identification of specific factors appropriate for interventions.

2.3.3 Inadequate finance

The need for external financing for investment in agriculture in sub-Saharan Africa has been highlighted (Zbinden, et al., 2005). In Trans Nzoia East district, lack of title deeds and low capital input limit agricultural development as farmers cannot acquire credit facilities from financing agencies. Inadequate internal financing and failure by credit markets as in the case of some areas in Kaplamai, adoption of conservation measures is limited by farmers' ability to finance the required investments (Gabremedhin et al., 2003; Brasselle et al., 2002). Most of the soil conservation technologies like terracing are capital intensive and require financing institutions like the Swedish International Development Agency (SIDA) and the Kenya Government to adopt the technologies.

This study in Kaplamai attempts in part to find out farmers willing to pay for soil conservation measures.

2.3.4 Limited incentives for soil conservation

Environment and natural resource policy variables include price incentives, public investment, institutional arrangements and internalising environment costs (Diagana, 2003). Government has responsibility for creating the environment that will facilitate conservation efforts e.g. raising farmers' incomes through improved marketing arrangements, better roads, increased prices of farm products and reduced taxes can stimulate farmers to improve the management of land (Diagana, 2003). The farmers' incentives to invest in soil conservation or incentives to deforest and quickly mine the soil's natural fertility may result from government good or poor investment policies (Nkonya et al. 2005; Bergerson and Pender, 1996).

The effectiveness of economic policies and investment strategies in combating upper degradation, e.g. upland watershed management projects, and sustaining agricultural development depends crucially on the incentives for farming households (Abdulai et al. 2011; Tizale, 2007). It is therefore necessary to understand the key economic factors which influence the decisions of upland farmers about the best way to manage their land, and in particular, about whether or not they see as beneficial, and so, adopt the available soil conservation practices and technologies at farm level. The development of farming systems appropriate to upland conditions and capable of improving soil and water conservation will not succeed unless when economic incentives are sufficient to encourage farmers to change their existing systems and land use patterns (Tizale, 2007).

Measures to adjust agricultural input prices toward their economic costs tend usually to benefit the environment by reducing uneconomic use of fertilisers and pesticides

(Hansen, 1991). Where such prices favour dairy production for example, improvement in output prices for milk would tend to raise farmers incentives for Napier planting and conservation and by extension soil conservation. Policies that reduce incentives to invest in agriculture often cause environmental degradation (OECD, 2009b; Nkonya et al., 2005). Most projects that have used food for work or cash payments, as an incentive to carry out soil and water conservation, have failed once the incentives were withdrawn. Also distribution in prices and other signals, uninternalized externalities and other policy failures contribute to soil degradation. Government has the responsibility to design appropriate policy responses to curb land degradation but in most cases the government's effort is hampered by lack of relevant data and micro-economics analyses of farmer’s responses to soil erosion and depletion and incentives to adopt conservation measures.

2.4 Causes of soil degradation.

2.4.1 Background information

In general land degradation implies a reduction in rank or status, for example degradation and/ or loss of fertile soil, or change of simpler floral /faunal composition or subtraction of one organic form for lower organic form. Land is degraded when it suffers a loss of intrinsic qualities or a decline in its capabilities Meadows (2003). It is therefore best viewed not as one way, but as a result of force or the product of an equation in which both human and natural forces find a place. Land degradation was something that can result from any causative factor or a combination of factors which may restrict the land's productive capacity. Some land degradation is due to natural (bio geophysical) causes, and some is due to human causes. Fertility erosion is the loss of plant nutrients by erosion and can be comparable in magnitude with the removal of the same elements in the harvested crop (Burwell et al 1975). For the purposes of this study the most important causes of fertility erosion include, soil erosion, fertility degradation, degradation of vegetative cover and degradation of water resources.

2.4.2 Degradation due to soil erosion.

Soil erosion is a natural geomorphological process which occurs on most of the world's land surface. Some areas are extremely susceptible to soil erosion like steep slopes which in other areas is a minor problem. Some areas do not experience erosion while others do. The natural factors influencing the severity of soil erosion are topographic such as steepness of the slope, intensity and frequency of rainfall storms (Meadows et al., 2002).

While soil erosion occurs naturally in the physical environment, the magnitude of environmental degradation is substantially increased by human invention into natural ecosystem (Meadows et. al., 2002). Apart from natural causes, population pressure, political and socio-economic forces affect the way people use resources leading to soil erosion (CBS, 2001). Others are marginalisation of the people, poverty, faulty land property rights and lack of market incentives. Degradation can also be caused by certain types of mining activities, industrial effluents, radioactive wastes and excessive use of fertiliser but these problems are, however, less common in Kaplamai and Kenya as a whole and are therefore not covered in this study.

2.4.3 Population growth and soil loss.

Demographic pressure is widely recognised as one of the clearest driving force behind depletive human interaction with the natural environment in the developing world (WRI, 2007; CBS, 2001; Mokwuye et al., 1996). Many views on population pressure, land degradation and poor agricultural performance have been postulated for a long time. Thomas Malthus argued that food supply grows according to arithmetic (additive) progression in nineteenth century. Malthus insisted that continuing population growth would require increasing intensity of cultivation and this would consequently bring down per capita production to subsistence level and put a stop to population growth. However, Malthus failed to recognise that technological innovations and market forces could lead to food production to increase faster than arithmetic progression.

Middleton (1995) argued that since land degradation is widespread in areas used by human kind, it is reasonable to regard it's degradation to anthropogenic factors. Increasing human population raises demand for natural resources whose supply is normally fixed. Increasing population exerts pressure on land resources (NEMA, 2004; WRI, 2007).

Boserup (1965) hypothesised that high population and market access lead to improvement in natural resources rather than deterioration. The effects of Boserup view depended on environmental policies that govern investment incentives to the farmers. Boserupian effects remain compelling, as land becomes scarce in relation to labour, and access to market improves, agricultural production is intensified and the end result of this process is higher productivity per unit area. The Boserup hypothesis has received empirical support from African wide study (Pingali Binswanger, 1987), and in depth longitudinal study of Machakos District of Kenya Tiffen, Mary (1991a). The Machakos study reveals that land conceived heavily degraded and beyond recovery in the 1940s and 1950s was restored in the 1990s. Despite population increasing fivefold crop yield increased and soil degradation decreased. This phenomenon is attributed to the use of soil conservation technologies such as contouring, terracing and composting. These were as a result of introduction of cash crops and better access to markets (Kessler, 2006; Bender and Smith, 1997).

Population increase has a double edged effect: a simultaneous increase in demand made upon environmental in order to support growing numbers of people, and destruction of the resource base (Clark and Munn1986). Napier (1994) hypothesised that as population pressure increases on land resources, the size of land holding usually declines. Poverty stricken land operators, like the women headed households, cannot adopt any soil conservation as they lack human skills and economic power. According to Swinton*et al.* (2003), poor people have no choice but to opt for immediate benefits, at the expense of long term sustainability. Poverty induces land degradation which in turn reinforces poverty leading to further degradation. Some writers, however, point out that higher population density if accompanied by greater access to markets will lead to improvement in management of natural resources rather than environmental degradation (GoK, 2001; Stocking, 1988; Boserup, 1965).

Kenyan's population has continued to increase very rapidly, creating additional one million people every year (Population Census, 2009). By the year 2000, the country was estimated to have a population of about 35 million up from the estimate of 23 million earlier. The aspirations of the people for high standard of living, education, health, improved shelter and balanced diet may not be met due to increased soil degradation resulting from population pressure. Many writers have identified the causal role of rapid population in environmental degradation (Meadows et al., 2002). However few of these writings have addressed the more complex relationships between population and environmental degradation. Human accelerated soil degradation, mainly occasioned by increasing population, results primarily from incorrect land use or bad land management, and from land being used in a manner incompatible with its capability (Pannell et al., 2006).

2.5 Impact of soil erosion on conservation.

The movement of soil and other sediments by erosion forces has a large number of environmental impacts which can affect farmers and many other sectors of the society. Many of these effects are consequent upon natural erosion, but are exacerbated in areas where rates are accelerated by human activity. The environmental effects associated with erosion occur due to the three fundamental processes of transport and deposition.

Effects of soil degradation fall under two categories; on site effects exhibit deformation of terrain due to uneven displacement of soil that can result in hills, gullies, mass movement hummocks or dunes. On other is, off site effects of eroded soil are caused by its transport and deposition. This externality is a condition which exists whenever the welfare of some agent, either a farm or household, depends directly not only on his/her activities, but under the control of some other agent as well (Tieterberg, 1988). The excessive soil erosion which is as a result of farmers activities on high slopes result in destruction of crops at hill bottom and may cause a threat to the biodiversity of Kaplamai division leading to external diseconomy.

Ancient indigenous cultures developed production systems that were well adapted to the fragile conditions known as shifting cultivation and furrow system. These methods allowed the fields to rest and recover nutrients and moisture for long periods following two or more seasons of crop production. Unfortunately traditional systems have been disrupted by rapid population growth, changing social, political and economic policies and inappropriate Western style development plans. A fragile ecosystem exploited beyond its carrying capacity eventually breaks down. Deforestation, overgrazing, expanding rain fed agriculture and other practices have combined to severely degrade many watersheds and accelerate soil erosion. Birungi, (2007) reported that soil erosion is not simply a function of soil exposure. It depends as well on inherent properties of the soil, the landscape in which it occurs, climate and the proportion which washes over the soil rather than seeping through it.

Deforestation is leading to increased rainfall run off and crop destroying floods. Pimentel et al. (1987) reveals that forest removal reduces fuel wood supplies and forces the poor in developing countries like Kenya to rely more heavily on crop residues and manure for fuel, which then further intensifies soil erosion and runoff. The carriage of soil particles in the runoff leads to problems where water stops moving and silt is deposited, resulting in burial of crops which is one kind of an external diseconomy (Greenland, 1977). The sediment deposits raise the level of the river bed and reduce the capacity of the channel to hold water. River banks overtop more frequently and valley bottoms land often extremely productive is damaged by flooding (Kelly, 1983).

2.6 Measurement of economic impacts of soil erosion.

Present average rates of soil erosion exceed average rates of soil formation. This is a serious decrease in top soil volume (Larson, 1991). This leads to gradual loss in soil productivity which, if left uncorrected, result in subsoil having little value for agricultural production for erosion reduces the top soil and subsequently the depth of root zone. According to Montgomery (2007) analysis of impacts of soil erosion on crop yields or impacts of runoff and sedimentation of off-site economic activities in developing countries is not easy. Research on declining crop yields attributable to soil erosion is not as extensive as might be expected. The impetus for such research is lacking since there are many factors that affect crop yields, and hence it is difficult to ascertain with authority that a single factor such as soil fertility is causing decline in crop yields. The impacts of erosion are very closely related to effects of other factors such as climatic variations, price changes, input mixes, labour use strategies etc. This is true when the adverse effects of soil erosion accumulate slowly and are affected by changes in climate, farming techniques, weather and even the economics of the farm. Very few empirical studies have attempted to establish the impacts of soil erosion on crop yields and by extension on farm and national income.

Determination of costs of land degradation is important in evaluating the significance, and the level of resources that should be allocated to diagnose and remedy the problem. In addition, it assists in assessment of the magnitude of the problem in comparison to other priorities facing the society Bekele, (2003) and to bring home to the decision makers the real but hidden cost of investing in soil conservation (Mwakubo, 2002; Bekele,2003; Fox, 2008). It could also be important from the perspective of modifying National Income Accounts to better reflect sustainable income. Nevertheless, national level cost estimates of land degradation cannot give a precise guide to counter measures to adopt in order to mitigate the problem.

While costs of soil conservation are readily determined; measuring benefits is often problematic especially in developing countries. In almost all cases, soil erosion is recognised as a serious problem (FAO, 2010a; Diagana, 2003; Boyce, 2000), although data bases are too weak to assess accurately the real extent and of the problem.

Productivity method, for example, permits estimation of soil loss on yields, for specific management practise (Bishop and Allen, 1989). The method often used to estimate economic impacts of land degradation include changes in productivity and replacement costs. This method involves finding the difference in crop yields with and without soil erosion. This is then multiplied by the unit price of the crops say maize, less the cost of production. This method also involves computation of amount of soil lost through erosion, and putting a value on by using equivalent cost of commercial fertiliser used since the loss of plant nutrients is associated with erosion. The limitation of this method is the fact that the declining trends in crop yields attributable to soil erosion are difficult to separate, primarily because there are so many factors that affect crop yields. Crop yields are dependent on multiple factors such as climatic variations, soil fertility, relative price changes, changing crop patterns, input mixes, labour use strategies, appropriate timing and so on. The adverse effects of soil erosion accumulate slowly and are covered by changes in farming techniques, weather or farm economics.

Estimating the off-site impacts accurately is also difficult, particularly separating sedimentation arising from geological and non-farm erosion caused by upland farms. Replacement cost method estimates the cost incurred to replace damaged productive assets such as degraded or depleted soil nutrients and considers the cost as the indicator of damage incurred by degradation (Stocking, 1986). The degraded nutrients are assumed to have an economic value equal to the market value of an equal amount of fertiliser.

On-site costs are sometimes measured in terms of loss in marginal productivity of crop output from changes in inputs multiplied by the unit price since loss of plant nutrients is associated with erosion. The method employed in estimating off site costs is specific to the type of downstream impacts and welfare losses encountered. Studies in Mali show that the cost of soil erosion could be substantial and estimated net farm income foregone from soil to be about US dollars 4.6 to 18.7 million annually and current plus future foregone income due to one year's soil erosion was estimated to be US dollars 31 to US dollars 123 million (Bishop and Allen, 1989). In Java, the off-site costs due to siltation of irrigation systems and reservoirs, and harbour dreading were estimated to be US dollars 58million in 1987 (Magrath and Arens, 1989). About 25 per cent of the sediment deposited in lakes and reservoirs in the USA is thought to originate from cropland. The resulting damage, which contributes to a 0.22 per cent annual loss in national water storage capacity, has been valued from 144 million to 194 million dollars per year. Deposition of sediment reaching the coastline can adversely affect many environments used by local populations, including coral reefs and shellfish beds.

The on-site impacts consist of a decline in the yields of agro-ecosystems arising from mass wasting, soil and nutrients losses and changes in the water holding capacity of the soil. On-site costs consist of user costs that farmers must eventually face for their choice of land use patterns. The off-site costs on the other hand were estimated in terms of the foregone hydroelectric and irrigation due to reservoir sedimentation in the major dams in Java, Indonesia. Off-site costs resulting from sediment flows into surface water ways with high value uses are higher than flows into deposition plains. Limited data available in Kenya suggests that impacts of soil erosion on crop yield may be more dramatic in the tropics than under temperate conditions due to fragility of tropical soils, or more extreme climatic conditions (Stocking, 1984, 1988).

Physical data are of little use to decision makers unless physical data on soil degradation is monetised into units comparable with the costs of soil erosion should be expressed as costs of total on-site and off-site damage experienced. The difficulty in quantifying eroded soil has however led nearly all researchers and regulatory agencies to substitute quantity of soil eroded as measured by Universal Soil Loss Equation (USLE)[1] for economic damages. This method is only accurate when the incremental damage is constant for each unit, for example a kilogram of soil eroded, which is only approximately true. A few attempts, mainly focusing on water erosion and nutrient depletion, have been made to turn data on annual soil loss per hectare into nutrient and productivity loss (Smaling et al. 1996; Young and Kanjo, 1991). Soil degradation figures quoted in the literature are often extrapolated from limited data and may exaggerate the problem (Barbier and Bishop, 1995 and Bender and Smith, 1997). Although moved soils may be considered as "lost soils" much of it may have been deposited on other agricultural fields, where it may add to productivity downstream.

The main problem is the comparison made between a situation "with" and 'without' erosion, as if it is possible to eliminate soil erosion altogether. Most of the studies focus on major crops just as in the studies conducted by Holmberg (1989) and Ekbom(1995) in Kitui and Murang'a District of Kenya respectively, focused on maize. The extent of crops inclusion will affect the level of damage estimated and off-site effects are usually much harder to evaluate. Quantifying the downstream effects associated with watershed degradation by upland farmers is difficult. Another problem is that the variability in data generated by these studies is mainly depended on price levels of the products.

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[1] USLE is a method developed in USA to predict soil loss by runoff from US fields east of the Rocky Mountains under particular crops and management systems.

While there is much qualitative debate about soil degradation, the quantitative environmental and economic aspects are rarely addressed. The variable impression of the importance of land degradation in Africa therefore, varies from carefree dismissal to exaggerated alarmism (Boyce, 2000; Diagana, 2003). Soil erosion is an important form of environmental degradation in developing countries because it causes on-site and off-site costs (Montgomery, 2007). Whatever qualifies as an on-site cost obviously depends on unit of analysis (Montgomery, 2007). Often, on-site costs are impacts of soil erosion that are internalised through financial feedback such as crop losses on the farm due to processes of soil erosion.

By comparison, some effects of these processes are externalities such as downstream siltation of dams where the loss of power or irrigation is not tied to any feedback to the upstream farmers. Decreased land value and crop yields as well as increased downstream externalities are the main economic costs reported to result from soil degradation (Crosson, 1997; Belshaw et al.1994). Some of the externalities include burying of cultivated fields by sediments in valley bottoms, deterioration in water resources resulting in spread of water borne diseases such as typhoid, cholera, dysentery and so on. It may cause siltation of dams and rivers, in addition, thus shortening their useable life and increasing costs of treating water, destroying beaches, and killing coral reefs. In the study area, that is Kaplamai ward, the main economic impacts of soil degradation include loss of crop yields and sedimentation of streams. Most of the permanent rivers in the area, like Saiwa river are tributaries of the Nzoia river that drain into Lake Victoria thus imposing external costs on the dwellers of lake Victoria basin due to eutrophication and sedimentation of the lake. Adoption of soil conservation practices is hypothesized to lessen these adverse impacts of soil erosion (Pender et al., 2006).

2.7Gender issues and soil conservation for agriculture

Over70% of all rural dwellers in developing countries engage in agriculture although their contribution to production of food is routinely mentioned in development policy and planning but often without a realistic assessment of their work, needs, motivations and constraints (World Bank 2007; Agarwal, 1985). Their roles in agricultural production presently include working in agricultural fields and in farm management activities. However in all these roles, women encounter physical, social, cultural and economic factors that influence their productivity (World Bank, 2007;1989b.). In Africa alone, women are responsible for at least 70% of the stable food production (FAO, 2009; Annabel, 1991). Throughout southern and eastern Africa, women engage in herding, farming, fuel wood gathering, food processing, home making, family care, market vendor, construction works, environmental conservation and management of both natural and artificial environments. In all these activities, women face increasing production costs with less labour and resources to meet the demands (ILO, 2009; Susana, 2006).

Studies have explored the role of women in various farming activities (ILO, 2009; World Bank 2007), separate farming roles from domestic duties. In households men assist in farming activities but harvesting is mainly undertaken by women. Women are not likely to maintain control of the farm income. This might have an impact on their contribution towards soil conservation.

Women in Kenya play a significant role in agricultural production especially in smallholder farms, a partly explained by migration of men to urban areas in search for off farm employment, making men absentee farmers whose major contribution to farming is by the way of remittances (FAO, 2010; Quisumbing, et al. 2009). The women undertake farm management tasks through their acquisition of farm ownership rights, burying or death of the spouses and in other societies through inheritance (Othuka, 2003; Splash, 1993). This has contributed to a large number of women being defector and dejure owners of land.

By mid 1990s, it was estimated that 27% of small holdings in Kenya were solely managed by women who were also heads of their households and another 47% of the holdings managed by women in absence of their spouses (RoK, 1985; 1992a, 1992b; World Bank, 1989a). In such households, women have assumed the responsibility for both home and farm management (Arya, et al. 2011; RoK, 1997; World Bank, 1989a, 1990, 2007). To date about 40% of smallholdings in the country are solely managed by women, with a figure ranging between 1/3 and 1/2 of all the rural dwellers in Kenya (APNET, 1997; World Bank, 2007).

It has been observed that women are mainly involved in planting, weeding, transporting, storing, processing and marketing making women to perform up 64% while men perform 36% of the agriculture work. Leonard (1989) however, says that due to poverty, women degrade the environment more in order to supplement their little family income. All these activities are performed on farms hence explaining the need for women to participate both in farm management and soil conservation.

A number of studies have indicated that as the population pressure increase on land resources, the size of land holding decreases and poverty of smallholder farmers increases (Quisumbing et al.2009; Swinton et al., 2003;Orodho, 1998; among others).

Poverty stricken farmers cannot adopt many soil conservation technologies as a result of lack of skills and economic power (Boserup, 1970; Bryceson and Mac Call, 1994). Mutoro (1997) and Munyua (1995) argue that poor smallholder farmers opt for immediate benefits instead of long term sustainability since they have no otherwise. Poverty causes women to allow degradation to continue, leading to further degradation and the poverty is greatly related to environmental degradation (Kioko, 1998; Leonard, 1989). Due to less knowledge of new technologies developed in response to rapid environmental degradation, women continue to apply traditional technologies for environmental conservation (APNET, 1997; Braidotti, 1994; Bryceson and McCall, 1994). In spite of their important roles in resource management, lack of property rights and political clout traditionally make women to be overlooked and often do not receive any training on agricultural technologies necessary for agricultural development wherever such programmes are implemented in rural areas (Munyua, 1995).

In Kenya, the assessment of women's capacity of contribution to soil conservation is yet to be determined. Khasiani(1992) revealed that women in Mutomo division of Kitui district participated effectively in soil conservation program at group level. A return study however, revealed that the marked performance in short term was due to incentives used during the implementation of the project. The incentives included regular farming implements such as hoes, spades, food for work, bee keeping technology and the 2000 plough competition. The implements worked as an incentive for farmers could borrow for use in their individual farms. This facilitated soil conservation on farms (Khasiani, 1992; MUSAWCOP, 1987). When the incentives were removed, most families did not continue with soil conservation. This however, suggests that analysis of their awareness, response and factors which influence participation in soil conservation would help to establish a long term response to the soil conservation problem.

Women despite being responsive to innovations and adopters of profitable technologies have been relegated to subsistence farming and use traditional technologies (Argawal, 1985; Boserup, 1965; Bryce son and McCall, 1994; Keter, 1998b; Gabriel 1991; Sighor, 1997). When it comes to management activities of resources, women in most cases remain invisible. A number of studies have demonstrated that women access to new technology, income, education and other resources have influenced their level of contribution to agricultural development and transformation (Boserup, 1965; Bryce son, 1994; Saito, 1995; World Bank, 1989b). Men and women respond to soil degradation by seeking to contain and reverse the effects. Women are mainly concerned with availability of food, fodder and fuel whose absence means undertaking long journeys in search for them.

2.8 Role of extension in soil conservation

Agriculture extension though one of the vital tools for improved farm management and agricultural productivity, diffusion to all regions as well as households, has been slow and unpredicted (Davis et al., 2003; Hassan et al., 2001; FAO, 1987). The extension methods employed in Kaplamai ward include contact farmer system, training and visits system and individual farm visits (NALEP, 2009; NSWCWP, 1999). The contact farmer system is where extension officer’s focus on progressive farmers with a view that the neighbors of such farmers will adopt innovation of those contact farms. The officers in contact farmer approach, however, often fail to cope with large number of smallholder farmers requiring extension advice in rural areas (Olubandwa, 1998).

In training and visit system extension officers concentrate on training groups of farmers on new technologies through demonstrations. Training and visits approach has been criticized for oversights on communication and resource differences at household level that influence participation and adoption of agricultural techniques (FAO, 1987; Olubandwa, 1998; World Bank, 1994b). Most women farmers are time constrained to fully participate in training (Davis et al., 2003;Macharia and Janet, 1992).

The last method is individual farm/group or area visit to identify problems facing a farmer, a group of farms or groups with a view of solving problems affecting the identified areas. The farmers of the affected areas are mobilized to undertake activities aimed at solving the problems. The Catchment Area Approach for soil conservation is an example of this approach where a committee is selected (women in most cases left out) to manage the catchments and eventually farmers within the catchment are mobilized to participate in soil conservation activities within the catchment area (NSWCWP, 1999). The individual visits approach is criticized for its up down approach for it has failed to include the views of all stakeholders in the management of resource base. As has been observed, representation of women in catchment committees and decision making is low for this remains the domain of few committee members and funding organizations.

2.9 Farmers' Perception on Soil Conservation

In Kenya soil conservation efforts have been undertaken since 1930s under the responsibility of engineering sections with the ministry of Agriculture (GoK, 2002). A lot of land has been terraced since then but maintenance has often been insufficient. The imposed colonial efforts in soil conservation were often resented by people, making farmers in Kenya to perceive the initiative differently. Whereas some farmers have adopted a limited range of soil conservation measures others have remained opposed to soil conservation initiatives. However, since the 1980s it has been the responsibility of the government to encourage a renewed perception of soil conservation among farmers in order to achieve sustainable agriculture (Amsalu, 2007; Bekele, 2003; GoK, 2002).

A new approach has been used in Kenya since 1980; farmers are involved in conservation works on their own farms, which is integrated into the general farm planning. Adoption of soil conservation measures in the country has not achieved full acceptance by smallholder farmers despite the efforts and experiences (FAO, 2008). Inadequate soil conservation efforts are always attributed to poor understanding by farmers about soil conservation, lack of basic information about soil conservation techniques, complexity in some soil conservation measures, and lack of locally validated data on soil conservation and limited research on soil conservation and developments. Since soil conservation technologies are in place, incorrect land use and soil degradation are a result of the farmers ignorance. Blaming the farmers' ignorance for the above situation is a common reaction by the government and their advisors (Barbier and Bishop, 1995). But more often, this is a result of the government's ignorance of the socio-economic factors that force the farmers to use the land the way they do, or utilise the appropriate soil conservation measures, resulting in soil erosion. The relevancy of novel development paradigms including soil conservation has not been well understood by farmers (Aboud, 1997). Application of soil conservation though appraised in government reports continue to yield little success.

Barbier and Bishop (1995) on the other hand support the view that the value farm households attach to the future as opposed to income, influences households decision to conserve soil. The farmers' attitude towards risks and uncertainty and household poverty are reflected. The amount of off-farm income and awareness of soil problem also influence soil conservation efforts. Smallholder farmers especially women are risk averse due to their concern of families' livelihoods (Babatunde et al, 2010). They have limited off-farm income, much of it come from their husbands' remittance. It has been argued that much of the off-farm income is spent on education of the children and other immediate demands like food requirement and health needs before anything (if any) can be spend on farm improvements including labour hiring and soil conservation (Mutoro, 1997). She asserts that smallholder farmers especially women see no immediate economic gain for their efforts. The determination of patterns of resource use includes incentives and disincentives individual household's face.

In the old settlements like Kaplamai, problems related to soil erosion, decline in soil fertility and per capita food production are being experienced despite efforts by the government to promote soil conservation in the area. Thus the smallholder farmers' resource management skills in soil conservation efforts and problems leading to low adoption of soil conservation measures should be addressed.

2.10 Land Cover changes and soil erosion in Kaplamai division

Land cover changes in Kaplamai are as a result of aspects of forestry, livestock and farm land. The impact of human management of the land cover for productive purposes and disturbances such as deforestation are of concern in the area. The changes taking place in the division are posing a threat to agricultural sustainability, rural development and livelihood systems of smallholder farmers (IGBP, 1998; NEAP, 1994). The changes brought about by surface run off and deforestation has confronted land management in the study area on a daily basis and the issue of sustainability is top on the research agenda (Aboud, 1997).Soil erosion was perceived in form of reduced soil fertility, declining yields and increased fuel wood shortages in the study area. Apart from land cover changes other forms of human accelerated soil erosion are through incorrect land use and management systems as well as the insufficient response by farmers toward adoption of soil conservation measures. The human response to land cover in Kaplamai division can be seen through efforts by farmers to reforestation and construction of physical structures such as terraces. Socio-economic factors, farm management decisions, farm resources, level of education and environmental setting influence the resulting individual and group behaviours towards soil conservation. The way individuals understand causes and consequences of these changes are influenced by political, social and economic factors that they encounter. These factors act as driving forces that give rise to land use dynamics and determining trends in land management in Kaplamai division. Adequate studies have not been done in the area to establish the role of women in soil conservation and factors that influence their response to the increasing soil erosion.

2.11 Women and socio-economic changes in Kenya

Kenya like many other developing countries has been undergoing economic crisis that has led to the government's cutbacks on many social and economic programmes that previously used to be financed or subsidised by the government. These programmes are in the areas of education, health and agriculture especially environmental conservation (Khasiani, 1992; Palmer, 1988; World Bank, 1994a). Numerous conservation programmes planned in 1980s were not implemented due to shortage of funds

Khasiani(1992). Conservation activities previously undertaken by local authorities on behalf of Central government were halted as a result of financial difficulties (Khasiani, 1992; RoK, 1987).

Pearson (1997) argues that due to difficult economic situations as result of Structural Adjustment Policies (SAPs), smallholder farmers especially women have increased their participation in formal and informal sector employment. This however suggests that women may find it difficult to maintain their place in soil conservation. They have also withdrawn their support from voluntary agricultural work to offer farm employment (Pearson, 1997) hence their contribution to resource management may not be as effective. The socio- economic changes have worked for the betterment of women. Many studies in environment conservation and their economic status show that improvement in economic status of women lead to lowered fertility, reduced child mortality, increased wage employment, improved education of the children and better response to resource degradation (Kioko, 1998; World Bank, 1990).

The Swynnerton Plan of 1954 provided for land consolidation and the growing of cash crops (Odendo, 1999). This brought the beginning of division of labour in Kenyan agriculture along production lines (Choti, 1998; Khasiani, 1997). Cash crops were men's crops and women only offered their labour and were left to manage production of food crops to sustain families. Due to penetration of capitalism and practice of cash crop farming, women's ability to produce and supply food has been deteriorating over time. This has also increased women's responsibility as main providers for their dependants.

2.12 Farm household characteristics

Several factors, including characteristics of the household, social status, attitude, social influence, educational level, skills, resource endowments and objectives of the household as well as attributes of technology, its appropriateness, complexity, friability and observerbility influence adoption of new technologies by farm households. These factors may be added to the existing external factors such as infrastructure and geographical conditions. The farmers will generally not adopt soil conservation practices when it is not demonstrated that it is in their economic interest to do so (Chinnappa, 2004).

While costs of adoption of soil conservation measures are relatively easy to estimate, benefits are difficult to quantify. The value a farm household attaches to the future as opposed to the present income and the costs as well as benefits of soil conservation influence the households perception of soil erosion problem and the decision to conserve the soil (Pande, 2011, Barbier and Bishop, 1995). Farm-level perception and decision made reflect on household’s availability of labour, farm size and farmer’s planning horizon.

It will be difficult for farmers to get encouraged to adopt soil conservation measures unless they come to realisation that soil erosion poses an environmental threat and hence become more concerned with on-site and off-site environmental damages associated with it (Brown and Wolf, 1984). A study in Konto river watershed in Indonesia found that many farmers recognised erosion symptoms but associated them to physical factors such as heavy rainfall and steep slopes (Graff, 1996). They rarely associated it to their own land uses and management. They put land degradation as an act of God (Allah) since they could not associate themselves with acceleration of soil erosion. For farmers to adopt soil conservation measures, they must be aware of soil conservation problem initially. The adoption rate depends on the households' resource endowment, conservation skills and educational level of household members (Mazvimavi et al., 2009).

The human capital available in the household is indicated by the number of persons in the household and hence reflects the households labour availability (Burger et al., 2002). These studies report that resources are often allocated for investment on the farm, including soil conservation and household consumption if the household is large. Clay and Reardon (1994) found out that the availability of family labour was crucial in adoption of grass strips and anti-erosion ditches in Rwanda. The size of the household on the other hand negatively influenced adoption of bench terraces, grass strips and trees but positively influenced the Fanyajuu terraces (Kagwanja, 1996). There is enough evidence to support a positive correlation between adoption of new technologies such as soil conservation technologies and human capital as indicated by household size, education, experience, exposure to extension services (Blackman and Bannister, 1998; Clay and Reardon, 1994). Adoption of soil conservation practices such as bench terraces, infiltration ditches, and cut of drains require a lot of labour and farm households make frequent allocation decisions about labour than all other resources on the farm combined (Burger, 2003).

Educated farmers are more likely to include soil conservation technologies into farm operation (Napier, 1994). Kagwanja (1996) in a study conducted in Embu, Kenya found out that education positively influenced adoption of bench terraces and contour operations, while it negatively affected the adoption of grass strips and trees. The study by Clay and Reardon (1994) however shows that the number of literate farmers in the household negatively influenced adoption of grass strips, anti-erosion ditches and hedgerows.

Farmers with high income have ability to purchase materials and tools or hire labour. There are arguments that farmers with high incomes are associated with low discount rate and therefore make long term investments like soil conservation (Barrow, 1991; Mwakubo, 2002). Napier (1994) however argues that high incomes are associated with profit maximisation by farmers with high discount rates and hence low adoption of soil conservation technologies.

Access to credit facilities and off-farm incomes increase the liquidity in the household thereby availing resources for investment. But literature has indicated that little credit goes towards capital improvements on the farm (Thurow et al., 2002). In Kenya, there is relatively little credit for smallholder farmers who in most cases are not growing cash or export crops. For example, farmers growing maize, like the majority of farmers in Kaplamai division, must have more than 5 acres to qualify for credit, a provision that eliminates most of the smallholder farmers (McNamara et al., 2005; NTF and ICRAF, 1998). Even in cases where credit is available, it is mainly for the purchase of inputs such as fertiliser for cash crops like tea and coffee and not for food crops meant for domestic consumption.

Livestock on the other hand, is a form of capital which can play an important role in soil conservation if integrated with crop production. Recycling of nutrients can be facilitated by using crop residues and providing manure (Thomas, 1997). A study on the adoption of soil conservation technologies revealed that the value of livestock is positively related to adoption of bench terraces, grass strips, Fanya juu terraces, and trees and contouring (Kagwanja, 1996).

2.13 Measuring adoption of soil conservation technologies

Measuring adoption of soil conservation technologies is a major challenge in attempts to model soil conservation decision process (Schipper et al., 2005; Kagwanja, 1996). Some of the measures that have been used include willingness to adopt, actual adoption decision and conservation effort. Purvis et al. (1989) measured the willingness of Michigan farmers to accept yearly payments for participating in filter strips program using contingent valuation methods. It is difficult to draw policy implications of such a model since farmers actual decisions are not provided. Considering the farmers actual use of conservation practice is a more reliable measures with regard to usefulness in policy analysis (Kagwanja, 1996). Such methods include a dichotomous choice model to measure the probability of adoption and actual number of soil conservation effort that the farmer uses. There is a weakness in using the binary variable and conservation effort (Kagwanja, 1996). Although binary model has been widely used, a binary dependent variable model representing the adopt-not adopt decision may ignore important behavioural information and fail to capture the extent of farmers actual conservation effort.

Due to the fact that dependent variable is only a proxy for effort (Lynne et al., 1988), the problem is made more difficult. When a soil conservation measure is not adopted on the farm, effort is identically zero and hence accurately measures some effort on conservation. When dependent variable is greater than zero, it measures some effort, but this measurement is however subject to error. A farmer who has adopted four soil conservation measures for example does not necessarily show greater effort than a farmer who has only adopted two. Given that the purpose of soil conservation is to arrest soil erosion, conservation effort will best be measured by an estimate that shows how close a farmer is to arresting soil erosion. The predictor variables should not necessarily be interpreted as having any causal relationship with soil conservation measures, but rather as being associated with the presence of soil conservation measures.

2.14 Gender and natural resource management policy

Natural resource policy and management in Africa does not get sufficient and timely attention. The roles of both men and women's contribution to family welfare go unrecognised in natural resources management policy. Maringa (1993) emphasised the need to highlight certain factors such as demographic trends which indicate that 50% of the Africa's population is female. Furthermore 50% is under 30 years of age and the trend is expected to continue in the next century. Although well over a half the population is female, African policies and institutions glorify and entrench the aged and the male. This alienates over a half the population from decision making process which determines their future and the fate of natural resources on which they depend on for survival.

The top down approaches often adopted for decision making and policy processes undermine people's capabilities to use their knowledge and experience to manage their own resources. In order to counteract what continues to be a widespread and pivotal omission of women, acknowledgement of gender roles and accounting for women's knowledge is what can lead to social equity and environmentally sound and productive development (Florent et al., 2010; Lazreg, 1998). Sustainable development requires the restructuring of existing policies to make them gender sensitive in natural resource management. Maringa (1993) lists a number of areas for policy intervention in terms of gender perspective i.e. positive legislation, education, capacity building and presentation. Citizen participation in the policy/legal processes and positive socio-cultural changes within and outside of the individual Africa, however, needs to recognise the importance of long term integral and interdisciplinary policy planning in order to conserve and manage natural resources for the benefit of present and future generations.

Studies on women in general and on African ones in particular, demonstrate the importance of women acting simply as economic agents. Policies that reduce incentives to invest in agriculture often cause environmental degradation. Appropriate policy responses to curb land degradation are hampered by data limitation and lack of micro-economic analysis of farmers’ responses to soil erosion depletion and incentives to adopt conservation measures.

The lack of gender perspective in environmental planning and implementation results because of women's absence or near absence from public domain and society has failed to recognise that women have a valuable contribution to make. A gender based framework, therefore, places both women and men at the centre of development process and recognise that men and women are affected differently by change, irrespective of heredity or environment.

2.15 The Contingent Valuation Method

The contingent valuation method uses survey questions to elicit people's preferences for public goods by finding out what they will be willing to pay for specified improvement in them. The method is thus aimed at eliciting their willingness to pay

(WTP) in monetary terms. It circumvents the absence of markets for public goods by presenting consumers with hypothetical markets in which they have opportunity to buy the goods in question. The hypothetical market may be modelled after either a private goods market or a political market. Because the elicited WTP values are contingent upon the particular hypothetical market described to the respondent, the approach came to be called the Contingent Valuation Method (Brookshire and Eubanks, 1978; Brookshire and Randall, 1978; Schulze and d'Arge, 1978).

For decades economists have been faced with the challenge of valuing public goods. The Contingent Valuation (CV) Method is one of a number of ingenious ways they have developed to accomplish this demanding and important task. Contingent Valuation method represents the promising approach yet developed for determining the public's willingness to pay for public goods. The CV Method assess the value of non-market commodities by asking respondents to match an option defined by clearly specified level of environmental goods (like air quality) and a given wealth level, with a second option defined by a more preferred level of an environmental but less preferred wealthy land. A typical willingness to pay (WTP) CV asks the respondent to determine what change in his/ her income, coupled with in the level of public good leaves his/her utility level unchanged (Mitchell and Carson, 1989; 26). The technique comprises two forms (1) employing experimental approach based upon simulation game analysis and (2) uses data derived from surveys or questionnaires. It’s normally uses either to estimate WTP for an improvement in the quality or quantity of some environmental good (employing soil conservation technologies in Kaplamai division farms) or the willingness to accept compensation for deterioration in environmental quality (soil degradation in this Kaplamai case).

Contingent valuation method however, can only be accurate as put by Randall, Hoehn, and Brookshire (1983; 635) when the respondents are confronted with well-defined situation and elicit a circumstantial choice contingent upon the occurrence of the posited situation. The “posited situation” typically includes such factors as the current level of the provision of the amenity, the amount of increase or decrease in provision the respondent is to value, how this will be provided, how the respondent will pay for it, and who else will pay for it.

2.16 The Challenge to the Contingent Valuation (CV) Research

The principal challenge facing the designer of a CV study is to make the scenario sufficiently understandable, plausible and meaningful to respondents so that they can and will give valid and reliable values despite their lack of experience with one or more scenario’s dimension. The difficulty of writing CV scenarios which accurately communicate the intended meaning to respondents who have varying levels of education, life experience, and interested in the topic like farmers in Kaplamai and soil degradation is often underestimated by researchers who have little experience in survey research. Unless the respondents understand all the components of a scenario like in the way that the researcher intends them to be understood, there is no assurance that those surveyed will properly value the good. And even if an instrument is understandable, the market it portrays must also be plausible. On the other hand unless the respondents are able to relate the Scenario (soil conservation) to their personal knowledge and experience in such a way that the market is meaningful to them, they will not be moderated to expand their effort necessary to determine their personal value for the good.

2.17 Summary of Related Literature

The search of literature on economic aspects of soil conservation identifies a few studies in Kenya and other parts of the world. This forms a basis for general theoretical explanations on the causes of soil erosion and low adoption of soil conservation technologies. The differences in infrastructure, institutions, and politics, farming systems experience with soil degradation, policy responses and natural resource base necessitate a separate site-specific investigation and response. Socio-economic characteristics are locale-specific usually. A household evaluation of smallholder farm practices like soil conservation should be in specific areas like Kaplamai division so that particular circumstances and obstacles for improvement can be addressed.

Human interactions accelerate soil erosion’s magnitude into the natural ecosystems although it also occurs naturally in the physical environment. Incorrect land uses must be originating from inter play of factors including demographic, socio-economic and political factors that force farmers to allow land degradation, but some authors argue that land users are unlikely to degrade land resources from which they make a living. Many authors however differ on whether soil degradation arises from ignorance of the farmers or ignorance of soil conservation extension workers or decision makers. Many authors have suggested a series of explanations since the causal factors of soil degradation interact. Many governments of the developing countries mistake symptoms of soil erosion to causes and hence incorrectly develop treatments for the symptoms which eventually lead to development of soil conservation program that do not work. There is therefore need for identification of the real causes of soil erosion and incentives to effective soil conservation measures.

Despite several decades of soil degradation problem, and conservation technologies, its effects on crop productivity and externalities caused by it remain extremely scarce due to unavailability of related data. Soil erosion is widely recognised as a serious environmental problem associated with agriculture but only anecdotal evidence exists on its on-site and off-site impacts.

Empirical evidence on the relationship between the role of women on smallholder farms and their participation in soil conservation has been documented (Pearson, 1992; 1998; Mutoro, 1997). This studies show that women are involved in most of the agriculture work on smallholder farms. Women while carrying out various farm activities they encounter roles concerned with soil conservation but this is undermined by households' socio-economic, farm resources and decision making characteristics.

Physical environment and public pressure influence the manner in which individuals respond to environmental degradation (Barbier and Bishop, 1995). Socio-economic, financial and institutional factors influence women's participation in environmental conservation (Kioko, 1998,Khasiani, 1992). The women's poverty, limited rights to land ownership and available resources on the farm influence their participation in soil conservation at household level.

Studies by Orodho, (1998) and Kinkinnin-MedagbeFlorent (2010) show that institution arrangements that have placed women to the periphery have resulted in women's under participation in resource management. Lack of information regarding new technologies down plays their effort in soil conservation as compared to their male counter parts though responsive to agriculture development.

The present study deviates from the reviewed cases in that it employs contingent valuation method to estimate the willingness to pay (WTP) for an improvement in the quality and quantity of soil conservation practices. It addresses socio-economic issues affecting soil erosion and conservation in a specific area using farm household model with emphasis on gender roles in soil conservation, unlike the classical approaches used by most of the earlier studies.

2.18 Theoretical Framework

In this study the household is defined as a group of individuals who reside together, pool all or most of their income, and basically share same food supply. This definition allows individuals to retain some income for their own expenditures and pay for some farm activities outside the household. In rural Kenya, like Kaplamai division, the data source for the empirical analysis, the household as defined above typically coincide with the nuclear family composed of a husband and wife and their children. Current economic modelling of the household follows two schools of thought: one school assumes the existence of a joint household utility function (Pitt and Rosen Zweig, 1985, 1986; Rosen Zweig; Strauss). In earlier contribution to this approach, Becker demonstrates the condition under which a multi-person household can be treated as an individual utility maximizer. The other school allows preferences to vary among the household members and proposes a bargaining theory to reconcile the differences (Manser, M. and M. Brown, (1980), McElroy and Horney, (1980) Fabella, (1982), Folbre (1984), Jones, (1983). The bargaining theory model draws heavily on the work on co-operative games by Nash.

Several farm household micro-economic theories have been developed in an effort to explain the economic behaviour of such households (Ellis, 1988; Norman, 1991; Chen and Dunn, 1996). Agricultural scientists, however, frequently deal with variations in two contrasting models of economic decision making; the neo-classical economic model of profit maximisation by a decision maker who is "completely rational" and the behavioural model exemplified by bounded rationality and satisfying behaviour. The fundamental conceptualisation of the determinants of choice upon which neo-classical economic is based is an interaction of two phenomena: tastes or preferences and opportunities or constraints (Silberberg, 1978).

Neo-classical micro-economic theory, that represents the mainstream economic thought, recognises two units of analysis at micro-economic or household level: consumers and firms and treats them independently. All consumption activities are modelled in terms of the household while all production activities are modelled in terms of the firm (Chen and Dunn, 1996). In developing countries households engage in a mixture of market and non-market production hence the complete separation of consumption from production in modelling economic decisions is not especially useful. Behavioural model on the other hand is more useful in developing countries like Kenya for it integrates information on production and consumption activities of the household. The farm household model is a behavioural model originally designed as a presentation of agricultural households and forms the theoretical framework for this study.

2.19 Conceptual framework

Building on earlier theoretical analyses of peasant household behaviour by Chayanor, Nakajima; Sen and others (Singh, et al., 1986, Bezuneh et al., 1988; Chen and Dunn, 1996), the farm household model integrates production and consumption activities. The dual nature of the farm household model makes it attractive theoretical basis for analysing household soil conservation behaviour. The model is useful in analysing interactions between different activities of the household, production for market and for home consumption, off-farm employment and consumption of purchased goods. The model is also important in analysing household aggregate level and its association with socio-economic environment. The model can be used to describe and analyse variations among farm households as far as differences in composition of their economic decisions and identification of types of households is concerned. Other than profit maximisation, the farm household model assumes that smallholder farmers have multiple objectives focusing on welfare maximization (Upton, 1987; Ellis, 1988; Scherr, 1995).

Farm household decision making in soil conservation could be presented in general farm household models adding soil conservation and social activities in utility function and in the time constraint. Following the farm household model Singh et al. (1986), theoretical farm household with soil erosion problem can be formulated as follows:

(1) Maximising utility of consumption over time, subject to: 2) Budget constraint imposed as income from agriculture production over time and any returns from non- farm activities (3) agricultural production functions (4) total time available to the household: -

The joint utility function for the j^{th} household may be specified as:

(1) $U^j = U^j(X^j, Y^j, Z^j, C^j)$

Given n family members X^j, Y^j and Z^j are 1xn vectors where X^j is payment for soil conservation practices, Y^j is payment for other farm practices, and Z^j is leisure. The personal characteristics of the household members (C^j) such as age, tastes and preferences are parameters of the utility function. More specifically, C^j is an mxn matrix of the m personal characteristics for the n family members.

$$(2) \qquad PxX^J + Py\,Y^J = \sum_{i=1}^{n} W^{ij} L^{ij}$$

The Px households budget constraint is where Px is the price of soil conservation measure, Py is the price of other farm activities and services, W^{ij} is the i^{th} individuals wage rate in the j^{th} household, and L^{ij} is labour hours or time worked. Each household member is also limited by time.

In line with Grass-man, the total healthy time available to an individual can be specified as a function of his/her farm work (Strauss et al., 1986).

$$(3) \qquad L^{ij} + Z^{ij} = f^{ij}(X^{ij})$$

The maximization of (Equation 1) subject to the constraints (2) and (3) leads to the following reduced form demand equation for conservation practices for the i^{th} individual in the j^{th}, Household (Pitt and Rosenzweig, (1986):

$$(4) \qquad X^{ij} = g^{ij}(Px, Py, W^j, C^j)$$

Where w^j is a vector of wages of n individuals and C^j is the matrix of the personal characteristics. Equation (3) enhances the model by providing a factor which can influence the household willingness to pay for soil conservation practices. From equation (3), individuals with a higher value of time (wage) might be willing to pay more for soil and water conservation practices at household level. Furthermore, equation (3) implies that the household decision may itself affect the total quantity of resource available for allocation.

In the bargaining model, the i^{th} household members' utility function in the j^{th} household is given by:

$$(5) \qquad U^{ij} = U^{ij}(X^j, Y^j, Z^j, C^j)$$

Where the variables X^j, Y^j, and Z^j are vectors across the n household members including the i^{th} individual. The i^{th} individual' utility depends not only on one's own willingness to pay for soil and water conservation practices, other practices and services and leisure, but also on other members of the household. This reflects utility interdependence that occurs among household members who care about each other's welfare. Tastes and preferences are influenced by the personal characteristics of the individual and other family members.

If the households' co-operation breaks down, individual incomes are no longer pooled and common farm practices are not shared. In the event of non-co-operation and the break-up of the household, the individual seeks to maximise utility function.

(6) $U^i_o = U^i_o(X^i, Y^i, Z^i, C^i)$

This equation is subject to individual's budget and time constraints. The individual's utility pay off under non co-operation, which is referred to as "threat point", is represented by the indirect utility function.

(7) $V^i_o = V^i_o(PxPy\ W^i, C^i)$

Threat points serve as bargaining chips in reconciling preference difference between individuals in the household since it represents how well a person would do if a bargained solution is not achieved.

The Nash solution to the bargaining problem of household is obtained by choosing values of vectors X^j, Y^j and Z^j for various individuals to maximise the utility gain product function.

(8) Maximise $N = \text{Max} \prod_{i=1}^{n} [U^{ij} - V^i_o]$

This function represents the product of each individuals gain from a co-operative agreement over next best alternative, which is the threat point shown in equation (7).

This optimisation yields the following reduced demand function for soil conservation for the i^{th}individual in the j^{th}household (Manser and Brown, (1980), McElroy and Horney, (1981)

(9) $X^{ij} = h^{ij} (Px, Py, W^{j}, C^{j})$

Where Px and Py are market prices of food and other goods and services, W^j is the vector of wages for household members; C^j is the matrix of personal characteristics. The bargaining model thus yields the same reduced form - demand function for farm practices as in equation (4) for the joint household utility function model. In either model, an increase in the wage rate of individual will result in an increased willingness to pay for soil conservation.

The study focuses on household willingness to pay for improved soil conservation. To obtain the estimating equation utilised in the empirical analysis, the household demand for improved soil conservation for the j^{th} household is specified based on equation (4) as

$$(10) \qquad X^{j} = \sum_{i=1}^{n} X^{ij} = \sum_{i=1}^{n} g^{ij} (Px, Py, W^{j}, C^{j})$$

This means that the demand for improved soil conservation by the j^{th} house-hold (x^j) is equal to the summation of the food demand of the individuals in that household. If the equation (4) is then divided by equation (10)

$$(11) \qquad \frac{X^{ij}}{X^{j}} = \frac{g^{ij}(Px, Py, W^{j}, C^{j})}{\sum_{i=1}^{n} g^{ij} (Px, Py, W^{j}, C^{j})} = r^{ij}(Px, PyW^{j}, C^{j})$$

The left hand variable, X^{ij} / X^{j}, reflects the individual demand for improved soil conservation in relation to the total improved soil conservation demand of the household. The assumption that prices are constant has frequently been made in the household consumption studies based on survey data. This study treats prices as constants in household allocation division. Furthermore, prices are invariant for the members of the same household. Hence, the resulting estimating equation is

$$(12) \qquad \frac{X^{ij}}{X^{j}} = r^{ij}(W^{j}\, C^{i})$$

Both the joint household utility function and the bargaining model lead to equation (12), which states that an individual's demand for improved soil conservation in relation to the total amount the household is willing to pay is determined by the wage rates, farm income and characteristics of the household members. Equation (12) constitutes the basic relationship analysed in the empirical section of the study.

The empirical analysis also covers young children, who represent a special case, since they do not make current economic contribution to the household and have no alternative opportunities independent of the household. Backer's altruistic dictator model of the household is particularly relevant in this case, because of the parents control over allocation of household resources to children (Folbre, 1984 p.307). Altruism is the key factor in the distribution of household resources to children because parents care deeply about the welfare of their children.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology employed to attain the objectives of the study. The chapter begins with a brief description of the study area and then presents sources and types of data collected, the sampling design and the procedures followed. To conclude the chapter, the survey instruments and techniques for data collection are discussed.

3.2 The study Area

Kaplamai division is one of two administrative divisions of the Trans Nzoia East sub County in Trans Nzoia County of Kenya. The other division is Cherangani. Kaplamai has a total area of 25,344.2 hectares (approximately 253.442 km^2). To the North are West Pokot and Marakwet Sub Countys, to the North West is Kwanza Sub County, to the South UasinGishu Sub County to the East is Cherangani division. The altitude ranges from 1700 m to 2310 m above sea level. Kaplamai division comprises of 5 locations, (i.e. Makutano, Sitatunga, Sinyerere, Motosiet and Kaplamai) and a total of 9 sub-locations (i.e. Kapsara, Kapolet, Biribriet, Makoi, Orombe, Chematich, Sinyerere, Motosiet and Kimoson).

The division has a high prevalence of soil erosion since it's characterised by high rainfall, sloppy terrain and highly erodible soils making it very susceptible to soil degradation (Jaetzold and Schmidt, 1983). Moreover, Kaplamai division has intensive land use, declining per capita food production, and diverse farming systems and natural environment (CBS 2001, Jaetzold and Schmidt, 1983). Below is a map showing the study area.

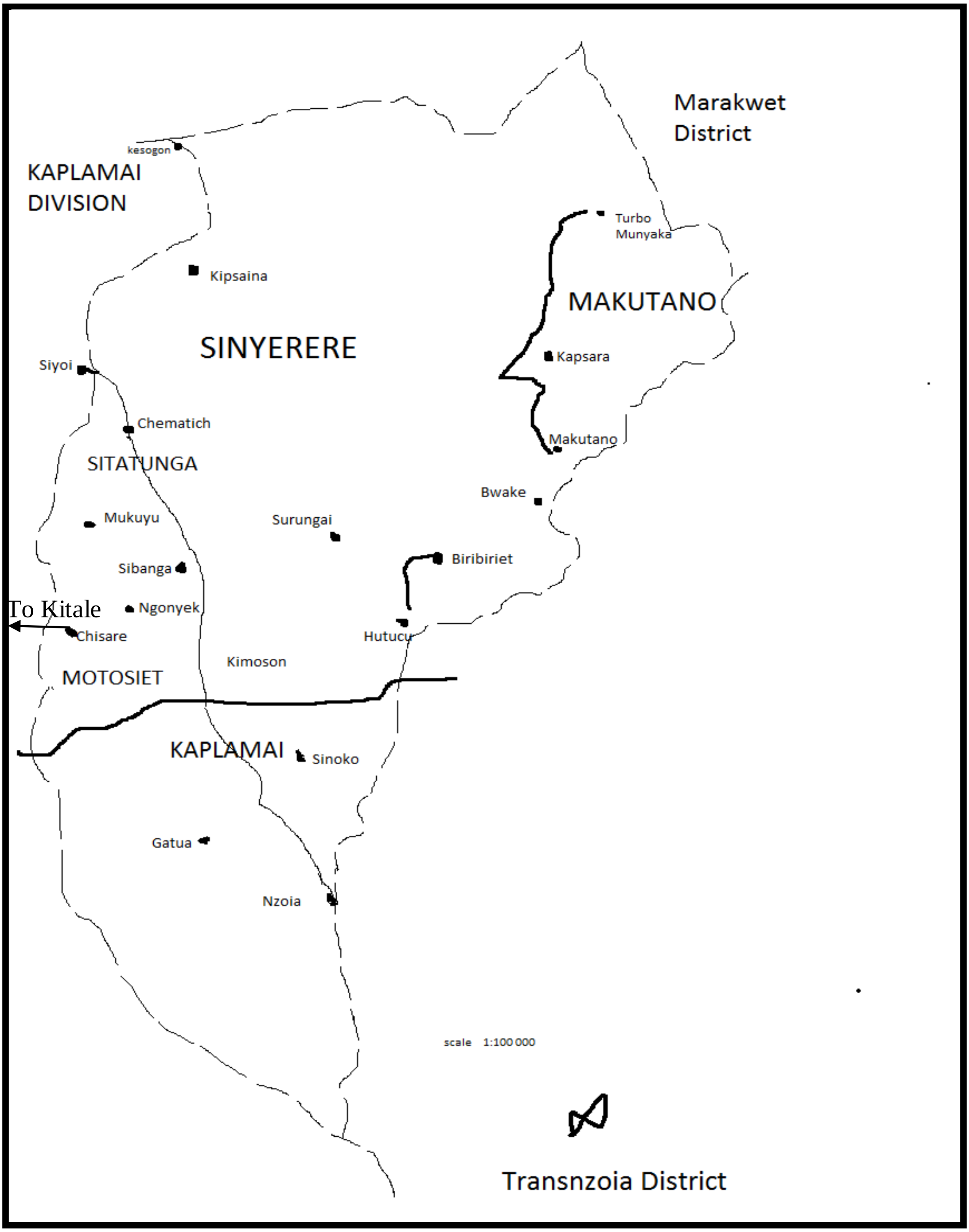

Figure 3.1 Map of Kaplamai division, Trans Nzoia County

3.2.1 Topography, geology and soils

The study area, which encloses Saiwa swamp, is endowed with abundant surface water resources. It has 9 km of rivers with a combined discharge of 4.5 km (cubic metres). The water table is shallow in some parts of the division at about 2.1 m below the ground surface resulting in numerous springs flowing in the study area. Saiwa wetlands within the study area are maintained by river Kapenguria and river Sinyerere. River Sinyerere originates from Mt. Elgon while Kapenguria river originates from Cherangani hills (Jactzold and Schmidt, 1983)

Saiwa Swamp National Park on the other hand is a bottom valley (Jactzold and Schmidt, 1983) that is traversed by the permanent Saiwa river, a tributary of the Nzoia river which drains into Lake Victoria. The soils in Sinyerere location are described by Jactzold and Schmidt (1983) as having developed mainly on infill from limestone and undifferentiated basement systems rocks. These soils are very deep, dark red to dark reddish brown in colour, and consist of friable sandy clay to clay, with acid humid top soil. The soil structure is weak to moderate to high bio porosity. These soils are well drained (KARI -Kitale 2009).

3.2.2 Population and economic activities.

The Kaplamai division has a population density of 341 people per km^2 and has high agricultural potential hence the reason for it being chosen as a study area (CBS, 2001). The division is one of the densely populated areas in Trans Nzoia East sub County. According to 2009 population census, the population of Kaplamai division was estimated at 87,560 with about (17,944) farm families and 20,265 households assuming growth rate of 3.5% per annum (GOK, 2006; CBS, 2001,)

Table 3.1: Composition of sample size by Location

	Population	Sample population	Sample %
Kaplamai	14,867	40	0.26
Motosiet	15,881	42	0.26
Sinyerere	24,168	113	0.46
Sitatunga	16,580	28	0.16
Makutano	14,867	8	0.05
Total	86,363	231	2.67

Kaplamai division is inhabited by multiple ethnic groups that have migrated from other parts of the country (Kenya) to benefit from the former White Highland settlement schemes in Trans Nzoia East Sub County. In particular, there are immigrants from Bungoma, Baringo, Elgeyo, Marakwet, Kericho, Kisumu, Kisii, Kiambu, Machakos, Nandi, West Pokot and Turkana Sub Counties. These people who belong to different ethnic groups are settled in separate parts of the area. The general pattern of land use in the area occupied by each group is similar in form of crop mix, despite small differences that are related to socio-economic situation of each family. The result of this growth in population is increased pressure on land arising from increased demand on various resources thus exacerbating the existing pressure on land.

Agriculture is the backbone of the Kaplamai's economy and the nation at large. It supports slightly over 80% of the population in Kaplamai and the remaining population is supported by other activities such as off-farm employment and trade (MOA, personal comm.2009). The current owners of the land are mainly smallholder farmers with farm sizes ranging from less than 1 acre to about 20 acres. Maize is the main crop grown (covers 80% of the total acreage) in the area for both cash and subsistence production. Other crops grown include tea, beans, citrus, pyrethrum, bananas, finger millet, sweet potatoes and various vegetables. People grow these crops a long side trees in a rudimentary agro-forestry system. Trees grown include Grevillea, Sesbania, Cypress, Eucalyptus and Markhamia. Other enterprises in the area include livestock enterprises such as dairy, poultry and rearing of small ruminants on a small scale.

3.2.3 Climate

The rainfall in Kaplamai division averages between 1000 mm and 1250 mm per annum and occurs in one long season from March to October with two distinct peaks in April-May and July-August. The dry season is from November to February. Rainfall reliability is good with a 0-15% probability of getting less than 750 mm annual rainfall. Ecologically the division falls in the Upper Midland 4 (UM_4) and LH_2 zone. The UM_4 has higher agricultural potential than LH_2 and is suitable for growing maize, beans, and many other crops as mentioned above as well as rearing cattle and small ruminant animals (Jaetzold and Schmidt, 1983). Temperatures in the division average 18^oC during wet season with minimum of about 8^oC, although temperatures as low as 4 (have been recorded and mean maximum of about 26^oC). February is the hottest month while July is the coolest (Jaetzold and Schmidt, 1983).

3.3 Data requirements, Sources and Types

The study sought data on a diverse set of variables that were both qualitative and quantitative in nature. The study aimed to assess the influence of variables on smallholder farmers' awareness and response to soil conservation in Kaplamai division. Qualitative data was sought to establish patterns that emerge between variables and smallholder farmers, and response to soil erosion. The magnitude of soil erosion and conservation in the area was sought especially by the types of soil conservation measures commonly used by smallholder farmers. Reasons for popularity of some measures of soil conservation to smallholder farmers were established.

The data collected was household information regarding the household objectives, awareness and experiencing of soil erosion problems, a list of relevant farm resources, soil conservation techniques practised by the households, the constraints faced in adopting soil conservation practices and the role of either male or female in the adoption of soil conservation practices. Adoption of soil conservation technologies was measured by farmers' responses if they knew and used any soil conservation technologies by their response to the willingness to pay questions for continued services on soil conservation and the researcher assistances', confirmation that these practices were on the farm. Data on farm household socio-economic characteristics correlation to decision and to adoption of soil conservation practices was included. Also included were attributes of the household male and female (gender, occupation, education level, contribution to soil conservation practices, farm size, income sources and amounts, livestock, crops and tools), household demographics, land tenure, and access to credit and extension education.

This study was based on both primary and secondary data. The secondary data was obtained by reviewing literature in various book chapters, annual reports, and population Census reports and journals. These and other relevant materials including unpublished sources were consulted. KARI regional research centre, Kitale, Central Bureau of statistics Kitale, Ministry of Agriculture offices of Provincial Director of Agriculture Nakuru, Agriculture office Trans Nzoia East and Kaplamai division, Egerton and University of Eldoret libraries formed the major sources of data.

Primary data were collected in April and August of 2009 in a single period cross section and this was from randomly selected farm households in the entire Kaplamai division and from key informants using informal and formal survey techniques respectively. From the above sources, the following information was sited; data regarding households' awareness of soil erosion problems, inventory of farm resources, soil conservation practices adopted and factors influencing the adoption of soil conservation practices by farmers were gathered.

The response to soil erosion via specific soil conservation measures adopted by farmers was determined by the total number of soil conservation technologies adopted on the farm. Farm household socio-economic characteristics such as farm resources and decision making techniques were also looked at. The farmers were assessed against the total number of soil conservation measures on the farm with the latter serving as an indicator of farmers' response to the problem of soil erosion.

The study dealt with individual farm households because an understanding of household allocation was necessary to fully evaluate the effect of government food and environmental policies or specific development projects. Secondly, the individual farm household is a dynamic unit where all decisions relating to resource allocation in farm management are made. Usually decisions are made by the head of the household (i.e.

either the male or female), or through consensus among household members. Thirdly, household level approach was useful in the study of on-site effects of soil erosion on the farm productivity and the other externalities. As households struggle to improve food productivity by soil conservation, the downstream farmers benefited from clean water, increased food productivity and reduced erosion. Such outcome was unlikely because the invisible hand is known to perform very poorly under imperfect markets and where there are externalities as in the case of most developing countries like Kenya. Lastly, farm household level studies provide a clear picture on soil conservation that national studies may miss. The household level analysis outlines opportunities and difficulties that are applicable to a specific agricultural society and provides description and explanation of adoption of new or latest technologies. Information on both soil conservation adoption behaviour based on farm households determinants of soil conservation is important in farm management and future policy direction.

3.4 Sampling Design and Procedures

The impracticability of surveying the universe through a census provided the rationale for sampling farm households in Kaplamai. A simple random sampling procedure was used in selecting households to whom a questionnaire was administered. The study covered the whole of Kaplamai but it was not possible to group the sample together because the soil conservation catchment areas were scattered all over the division. The researcher deemed it necessary to collect data in soil conservation catchment areas so as to gauge the participation by gender in soil conservation practices.

The following procedure was followed with regard to determining the study sample. A list of locations and sub-locations in the division was obtained from the divisional Agricultural office. The study area was studied in depth by the enumerators, so as to carry out simple random sampling. The catchment and non-catchment areas were explored and pre-test sampling done. From the results, it was deemed necessary to sample from the whole division and the list of all farmers was obtained from the farmers register at the division and simple random sampling carried out. From the list of locations and sub-locations it was discovered that most locations had just one sub-location hence there was no need to do the sub-location sampling. Households were given numbers on pieces of paper which were placed in a box. Subsequently, the enumerators picked the papers at random which constituted a sample of 116 selected households to be visited. On reaching the household, if they didn't find both the male and female at home, they were forced to move to the next household so as to interview both male andfemale on the same day, but individually.

Upon examining and editing to asses completeness and consistency of responses, 232 (97%) of the questionnaires(out of 240) were considered useful for analysis and given serial numbers. The survey questions were numerically coded and responses stored in spread sheet, Excel, under assigned variable names. The data was later imported into the Statistics Package for Social Sciences (SPSS version 12.1) for further analysis.

3.5 Unit of Analysis

Individual households were the focus of the study. The enumerators interviewed both male and female individually. The individual farm household was dealt with for several reasons. The individual farm household is a unit where all decisions regarding resource allocation in farm management are made. Farm level approach is appropriate in evaluating the on-site effects of soil erosion on productivity. The farm therefore acted as a ground from which to evaluate households' awareness and response to soil erosion problems. Farm level studies were perceived by the researcher to offer insights that regional or national studies often miss or sometimes overlook. This household level analysis can pin point resource abundance and scarcities that are not experienced across regional or national spectrum of agrarian society and thus provide an explanation for adoption of certain soil conservation methods (Paulos, 2002; Graff, 1993).

In this study the enumerators sought information about broader soil conservation methods by rural farm households by comparing results of a cross section of farms to determine the factors that influence soil conservation and the measure to improve adoption of soil conservation technologies. Past research has stressed the need to understand soil conservation at household level with emphasis on institutions and individuals who undertake soil conservation decisions (Shiferaw et al., 2001, Rocheleau, 1993). The study distinguished the gender of the farmer as a significant factor in soil conservation, and therefore analyses the ways in which an individual households respond to soil erosion on their farms in regard to differing social and economic environments.

3.6 Survey Instruments and Data Collection

3.6.1 Survey Instruments

The data collection procedures were used either singly or in combination to obtain the primary and secondary data required for the study. The fieldwork preparation and collection of both primary and secondary data was organised in several phases. The first phase involved field preparation work and survey of the study area. Procurement of 'Research Permit' from the District Officer's Office, Kaplamai division, and courtesy visits to the Agriculture Extension Officer in charge of the randomly selected areas followed. Questionnaire pre-testing was done and this assisted in development of rapport with farmers in the company of Agricultural Extension officers. This helped to gain confidence with the interviewees and facilitate easier entry in the study area by the researcher during the actual survey. Analysis of the data resulting from the pre-test was done. From the results of the pre-test survey, restructuring of the questionnaire by incorporating the missing information, omitting irrelevant questions and paraphrasing questions that appeared ambiguous to the respondents was done.

Phase two of the field study involved the actual field work. This concerned actual methods used in primary data collection which consisted of questionnaire, structured interview and observations. Group discussions were also used in the advanced stage of data collection to obtain views from farmers' groups.

In phase three, additional information of secondary data from both published and unpublished sources were collected. This mainly focused on the role of household members in soil conservation and promotion of agricultural productivity. Background information such as physical and socio-economic aspects was also gathered.

3.7 Data Collection

3.7.1 Questionnaire Administration

A questionnaire composing of both open and closed ended questions was designed to help collect primary data. The questionnaire consisted of five sections; general information, farm-farmer characteristics, farm resource assessment, willingness to pay questions and socio-economic and demographic profile (see Appendix). Personal field observation and experiences, interview of the key informants such as extension officers, local leaders and farmers were used to obtain additional information by the use of a check-list.

Training of enumerators was necessary before the draft questionnaire was administered. Upon the correction and receipt of final questionnaires, the enumerators again received one day's intensive training. The training included translation of the questionnaire to Kiswahili language widely understood by the residents of Kaplamai since it is a cosmopolitan area. In the training also were the role playing on administration of the questionnaire and on how to ask questions and record answers. The enumerators were also trained on how to estimate the size of the household farms since most of the respondents were not sure of the size and the land title deeds were not readily available.

At the household, face to face interview method was used by the enumerators to obtain information from the study area. The enumerators introduced themselves to the household and explained the purpose of the visit and the aim of the study. The enumerators then asked to speak to both male and female at each and every farm they visited. Where either of the members was absent the enumerators opted to either come another day or to move to the nearest farm household since it was necessary that both male and female get interviewed the same day before they discuss to each other. To allow for the verification of information such as type and number of soil conservation structures, gravity of erosion and farm size, the interviews were conducted in the fields. The completed questionnaires were checked for omissions and commissions and where mistakes were detected, the matter was raised with the enumerator and where necessary the respondents were revisited to correct the errors. At the completion of the exercise two hundred and thirty two respondents(116males and 116 Females) were interviewed.

3.7.2 Structured Interviews

The structured interview was used to collect data from the key informants. Among those interviewed included divisional Agriculture Extension officers in Kaplamai division, VI-Agro-forestry officers and the Sub County Agriculture officer (SCAO). They were identified as having information on participation of smallholder farmers on agricultural transformation and soil conservation in Kaplamai division.

The open-ended interview schedule used allowed respondents freedom to go beyond simple responses to questions asked and reveal their views freely. The questions could deviate from the planned and centre on points that seemed important according to the respondents. Results obtained did not land themselves readily to qualification but did help to generate and clarify issues identified in the study.

3.7.3 Observation method

The observation method was used to identify actual soil conservation structures on the farm, the nature of farm organisation, farming characteristics, farming equipment, tools and estimated farm slope. The severity of soil erosion was based on observable features and characteristics of soil erosion on the farm. These included the presence of gullies, washed plains, colour of the top soil, road cuttings, routes and paths and the level of sediments deposited in river valleys and dried streams. The general topography of the farm defined the severity of soil erosion. Farms in valleys and lower slopes experienced least erosion while those on steep slopes were subject to severe erosion. Observation method's objective was to see whether information given by respondents tallied with the observable features on the farm, especially signs of soil erosion and type of soil conservation structures.

3.8 Limitations of the Study

Cost and time spent in undertaking the study formed most significant factors influencing the success of the field work. The scope of the study was limited for it required a lot of stationery, travelling expenses and money for secretarial services plus subsistence allowances. The transport network in the study area was a hindrance as well. There were no clear routes linking farms to the main transport routes. Much of the movements were by walking, using bicycles or hiking lifts on tractors and private vehicles whenever possible. This lengthened the period taken to collect primary data.

Languages of communication caused another problem although Kiswahili and English are the national and official languages in Kenya. It was difficult to obtain data from respondents who were not conversant with either of the two languages. This called for use of a translator hence distortion in the flow of communication between the respondent, and the enumerators. The translator had to be taught the objectives and need for objectivity of the study to minimize the problem. Few cases of lack of cooperation from the respondents were observed, which necessitated explanation of the main objective of the study to the respondents. This assisted in establishing good rapport with the respondents.

3.9 Conceptualisation of Key Variables

The variables in the study fall in two categories thus the independent and dependent variables. The dependent variable in the study was awareness and response of smallholder farmers to soil erosion. Awareness refers to knowledge by smallholder farmers to the existence of soil erosion and their knowledge of various conservation practices in the study area. Awareness (or lack of it) to soil erosion is a factor to reckon with in determination of adoption of soil conservation measures. Response to soil erosion refers to reaction to soil degradation by smallholder farmers in relation to adoption of soil conservation practices. Response in the study was assessed in terms of the total number of soil conservation measures adopted on the farm. The independent variables in the study included farmers' age, farm size, education level, family size, family income, household decision making and farm implements.

Conceptual Framework

Independent Variables

- Perceptions
- Adoption of soil conservation measures
- Socio-economic factors
- Willingness to pay for soil conservation services

Dependent factors

Level of adoption of soil conservation structures such as contour ploughing, bare terraces, trees/hedges, and cut- off drains.

In summary, the model does not incorporate the role of risk and uncertainty, and its influence on household decision making, though it is well known that smallholder households face several types of production risks.

3.10 Data Processing for Analysis

Questionnaires were examined and edited for completeness and consistency in the field. The filled out questionnaires were numbered, coded and entered into Spread sheet to facilitate data analysis. Frequency distribution and cross tabulations between key variables in the study were used to describe data sets. The inferential statistics used in hypotheses testing was the regression models. Pearson's correlation analysis was used to give support to the regression model as well as testing the suitability of the variable before entering into the model. The hypotheses were tested at 0.05 confidence level.Upon examining and editing to asses completeness and consistency of responses, 232 (97%) of the questionnaires (out of 240) were complete and thus useful for analysis and given serial numbers. The survey questions were numerically coded and responses stored in spread sheet, Excel, under assigned variable names. The data was later imported into the Statistics Package for Social Sciences (SPSS. 12.1) for analysis**.**

3.11. Analytical framework

The data from this study were analysed using descriptive statistics (mean, standard deviation and range), regression (Logistic) analysis Greene, (2008) and Pyndick, (1998). It is realised that descriptive statistics do not effectively predict the combined effect of explanatory variables on the dependent variable. This problem was however, solved by selecting and using appropriate econometric models. Logistic regression was used to compare relative important variables, to evaluate interaction effects and to determine the impact of the control variables. To analyse this data, binomial logistic regression model was used. Binary logistic (logit) is used when the dependent variable is dichotomous and the independent variable can take any form. The logit model was used to evaluate factors influencing adoption of soil conservation practices. The dependent variable indicated whether the farmer adopted the practice (=1) or did not adopt (=0). The logit regression model applies the maximum likelihood estimation after transforming the dependent variable into logit variable (the natural logarithm of the odds of the dependent variable occurring or not). The logit regression calculates changes in the log odds of the dependent variable but not changes in dependent variable. Logit model is a logistic distribution bound between 0 and 1.

The analytical framework for adoption of any technology is based on assumption that the expected utility will be maximized if the new soil conservation technology is adopted and if the probability of adoption were one (Rahn and Huffman, 1984).The study assumes that the smallholder household will adopt one or a combination of soil conservation practices if the expected value of benefits accrued from using the new technology exceeds the use of the current one.

The study also assumes that a smallholder household faced by technology alternatives maximizes the anticipated utility when it chooses the technology u^1 or otherwise $U^{0.}$ Adoption only occurs if $U^1 > U^0$. When a household adopts soil conservation technology it anticipates that the net benefit is greater than zero.

Production and consumption decisions are simultaneously determined in practice, making mathematical modelling more difficult. Empirical farm household modelling has previously employed different approaches for analysing production and consumption. Bezuneb (1988) assessed impact of food for work as payment in kind directly to people who provided labour for public works, particularly erosion control and water harvesting devices in Baringo district, Kenya using linear programming and econometric model for analysing production and consumption respectively. This study on the other hand provides a partial analysis of the production component of the farm household model in soil conservation to the exclusion of household expenditure and prices faced by the household.

Statistical inferences assume that a model to be estimated and used for making inferences is correctly specified (Aldrich and Nelson, 1984). The presumption is that substantive theory of concern gives rise and justifies a particular statistical model. Wrong predictions result from incorrect model specifications which lead into wrong predictions as all properties of the estimates may be incorrect. The two commonly mentioned aspects concern specifications of correct set of variables to be included in the model and the nature of functional form. Three statistical functional forms namely, linear probability, cumulative logistic (Logit) and cumulative normal (Probit) models, are available for analysing binary choice problems such as adopt or not adopt a technology (Aldrin and Nelson, 1984, Jarvis, 1990). Most researchers prefer assuming the simplest case (Aldrich and Nelson 1984) since they are theoretically simple hence make linear specification simple. The main limitation of linear models is that their predictions may lie outside the limiting interval (0,1) imposed by the laws of probability (Pindyck and Rubinfeld, 1998, Aldrich and Nelson 1984) such a result forces arbitrary defining of outcomes which are less than 0 or greater than 1 (Capps and Kramer, 1986). Since both Logit and Probit models are cumulative probability functions, the distribution of the difference between the error terms associated with one choice or another is estimated, thus eliminating the 0-1 problem associated with linear probability model. Moreover, they compel disturbance terms to be homoscedastic because the forms of probability functions depend on distributions of the difference between error terms associated with one particular choice or another. Again, linear probability models assume that marginal effects of the independent variable X^i remain constant. This is unrealistic. It is for instance; more realistic to assume that probability of adopting a soil conservation measure (Yi) is non-linearly related to household income. At very low income, the household may not adopt any soil conservation. At some higher level of income however, the household will most probably adopt some soil conservation measures. Additional income thereafter will have very little effect on the probability of adopting soil conservation measures. At both ends of distribution, the probability of adopting some soil conservation measure will be unaffected by small changes in income.

Linear models are often non tenable and are replaced by nonlinear models such as Probit and Logit models with some theoretical guidance to the contrary. Probit and Logit models enhance explanation of the effects of several predictor variables, which may be qualitative, categorical or a mixture of the two. Both models are normalisation's and so similar as to yield essentially the same results. The convenient transformation is one that fixes standard deviation at 1 in Probit and 1.8138 for Logit (Aldrich and Nelson, 1984). From empirical evidence, it is demonstrated that neither Logit nor Probit has advantage over the other (Aldrich and Nelson, 1984; Capps and Kramer, 1986). Both analyses applied on same set of data should produce coefficient estimates which differ by a factor 1.8. Coefficient for Logit is 1.8 times the value of Probit. The choice between the models therefore revolves around convenience such as the availability and flexibility of the computer programs and personal preference and experience. For this study, since the dependent variables were dichotomous thus adopt or not adopt a soil conservation measure, the Logit model was used since it is computationally simpler and convenient and the computer program is readily available. Following (Agresti. 1996), the functional form of the Logit model was specified as:

$$In[P_x/(1-P_x)]=\beta_0+\beta_iX_i+\beta_2X_2+\text{------------------------------}\beta_kX_{ki}$$

Where the subscript i is the ith observation in the sample, P_x is the probability of an event occurring for an observed set of variables X_i, the probability that the farmer adopts a soil conservation practice and (1-Px) is probability of not adopting. β_0 is the intercept term, and β_1, β2, ---------β_k are estimated coefficients of independent variables X_1, X_2, -----------$X_{k.}$ For this study, an adopter was a household that adopted one or more soil conservation practices. The dependent variables for this adoption models were dummies showing whether or not a soil conservation practice had been adopted.

To choose an appropriate model to reflect the complex household allocative decision in soil conservation is problematic. The determinants of decisions to invest in soil conservation were however, specified based on a group of working hypotheses suggested by economic theory and empirical findings from similar studies. It was hypothesised that a decision to adopt or not to adopt new technologies is influenced by a combined effect of many factors related to household's objectives and constraints. A major assumption was made that the presence of a given soil conservation measure on the farm is determined by the current household socio-economic variables.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

This Chapter contains data analysis, empirical results and discussion of the findings. Section 4.2 deals with descriptive statistics. The presentation of empirical findings and discussion of determinants of soil conservation fall in sections 4.3, 4.4, 4.5, 4.6 and 4.7 respectively. The empirical results and their discussion are based on the questionnaire responses, interview of key informants and field observation. The aspects covered in this chapter include description and discussion of socio-economic and demographic characteristics of sampled households, perception of effects of soil conservation, adoption rates of selected soil conservation measures, farmer perceived constraints to soil conservation and adoption by gender.

4.2 Descriptive Statistics

First and foremost, frequency distributions were computed and used to explain the direction of the difference between characteristics being compared such as profile of household goals, adoption rates of soil conservation measures and farmers' perception of constraints to adoption of soil conservation measures. Descriptive statistics table4.1, especially mean, median and standard deviation were used to summarise quantitative variables such as farm resources, while the mode was used for quantitative analysis. The problem of multicollinearity between pairs of explanatory variables was assessed by computing Pearson correlation coefficients. Logit analysis was used to determine the influence of household's socio-economic attributes on decisions to adopt particular soil conservation measures.

Table 4.1Summary of key variables used in analysis

Description of variables	Gender	N	Mean	Std. Deviation	Minimum	Maximum
WTP for service charge per year	Male	116	1.16	0.364	1	2
	Female	116	1.16	0.364	1	2
	Total	232	1.16	0.363	1	2
Maximum amount of service charge WTP	Male	99	465.35	797.093	0	7500
	Female	101	354.26	750.809	0	7500
	Total	200	409.25	774.122	0	7500
Highest level of education	Male	116	2.53	0.899	1	5
	Female	116	2.21	0.786	1	5
	Total	232	2.37	0.858	1	5
Average net monthly cash income	Male	116	23324.14	28679.876	500	214500
	Female	116	26192.24	62053.252	500	612000
	Total	232	24758.19	48254.752	500	612000
WTP	Male	99	3.4949	1.69256	1.00	6.00
	Female	101	2.8713	1.74163	1.00	6.00
	Total	200	3.1800	1.74148	1.00	6.00
Bare terraces	Male	116	1.42	.496	1	2
	Female	116	1.42	.496	1	2
	Total	232	1.42	.495	1	2
Provision of finance	Male	116	2.84	1.336	1	2
	Female	116	3.37	1.169	1	2
	Total	232	3.11	1.280	1	2

4.3 Perceptions on soil conservation

4.3.1 Perceptions on effect of soil erosion

The findings showed that general perceptions of the interviewed farmers were similar among the sexes although the numbers of females were slightly higher for each factor considered (Table 4.2). Majority of the responses indicated that over 57% of the households viewed soil erosion as causing low soil fertility that results in low crop yields while about 31% felt that carrying away of planted seeds was due to soil erosion. About 12% of the respondents attributed sedimentation by uphill users to erosion problems. These results suggest that there was a relationship between agricultural productivity and the state of soil erosion on smallholder farms.

Table 4.2: Perception on effects of soil erosion by household (percent proportion)

Soil erosion effect	Male	Female	Household
Low fertility / low crop yields	28.0	29.3	57.3
Sedimentation by uphill users	5.2	6.7	11.8
Carrying away of planted seeds	14.9	16.0	30.9
Total	48.1	51.9	100.0

4.3.2 Household perception on soil conservation

The respondents perceived soil erosion as a major problem when soil conservation efforts are ignored (Table 4.2). The constraints to soil conservation as perceived by the respondents result from a myriad of causes. This can be explained by the fact that many young people are now going to school and those through with education at whatever level have moved to urban areas in search of formal employment, causing labour shortage and also expensive to hire. The notion that "*farming is a poor man's job, is* *dirty work and often not reliable due to unpredictable weather patterns*" is misplaced since agriculture has remained the mainstay of Kenya's economy for long and this is not about to change soon.

4.3.3 Economic Perceptions on Adoption of Soil Conservation Practices

The farmers interviewed showed varied perceptions regarding the economics of adopting available soil conservation technologies. More than half of the respondents (51%) perceived lack of finances and the high attendant cost of adopting soil conservation technologies as the main reason behind low adoption rates. About 20% of the total respondents `ranked second soil conservation technologies as too labour intensive and limited labour availability as third constraints to adoption of the soil conservation practices (Table 4.3). These three factors or perceptions constituted over 90% of the respondents, meaning that they are the most considered factors when the farmers make economic decisions as to whether or not to adopt a given soil conservation technology on the farm.

The results suggest that farmers may perceive low fertility and low crop yields but may not adopt the effective soil conservation practice to reverse the problem. They may opt for the soil conservation practices that can be easily adopted such as contour ploughing even if they are not very effective. The results of this study are in agreement with earlier studies' findings for example(Solis et al. 2007 and Odendo et al. 2009), which found that perception of soil degradation was an important precondition for adoption of soil conservation practices. The findings of this study contrast similar studies by (Odendo, et al. 2009) where perception of severity of soil fertility depletion on farms had a negative significant effect on adoption of inorganic fertilizers.

Table 4.3: Farmers' Perception of Constraints to Soil Conservation

Constraints	Perception % by sex		Total H/holds (%)
	Male (%)	Female (%)	
Limited labour availability	10.4	9.4	19.8
Lack of finance & too expensive	25.7	25.3	51.0
Too labour intensive	9.9	10.8	20.7
Too risky	1.8	0.9	2.7
See no need for it	1.8	0.9	2.7
Small land size	0.4	0.4	0.8
Insecure land tenure	1.4	0.9	2.3
Total	51.4	48.6	100.0

Generally the major objective of the farmer is to maximize returns on investment on production factors which are in short supply but are required for adoption of soil conservation. The choice of appropriate criteria for the technology adoption should be determined by the production factor requirements of the technology and availability of production factors. It is crucial to base the analysis on local conditions and farmers' seasonal perspectives of "factor scarcity". Especially the returns to labour (gross margin per hour or man day), in addition to returns to land (gross margin per hectare) are critical but often neglected variable to understand farmers' reasoning.

But even where the financial incentives may appear attractive, a consideration of non-financial factors is required to understand the actual and potential adoption of conservation technologies. A number of studies have sought to identify barriers to adoption beyond the obvious divergence between on-farm costs and wider social benefits (FAO, 2001a). Examples are:

- Large investment costs may discourage adoption.
- The perceived risk of adopting the technologies may serve as a barrier.
- Long gestation periods for the benefits to materialize.
- Barriers may be particular to culture and recent history.

4.4 Adoption of Soil Conservation Measures by Smallholder Farmers

The smallholder farmers own land less than or equal to 20 acres and any farmer practicing one of the soil conservation practices(contour ploughing, bare terraces, trees/hedges, cut–off drains etc.) is an adopter of soil conservation practices.

4.4.1 Proportion of adopters

The results reveal that the proportion of males to females who had adopted various soil conservation practices were generally 1:1 (Table 4.4), also called 'adopters'. The results also show that about one-third (34.2%) of the total households interviewed practiced contour farming as a soil conservation measure, followed by the use of bare terraces (20.4%) and tree lines/hedges (19.5%). These three practices adopted constitute almost three quarters (74.1%) of the respondents. Use of cut off-drains and infiltration ditches present 13.3% and 2.5% respectively of the farm households who adopted these measures to conserve soils on their farms. Stone lines are hardly adopted by the Kaplamai farmers as less than one per cent (0.6%) of the households adopted them for soil management purposes on their farms.

Table 4.4: Farmers responses to adoption of soil conservation practices

Conservation practices	Male	Female	Household
Bare terraces	10.2	10.2	20.4
Infiltration ditches	1.3	1.2	2.5
Contour ploughing	17.1	17.1	34.2
Stone lines	0.3	0.3	0.6
Tree lines/hedge	9.5	10.0	19.5
Cut off drains	6.4	6.9	13.3
Grassed terraces	4.9	4.6	9.5
Total	49.7	50.3	100.0

Differences in the methods of land preparation, the quantity and quality of animal holdings, together with the method of feed provision resulted in different implications for the adoption of soil conservation measures. Hoe cultivation and the small number of cross-breed cows kept created conducive environment for the sustained adoption of soil conservation measures in study area, whereas land preparation by tractors in parts of area and large size of herds that frequently grazed on stalk made adoption of contour ploughing popular.

From the data 190 respondents (67%, i.e. 95 females and 95 males) received technical advice. As for terraces, 176 respondents (i.e. 90 males and 86 females) were helped by technical staff in the survey and layout of the terraces. Only 18 respondents had provision of labour from government funds. Off-farm conservation work was not provided for in the activities of the Divisional Planning Teams (DPTs) except for cut of drains carried out mainly on community basis. Nothing was done to control the gullies that had developed along the roads, cattle tracks, and farm boundaries. The respondents pointed out that gully erosion took place in catchments; and it was unlikely that the problem could be safely ignored for a long time.

Table 4.6: The inter-location variations in soil conservation practices

	Kaplamai	Makutano	Motosiet	Sinyerere	Sitatunga	Per cent
Bare terraces	25	8	16	68	18	58
Contour ploughing	40	8	42	108	26	97
Stone lines	1	1	8	1	5	0.01
Cut of drains	18	3	20	54	14	38
Tree lines/hedges	24	5	3	62		54
Infiltration ditches	3			8		0.06
Grassed strips				8		0.03

Almost a half of the respondents considered bare terraces beneficial to their households for soil conservation (Table 4.6). More than a half of the respondents appreciated contour farming especially on slightly larger farms for it was easy to implement as tractors ploughed. The marked inter-location variations in this regard were only as a result of differences in the types and practices implemented.

Farm inputs, particularly manure, fertilisers, terracing, compositing, biomass transfer and tree seedling/hedges were used by more than three-quarters of the respondents (Table 4.7), while pesticides, fungicides and animal drugs were used by almost a quarter of the respondents to improve soil fertility in the study area.. In spite of their heavy reliance on farm inputs, 14.3% of the respondents ranked soil conservation measures as the third most important farm input.

Table 4.7: Farm Inputs on Smallholder Farms

	Males	Females	Pooled
Fertilizer	88	83	171
Terrace	107	107	214
Composting	69	71	140
Manure use	82	84	166
Agro forestry	73	71	144
Tree/Hedge Est.	55	50	105
Biomass transfer	3	2	5

4.5 Socio-Economic Factors influencing soil conservation

4.5.1 Social Factors - Gender of the household member

In soil conservation programme there are often conflicts of interest between various groups or actors, directly or indirectly involved in such programmes. The well most known conflict is the gender conflict. Especially the problem of shifting of tasks and the increasing of workload for women can have a negative impact on a soil and water conservation project. Projects can be damaging to women’s live, when they are not looked after as a special actor group. For example, the Bura Cotton Project in Kenya, backed by ODA and the World Bank, allowed cash croppers to improve their production on irrigated land. But women subsistence farmers, with no access to irrigated plots, needed to walk further each day to cultivate land.

Gender played an important role in farming and by extension on soil conservation practices and this was why sex of the household was included in the model. Women are more responsive to soil and water conservation practices. Women are also efficient in areas of food security, sustainability and resource management (FAO, 2010).Most of the activities such as planting tree seedlings, grassed terraces and agro-forestry were carried out by the women using family labour. In most farms digging of cut off- drains and terraces was undertaken by men, using family labour. Through these responsibilities, women were directly involved in the use and management of natural resources: soil, water, and forests. Environmental degradation made it increasingly difficult for women to cope with their tasks in providing basic needs for their families. Because they were hit first and hardest, they may be most interested to be mobilised for sustainable use of natural resources. However, it is then crucial that they are helped to overcome poverty and hunger. This also means that they get control of the resources they are using, and certainly also of the benefits of any programme or project which involves sustainable management of resources.

Farmers are often reluctant to engage in soil and water conservation practices, because of the high costs and the time it takes to realise the benefits. For establishment of (physical) soil conservation measures, farmers generally lacked the necessary own family labour. They usually had to hire labourers or had to agree with neighbours to help each other in turn (labour pooling strategies at the local or village level). In planning and designing of soil conservation measures, as observed in Kaplamai division, it would be wise to make sure that the farm families cope with annual maintenance activities that form part of the farm or land husbandry operations.

It was noted that slightly more females prefer adopting hedges and cut-off drains as compared to their male counterparts while slightly more males than females prefer adopting grassed terraces in their family farm (Table 4.3). This may be explained by the fact that gender biases are influenced by aspects of food security and socio-economic returns. The female preferred soil conservation practices that provide protection from animals and petty thieves while the grassed terraces were preferred by males for these provided extra pasture for their livestock, a traditional preserve of men among the Kaplamai community.

Contour farming was the most widely practised soil conservation measure. Whenever farmers were asked about soil erosion control measures they knew and practised, contour farming and bare terraces were the most frequently practiced methods. Adoption of terraces by many households indicates the existence of soil erosion problem. The colonial policies on the use of terraces for soil erosion control was the reason behind the use of physical structures like terraces in soil erosion control as reflected in the Swynnerton plan (RoK, 1955).

Despite adoption of contour ploughing and bare terraces, most farmers still experienced problems related to soil erosion especially low fertility and low crop yields, and carrying away of planted seeds which were attributed to run off from other farms, roof catchments, and from road drainage systems. Engineers for instance, considered their work completed once they discharged run off from the road reserves. Adoption of contour farming was noticed in all the locations of Kaplamai, Makutano, Motosiet, Sinyerere and Sitatunga, since most farmers used tractors to plough and hence practised contour ploughing. Adoption of bare terraces was high in Sinyerere location due to rugged terrain in some parts of the location. Adoption of stone lines was found in only 4 households due to lack of stones in most parts of the division.

4.5.2 Educational level of the respondents

Education was assumed to make farmers understand soil conservation technology information easily. It was expected to positively influence adoption of soil conservation practices as documented by Samiee et al. (2009). In the current study, the level of education refers to the actual number of years spent at school. Seven or eight years are equivalent to primary level, eleven years secondary level, and fifteen years post-secondary level. Table 4.8 indicates that more than 50% of the respondents had obtained primary education with 56.90% for males and 52.59% for females. This represents about 55% of the total interviewees. It also shows that 31.47% of the respondents had obtained secondary education while 10.34% had no formal education and 4.31% had tertiary education.

Table 4.8 Distribution of education level according to sex of the respondents

Education Level	Female			Male			Percent Average
	Sample size	Frequency	Cumulative frequency	Sample size	Frequency	Cumulative frequency	
	20	17.24	17.24	2	1.72	1.72	9.48
Primary	61	52.59	69.83	66	56.9	58.62	54.74
Secondary	33	28.45	98.38	40	34.48	93.1	31.46
College/University	2	1.72	100	8	6.9	100	4.31
Totals	116	100		116	100		100

On average, the results show that over 90% of the respondents had some formal education and the rest (i.e. about 9%) had no formal education. Generally more men had received formal education at all levels compared to females although the proportions of those with either primary or secondary school level are comparable (Table 4.8).

Level of education of the household members was included in the model as indication for management skills or farming experience. Majority of the household members especially female had none or primary education (approx. 64%) and inclusion of education as a predictor was easier to interpret than potential variables concerning managerial ability. The expected positive effect for the level of education in adoption of contour ploughing, bare terraces, stone lines, cut off drains and infiltration ditches was consistent with conventional wisdom (Childress, 1994; Blackman and Banister; 1998) that improved farming practises and adoption of new technologies were related to higher levels of education. Odendo et. al, (2009) in a related study found that education of the household head was positively associated with both the adoption of inorganic fertilizers and combination of inorganic with organic resources. Abdulaiet.al (2011) also found education positively related to adoption of safer irrigation technologies and cropping patterns. However, Nkegbe, et al, (2012), found conflicting result on the decision to adopt compositing.

4.5.3Age of the respondents

Age was assumed to be a proxy for experience in adoption of soil conservation practices. It was therefore hypothesized to positively influence the adoption of soil conservation practices. In addition, age can also be a proxy to non- adoption of new technologies. The scenario means that increasing the farmer’s age positively influences adoption of soil conservation practices.

Age was measured by how old the smallholder farmer was by the time of survey. In the bracket of 21 and 60 years, more female were relatively younger compared to their male respondents (Table 4.9). This suggests that most female got married at a relatively younger age compared to males. The male in this area marry women who are comparatively younger in age. Majority of the respondents' are between 31-40 (28.9%) and 41-50 (26.3%) years old. This appears to be the age when those engaged in smallholder farming are actively involved in production.

Table 4.9: Distribution of smallholder farmers by sex and age

Age group	**Female**			**Male**			**Percent**
(years)	Frequency	Percent	Cumulative	Frequency	Percent	cumulative	**Average**
Below 20	-	0	0	16	13.79	13.79	6.90
21-30	24	20.69	20.69	20	17.24	31.03	18.97
31-40	37	31.90	52.59	30	25.86	56.89	28.88
41-50	30	25.86	78.45	31	26.73	83.62	26.30
51-60	19	16.38	94.83	11	9.48	93.10	12.93
Above 61	6	5.17	100	8	6.90	100	6.04
Total	**116**	**100.00**		**116**	**100.00**		**100**

None of the females below 20 years participated in farming among the respondents, while only about 6% of the males below 20 years participated (Table 4.9). This may be explained by the fact that this age constitutes the schooling period for young people and that males' start taking up economic responsibilities such as farming much earlier in life compared to females. The results also suggest that a large number of women who participated in farming are mature adults as none was below 20 years of age. Only about 6% of the interviewees were observed to be aged above 61 years and still engaged in smallholder farming, with the proportion of men being slightly higher than that of women (Table 4.9). It was perceived that smallholder farmers` level of participation in farm management was influenced by age. Age could also influence decision making at household level.

Ersado et al.(2004) in their study on productivity and land enhancing technologies in northern Ethiopia found that age had a significantly negative effect on adoption of productivity enhancing technology only as well as sequential adoption of productivity enhancing technology followed by resource conserving technology. Amsalu and de Graaff, (2007), who contacted their study in an Ethiopian highland watershed found weakly significant positive relation between age and innovativeness.

4.5.4 Household size

It was hypothesized that the larger the household size the bigger the amount of family labour available. The variable was expected to increase the probability of adopting soil conservation practic**e.** The household size was determined by the number of family members, including relatives staying with the family. They were clustered in ranges of five to six except for the (2-5) members which must constitute the male and female (Table 4.10). The results show that 65.5% of the households had between 6 and 11 members, constituting about a third of the respondents. Households with 2-5 and 12-17 members represented 17.4% and 12.9%, respectively of the sampled households. Only about 4% of the interviewed households had between 19 and 29 members.

The household size is important in determining the type of soil conservation practices adopted and provided family labour for erecting the attendant conservation structures. From the 1,033 members among the 116 households, the mean household size was 9 persons (Table 4.10). It may be argued that large families potentially availed more labour leading to high participation in farm activities, including soil conservation measures. Labour is an important input in soil conservation and household (or family) labour is an important factor in the implementation of soil conservation practices. Labour availability was measured as a proportion of household members who contribute to farm work. The practices of soil conservation studied here are labour intensive and it is hypothesized that the number of household members available to provide labour had a positive effect on adoption of the studied soil conservation practices. Contrary to their expectation, Bekele and Drake (2003) found family size, a proxy for own labour use, to have a significantly negative relation with certain adoption choices. Amsalu and de Graaff, (2007) who didn’t find statistically significant relationship between family size and adoption of stone terraces found that continued use of the practice was negatively impacted by the size of the family.

Table 4.10: Household sizes among smallholdings in Kaplamai division

Household size	Number of Households	Percent	Cumulative Percent	Estimated family members
2-5	20	17.2	17.2	50
6-11	76	65.6	82.8	646
12-17	15	12.9	95.6	218
19-22	2	1.7	97.3	41
23-29	3	2.6	100.0	78
Totals	116	100.00		1033

4.5.5 Decision Making at Farm Level

It was observed from the study that male member of the household had greater share of responsibility as far as decision making regarding credit facilities (50.0%), adopting new technologies (59.9%) and access to income (79.7%) were concerned (Table 4.11). Women on the other hand, exercised more power on decisions related to soil conservation (50.0%), crop disposal (50.0%) and tree planting (52.2%). On average it was revealed that males exercised over 50% of the power to decide on the various farm related activities and females about 33% of such decisions. Only about 23% of the decisions were on average made collectively by the male and female on matters affecting their farm and household economy (Table 4.11).Farm household make decisions primarily directed towards satisfying their different goals. Major decisions about land use and management are taken by either one person, the household head, or through a consensus among household members. Decisions are made in consideration of resources available for implementation and every household had multiple goals and allocated available resources on the basis of priority objectives.

Table 4.11: Decision making of sampled households

Farm management activity	Decision maker (%)		
	Male (%)	Female (%)	Pooled (%)
Credit facilities	50.0	19.8	30.2
New technologies	59.9	9.9	30.2
Access to income	79.7	15.1	5.2
Soil conservation	44.8	50.0	5.2
Crop disposal	39.7	50.0	10.3
Tree planting	47.8	52.2	0.0
Crops to grow	30.2	39.7	23.3

4.6 Economic Factors of Soil conservation practices

4.6.1 Farming equipment

Field data indicates that farming implements used on smallholder farms included hoes, pangas, spades and wheelbarrows. The type of equipment owned and used on the farm influenced farming characteristics (Table 4.12).

Table 4.12: Farming tools and livestock among farmers in Kaplamai division

Variable	Minimum	Maximum	Mode	Mean
Tools (Counts)				
Hoes	1	10	3	5
Pangas	1	4	0	2
Spades	0	2	0	2
Wheelbarrows	0	2	0	1
Livestock(Counts)				
Dairy cattle	0	20	0	2
Sheep	0	30	0	4
Poultry	0	300	0	10

Livestock ownership and farm tools are considered important assets in soil and water conservation activities. The average number of major farm tools was 5 hoes, 2 spades, 1 wheelbarrow and 2 pangas while the number of livestock owned included 340 dairy cattle reared by 116 households with an average of 2 cattle per household. As pertains to poultry, 71 males and 64 females reared chicken, and sheep was reared by 50 males and 48 females, respectively.

4.6.2 Farm size

A household's farm size determines both the farming characteristics as well as decisions pertaining to farm management. It was anticipated that farm size could influence adoption of soil conservation practices positively. However, in some cases, the bigger the farm size, the more the flexibility for crop rotations. In such a case, the variable was expected to negatively influence the adoption of soil conservation.

Table 4.13: Household farm size and how acquired among the households

	Inherited	Purchased	Total
0-5	13(11.2)	39(33.6)	52(44.8)
5 -10	4(3.4)	14(12.1)	18(15.5)
10 -20	7(6.0)	29(25.0)	36(31.0)
20-50	0	6(6.5)	6(5.2)
Above 50	0	4(3.2)	4(4.0)

(Figures in brackets are percentages)

The findings show that 60.3% of the respondents owned land sizes in the range of 0-10 acres, (Table 4.13). The results further revealed that 91.3% of the households had farms in the range of 0-20 acres while only 9.2% of the households had farms of above 20 acres. This means that majority of farms measure below 20 acres of land; hence most of the respondents ‘are smallholder farmers. This farm size reflects the kind of farming activities, and by extension soil conservation practices, adopted by the farmers in the study area. For instance, in the range of 0-5.0 acres, farmers concentrated more on food crops supplementing it with small scale maize production and dairy farming. It was observed that livestock keeping was mainly under zero grazing due to small size of land parcels owned by the respondents.

The main food crops grown include maize, beans, peas, Irish potatoes, sweet potatoes and various types of vegetables. Dairy farming was the main feature in livestock rearing but sheep was however kept on small scale. Households with more than 5 acres practiced cash crop farming and sometimes a combination of cash and food crops. Given the observed pattern between farm size and farming characteristics, farm size had more influence on farmer's farm management, as planting of napier grass on terraces was found on farms of 5 acres and below. It was evident from the study that majority of farm households (90%) practiced mixed farming. In most smallholder farms, use of manure to replenish nutrients was witnessed. It was also evident that most of the crops such as maize, bananas, beans, cassava, millet, potatoes and passion fruits were grown for subsistence and sale in all farm sizes. Tea and pyrethrum were mainly planted for commercial purposes. Majority of the farmers who planted tea had farms between 10 and 20 acres while farmers who planted pyrethrum had farms between 0 and 5 acres.

4.6.3 On-farm incomes

Farm income was expected to fuel adoption of soil conservation practices. This was expected to be a proxy to cash access which assists farmers to fund soil conservation technologies. About 37% of the respondents earned at least KShs.12, 000 per month from on-farm enterprises (Table 4.14). The respondents earning between KShs. (0-3000) constituted 13.4%, (3001-6000) 15.6%, (6001-9000) 19.8%, (9001-12000)14.6% and above 12000 36.6% respectively. The respondents earning up to KShs. 9000 from on-farm sources were about 49% of the total respondents. It is worth noting that the proportion of respondents increased with income category except for those in the KShs. (9001-12,000) income bracket. The total estimated earnings from on-farm sources were KShs. 2,057,500 with mean earnings of up to KShs. 8,868.53 per respondent, or KShs. 17,737.10 per household.

Table 4.14: On-farm income of the sample households

Income Category (KShs.)	Sample size	Frequency (%)	Cumulative frequency (%)
0 – 3000	31	13.4	13.4
3001 – 6000	36	15.6	29.0
6001- 9000	46	19.8	48.8
9001 – 12000	34	14.6	63.6
12001 and above	85	36.6	100.0
Total	232	100.0	

Since the average family size is 9 persons (Table 4.10), then each household member on average earns KShs. 1,970.80 per month which translates to KShs. 65.69 per day, which is below the poverty line. This agrees with reports that most Kenyans relying on agriculture and residing in rural areas live on less than US$ 1.25 per person per day CBS (2005), which as well applies to the Kaplamai residents. This explains why soil erosion problem is a common feature in Kaplamai division since most farmers cannot afford to invest their low incomes in soil conservation practices, as priority will be on food, medication and other services considered essential or of immediate needs.

4.6.4 Incomes from off-farm sources

Income from off-farm employment was hypothesized to be a source of cash to fund soil conservation technologies. It was assumed that it will positively influence adoption of soil conservation technologies. The results reveal that the proportion of respondents earning between KShs. 0 and 3000 and between 3001 and 6000 per month from off-farm sources were 28.9% and 26.7%, respectively (Table 4.15). The majority of the

Kaplamai residents (about 56%) earned less than KShs. 6000 per month from off-farm enterprises. The findings also indicate that respondents who earned in the range of KShs. 9001-12,000 and KShs. 12,001 and above present 18.1% and 16.4% of those interviewed. Less than 10% of the interviewees earned between KShs. 6001 and 9000 per month from off-farm sources. The off-farm sources are meant to supplement incomes from on-farm enterprises and the results indicate that the majority of the respondents of Kaplamai who engage in off-farm activities earned less than KShs. 6000 per month. The estimated total earnings from off-farm sources appear to generally increase with income brackets, totalling KShs.1, 505,500. This translates to an average of KShs. 6,489.24 per respondent per month or 12,978.45 per household. Each household member on average earned KShs. 1,442.05 per month or KShs. 48.07 per day from off-farm sources. This is again way below the poverty line of US $ 1.25 per person per day, and with current high cost of living occasioned by global economic meltdown, high fuel costs, increased food prices and sky-rocketing inflation, such farmers will merely survive in lean seasons when droughts, floods, pests and diseases occur. The average combined earning per day from on-farm and off-farm sources per family member gave KShs. 113.76.

This study in Kaplamai revealed that improved non-farm employment opportunities in the division increased the household welfare but reduced the household’s incentive to use labour for conservation leading to higher levels of soil erosion and rapid land degradation. This concurs with a related study cited by Nedumaran, (2013) in conference in Australia.

Table 4.15: Off-farm income of the households

Income category (KShs.)	Sample size	%	Cumulative frequency (%)
0 – 3000	67	28.9	28.9
3001 – 6000	62	26.7	55.6
6001- 9000	23	9.9	65.5
9001 – 12000	42	18.1	83.6
12001 and above	38	16.4	100.0
Total	232	100.0	

4.6.5 Total Income of farmers

The respondents whose total income fell within the KShs. 0 – 10,000 and KShs. 10,001 – 20,000 income brackets constituted 36.6% and 31.0%, respectively, with females being the majority in either category (Table 4.16). This makes two-thirds (67.6%) of the interviewees of Kaplamai division, meaning a majority of the farmers here received total earnings of KShs. 20,000.00 per month. The other respondents present about 15%, 13% and 5% for the KShs. 40,001 and above, 20,001 – 30,000 and 30,001 – 40,000 income clusters, respectively.

In general, the males-females ratio in terms of overall total earnings was 1:1, but with relatively more male respondents in the lower income groups (Table 4.16). The findings also indicated that the proportion of total earnings decreased progressively with increasing income brackets up to KShs. 40,000 per month but rises with those within the highest income cluster. The estimated total income is higher than the mathematical addition of the total incomes from on-farm and off-farm sources (Tables

4.14, 4.15 &4.16). This implies that the respondents might have had other undeclared sources of income not reflected in Tables 4.14 and 4.15. These may include bonuses, shares traded, donations and gifts from relatives such as employed children.

Table 4.16:Total income by sex of the respondents

Total income of the respondents (Kshs)	Total Sample	Response by gender (%)		
		Male	Female	Total
0 - 10,000	85	16.8	19.8	36.6
10,001 - 20,000	72	15.1	15.9	31.0
20,001 - 30,000	29	7.8	4.7	12.5
30,001 - 40,000	12	3.0	2.3	5.3
40,001 and above	34	7.3	7.3	14.6
Total	232	50	50	100.0

Farm households with off-farm income received relatively more income than those that relied entirely on on-farm income (Tables 4.14, 4.15 & 4.16). On-farm income was mainly from maize, beans, tea sales, horticultural crops and dairy produce. Many farmers had maize and beans on their farms which were both commercial and food crops. As observed from the results there is a wide fluctuation in mean monthly incomes, especially in households whose main income source was on-farm.

4.7 Willingness and Non-willingness to pay for soil conservation services

4.7.1 Willingness to pay for soil conservation practices

The magnitudes of the households' WTP for agriculture technologies, as well as the type of payment, varied with the nature of technology. Asrat, Belay and Hamito(2004) examined the determinants of farmers' WTP for soil conservation practices in Ethiopia's south eastern highlands and found that majority of farmers in study area were less willing to pay cash. However, the farmers were willing to spend big amounts of labour and time on soil conservation.

In the current study, the farmers were asked if they were willing to contribute a service charge to Kaplamai Environmental Conservation Group (KECG) if formed to continue securing material and advisory assistance for soil conservation. From the responses, 84.4% of the respondents indicated willingness to pay for the soil conservation services while 15.6% showed non-willingness to pay for the services (Table 4.17). The results also reveal that, based on gender, the ratio of responses were 1:1 for either willingness or non-willingness to pay for the environmental services. This means that again decisions regarding environmental conservation activities among the respondents were a family matter, resulting in common stand. The male and female generally agreed on what to pay or not to pay for in soil conservation.

Table 4.17: Proportion of the respondent's willingness to pay for soil Conservation measures

	Male	Female	Household
Yes	42.2	42.2	84.4
No	7.8	7.8	15.6
Total	50.0	50.0	100.0

4.7.2 Non-willingness to pay for soil conservation services

Among the respondents who showed non-willingness to pay for soil conservation services, various possible reasons were advanced. Of the 36 respondents, more than two-thirds (69.5%) indicated they were not able to pay, 16.7% reported to have no information on soil conservation practices while the rest consisting of 13.8% of the non-willing households would not place any value on soil conservation practices (Table 4.18).

Table 4.18: Frequency and reasons for not willing to pay for conservation practices

Reason for non-willingness	Response (%)		
	Male	Female	Household
Not willing to place any value on soil conservation practices	8.3	5.6	13.8
Had no enough information on soil conservation practices	8.3	8.3	16.7
Couldn't afford to pay for conservation of soil	30.6	38.9	69. 5
Total	47.2	52.8	100.0

It was noted that more males (8.3%) among these respondents were not willing to place any value on soil conservation practices compared to their female counterparts (5.6%). Responses on having limited information on soil conservation among the gender were at par and stood at 8.3%. Relatively more females (38.9%) compared to males (30.6%) among these respondents felt it was expensive to pay for soil conservation activities (Table 4.19). This is because most financial resources on smallholder farms are controlled by male members of the family.

4.7.3 Maximum willing to pay amount by the respondents

An evaluation for 196 farmers willing to pay for soil conservation activities on their farms was done and relative categories based on amount of willingness to pay done among the sex and household respondents. The findings revealed that households' willing to pay within KShs. 0-200 was 46.2% (Table 4.20). Overall the proportion of households willing to pay between KShs. 201 and KShs 500 were 44 % and the rest above KShs 500 constituted 9.8%.

Table 4.19: Categories of maximum willing to pay amount by the respondents

	Per cent Response		
Category amount (KShs.)	Male	Female	Household
0 – 100	8.2	15.6	23.8
101 – 200	10.2	12.2	22.4
201 – 300	4.6	6.1	10.7
301 – 400	10.2	5.3	15.5
401 – 500	10.2	7.6	17.8
500 and above	5.2	4.6	9.8
Total	48.6	51.4	100.0

4.8 Determinants of adoption of selected soil conservation practices

The first and second objective of the study sought to establish social and economic factors that influence farmers' adoption of soil conservation practices. Presence of any of identified conservation measures at the farm level was taken as indication of good farming practices and hence better crop production. Therefore farmers, especially smallholder farmers, we expect had an incentive to adopt yield improving soil (and moisture enhancing) conservation practices. Consequently, a logistic regression procedure using maximum likelihood estimation was used to estimate the probability of a soil conservation practices being adopted. The model was estimated for each of the six soil conservation measures; bare terraces, contour ploughing, stone lines, cut-off drains, tree lines and infiltration ditches. The Statistical Package for Social Sciences (SPSS 12.1) was used in the estimation of the logistic regression model. Before conducting the analysis, it was necessary to describe and measure the variables used in the adoption models. Table 4.20 presents the definition and measurement of the variables used.

Table 4.20: Definition and measurement of variables used in the models

Variables	**Description and unit of measurement**
Dependent variables	
Y_1=Bare terraces	1 if adopted; 0 otherwise
Y_2=Contour ploughing	1 if adopted; 0 otherwise
Y_3=Stone lines	1 if adopted; 0 otherwise
Y_4=Cut-off drains	1 if adopted; 0 otherwise
Y_5=Tree lines/hedges	1 if adopted; 0 otherwise
Y_6=Infiltration ditches	1 if adopted; 0 otherwise
Explanatory (independent variables)	
X1=Level of education (EL)	1 if up to O'level; 0 otherwise
X2=Decision making(DM)	1 if both male and female wife; 0 otherwise
X3=Household size(HS)	1 for most common average size; 0 otherwise
X4=Willingness to pay(WTP)	1 if yes; 0 if no
X5=Crop(CG)	1 if grown; 0 if not grown
X6=Farm equipment(FE)	1 if 2 or 3 in No.; 0 otherwise
X7=Farm size(FS)	1 if 1-20 acres; 0 otherwise

It is widely accepted that soil conservation practices may not be accepted unless farmers perceive a problem (Van Graaff, 1995). It is important therefore, to know their perceptions on soil erosion and soil conservation practices. Farmer perception on soil fertility status and trends motivate them to make farm decisions that influence improvement in farm productivity. As shown in Table 4.2., over 57% of smallholder farmers in Kaplamai division perceived soil erosion to cause low fertility and hence low crop yields. This is against the background that a number of soil conservation projects have been undertaken in the division for many years. Of the soil conservation practices, contour ploughing (34%) was the most adopted followed by bare terraces (20%) and tree lines/hedge (19.5%) Table: 4.4. The soil conservation practices that were least adopted included cut off drains, grassed terraces, stone lines and infiltration ditches. Among the least adopted, infiltration ditches were the lowest in Kaplamai division since the practice was unpopular to smallholder farmers. There is no satisfactory reason as to why contour ploughing was widely adopted as soil erosion control measure. Possible explanation may rest in tradition, farmers' perception and ease of implementation. One thing was however certain, that smallholder farmers of Kaplamai have continued to experience soil erosion problems. This eventually led to low fertility and low crop yields.

4.8.1 Factors influencing adoption of soil conservation practices

A logistic regression analysis was conducted to predict adoption of soil conservation measures for bare terraces, contour ploughing, stone lines, cut-off drains, tree lines/hedges, and infiltration ditches for 116 households using level of education, decision making, household size, willingness to pay, crops grown, farm equipment and farm size.

In order to test overall significance of the model, Chi square which was derived from the likelihood of observing the actual data was used. Examination of the standard errors of the variables (Table 4.21) revealed that none of the socio-economic factors in the analysis had a standard error larger than 2.0. This showed that there was no threat of multi-collinearity in the logistic regression solution. The Chi-square values show that parameters included in the models are significantly different from zero at the conventional significance levels. The model results (Table 4.21) confirmed the priori expectation that smallholder farmers' choice of soil conservation practice was determined by a myriad of socio economic factors. The signs of most coefficients are consistent with the priori expectations. The magnitude and direction of influence of the parameters varied across the soil conservation practices.

Table 4.21: Parameter estimates of logistic models of Socio-economic factors influencing adoption of Soil conservation practices

Explanatory Variable	C/ ploughing Parameter estimate β(wald statistic)	Bare terraces Parameter estimate β(wald statistic)	Cut-off drains Parameter estimate β(wald statistic)	Stone lines Parameter estimate β(wald statistic)
Educ. Level	1.789(0.713)**	2.104(0.733)***	2.816(0.758)***	0.871(0.658)
Dec. making	-0.348(0.334)	0.602(0.304)**	0.783(0.326)**	0.713(0.292)**
Farm size	1.085(0.583)*	0.412(0.414)	-0.166(0.469)	-0.580(0.407)
WTP	-0.126(0.446)	-0.762(0.436)	-0.631(0.459)	-0.752(0.426)*
Crops grown	1.269(0.356)***	0.993(0.313)***	0.897(0.332)***	0.547(0.301)*
F/Equipment	0.525(0.441)	0.458(0.392)	0.354(0.418)	1.262(0.388)***
H/size	1.147(0.332)***	1.075(0.314)***	1.555(0.329)***	0.971(0.316)***
Constant	-1.012(0.845)	-2.314(0.911)**	-2.479(0.928)***	-1.381(0.812)*
Log-likelihood	232.918	270.673	246.461	284.636
Cox & Snell RSquare	0.153	0.152	0.202	0.133

Notes: Values in parenthesis are standard errors

*; **; and *** indicate significant at 0.1; 0.05 and 0.01 respectively.

Education level of the household members (Educ. Level) was positively associated with the adoption of bare terraces, contour ploughing, stone lines, cut off drains and infiltration ditches. Education level significantly influenced the adoption of bare terraces ($p = 0.004$), contour ploughing ($p = 0.012$) and cut off drains ($p \leq 0.001$).

This result supports the relationship that farmers with an educational level of up to O'level are more likely to adopt bare terraces. This suggests that the use of bare terraces, contour ploughing and cut off drains are knowledge based and those household members' with high education are more likely to adopt them. The effects of education are consistent with Rodgers (1995) generalizations which state that early adopters of innovations are more educated. The findings also agree with Mbaga-Semgalawe and Folmer (2000) who reported that education had a positive effect on the adoption of improved natural resource conservation technologies. Odendo, et al. (2009) also observed that education was positively associated with the adoption of both inorganic fertilizers and a combination of inorganic and organic resources. The above studies contrasts other studies (Gould et al. 1989) which found education to be negatively related to the adoption of soil and water conservation. (Nkegbe, et al 2011.), also found that average level of education of household members had negative and significant effect on compositing adoption decision.

Decision making variable was positively associated with the adoption of bare terraces, cut off drains and stone lines. It is however, negatively associated with contour ploughing but significant. Decision making (where both male and female make decisions), significantly influenced the adoption of bare terraces ($p \leq 0.05$), stone lines ($p = 0.015$) and cut off drains ($p = 0.016$). This means that where smallholder farmers (both male and female) make decisions are more likely to adopt bare terraces, stone lines and cut off drains.

Crop growing was positively associated with bare terraces, contour ploughing, stone lines and cut off drains. Crop growing significantly influenced the adoption of bare terraces,($p \leq 0.001$), contour ploughing ($p \leq 0.001$), cut off drains ($p \leq 0.007$) and infiltration ditches ($p = 0.023$. This implies that farmers who grow maize, beans, tea, were more likely to adopt bare terraces, contour ploughing, cut off drains and infiltration ditches since the practices reduce water runoff on their farms.

House hold size was positively associated with bare terraces, contour ploughing, stone lines, cut off drains and infiltration ditches. Household size significantly influenced the adoption of bare terraces ($p \leq 0.001$), contour ploughing ($p \leq 0.001$), stone lines ($p \leq 0.002$), cut off drains ($p \leq 0.001$) and infiltration ditches ($p = 0.021$). This supports the fact that the ratio of household members who provide farm labour was positively related to the probability of adopting bare terraces. The results are consistent with the assertions that household labour is a major constraint to the adoption of labour intensive technologies Franzel's (1999), in western Kenya. Due to high labour demand for digging bare terraces, cut off drains, planting of tree lines/hedges and stone lines, households with a high ratio of members working on the farm are likely to adopt soil conservation practices. This is because household labour was most important source of labour supply for smallholder households, since low incomes constrained hiring of labour.

In addition, the Wald statistic and its associated probabilities provide an index of significance of each predictor in the equation. The Wald statistic has a chi-square distribution and the simplest way to assess is to take significance values and if less than 0.05 reject the null hypothesis as the variable does not make a significant contribution. In the current study, we note that in the case of bare terraces, education level significantly contributed to the prediction ($p = 0.004$). The Exp (β) presents the extent to which raising the corresponding measure by one unit influences the odds ratio. If the value exceeds 1 then the odds of an outcome occurring increase; if the figure is less than 1, any increase in the predictor leads to a drop in the odds of the outcome occurring. For example, the Exp (β) value associated with education is (8.199). It might imply that a one unit increase in educational level (with focus on up to (O'level) might increase the odds that farmers adopt bare terraces by approximately 8 times.

The Exp (β) value associated with decision making is 1.509. This indicate that a one unit increase in decision making (when both husband and wife make farm level conservation decisions) increased the odds that farmers adopt bare terraces by close to one and a half times. The value of EXP (β) of 2.698 further implies that a one unit increase in growing crops increases the odds that farmers adopt bare terraces by approximately two and a half times. The value of Exp (β) is 2.929 which imply that a one unit increase in house hold size (one person) above the average increased the odds that farmers adopt bare terraces by close to three times.

4.9 Household willingness to pay for improved soil conservation practices

The third objective of the study sought to explore households' willingness to pay for improved soil conservation in the area. To analyze this objective, multiple regression models were used in order to determine those socio-economic factors that best predict willingness to pay for improved soil conservation practices at the farm level. However, multiple regression models require that assumptions of normality, homoscedasticity, and linearity and autocorrelation errors be met. Thus before estimating the parameter estimates of the model, the tests of the basic classical assumptions of multiple regression model were first conducted; that is the tests for normality in the distribution of variables, common variance of the explanatory variables (homoscedasticity) and correlation of the variables (multi-collinearity).

4.9.1 Testing for the assumptions of normality

Skewness and Kurtosis statistics are commonly used to assess normality of the variables. Skewness is the measure of the degree of symmetry of a distribution in which values of mean, mode and median are not the same while Kurtosis is the measure of peakedness or flatness of a distribution curve (Tabachnick and Fidell, 2001).It shows the extent to which the curve is more peaked or more topped than the normal curve. Tabachnick and Fidell suggest that Skewness and Kurtosis values should be within the range of -2 to +2 when variables are normally distributed. Table4.22 presents the skewness and kurtosis statistics for the variables used in the analysis, and the values of all the variables are within the acceptable limits of normality (Tabachnick and Fidell2001). This confirms that normality requirements were met for this data.

Table 4.22: Normality of the observed data

	Skewness		**Kurtosis**	
	Statistic	Std. Error	Statistic	Std. Error
Farm Income	0.565	0.160	-1.265	0.318
Farm equipment	0.414	0.160	0.457	0.319
Crop grown	-0.852	0.160	0.036	0.318
Livestock reared	-0.359	0.160	-0.106	0.318
Family involvement	-0.764	0.160	1.975	0.318
Mode of working on farm	1.884	0.167	1.188	0.333
Highest level of education	1.045	0.160	1.947	0.318
Occupation of the farmer	1.780	0.160	1.177	0.319

4.9.2 Testing the assumption of homoscedasticity

The Levene statistic test for equality of variance across the male and female sub-groups was used to test for homogeneity of variance. The null hypothesis for this test was that the variance of each subgroup was the same. The desired result was therefore a failure to reject this null hypothesis. From Table 4.23, it can be seen that using a significance level of 0.05, only one variable (level of education) does not have the same variance for both male and female farmers. Since all the other factors had the same variance for both the male and female farmers, it can be concluded that the assumption of homoscedasticity had been met.

Table 4.23: Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Farm Income	0.048	1	230	0.826
Farm equipment	0.000	1	229	0.983
Crop grown	0.182	1	230	0.670
Livestock reared	0.000	1	230	0.990
Family involvement	0.003	1	230	0.955
Mode of working on farm	0.010	1	210	0.921
Highest level of education achieved	6.164	1	230	0.014
Occupation of the farmer	2.890	1	229	0.090

4.9.3 Testing the assumption of linearity

Linearity of the variables in the model is examined using correlation coefficients. As presented in Table 4.24, there are both positive and negative associations among the explanatory variables. These associations are however moderate indicating a general lack of multi-collinearity between the (regression) variables. The relationships between explanatory variables and the response variable (willingness to pay for conservation measures) are also linear and mainly positive. The correlation coefficients between the variables are also small in magnitude (i.e. ranging from-0.009 to 0.36) showing that the associations are weak. Therefore, based on the results the linearity assumption is deemed to have been met

Table 4.24: Test of Linearity between variables

	FI	FE	CG	LR	FIV	MW	ED	FO	WTP
FI	1								
FE	-0.078	1							
CG	0.325(**)	-0.145(*)	1						
LR	0.321(**)	-0.157(*)	0.512(**)	1					
FIV	0.102	0.013	0.371(**)	0.170(**)	1				
MW	-0.036	0.350(**)	0.094	-0.070	0.225(**)	1			
EL	0.323(**)	0.059	-0.037	-0.009	-0.138(*)	0.023	1		
FO	-0.034	-0.013	0.148(*)	-0.072	-0.074	0.011	0.467(**)	1	
WTP	0.295(**)	0.054	0.361(**)	0.116	0.270(**)	-.019	0.289(**)	0.042	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

4.9.4 Testing the assumption of independence of errors

The Durbin-Watson statistic was used to examine if prediction of dependence errors were correlated. As shown in Table 4.25, the Durbin-Watson statistic for the regression of WTP on the selected socio-economic factors was 1.713. This value was within the 1.50 to 2.50 interval suggested by Tabachnick and Fidell (2001) as acceptable for non-correlation of errors. The assumption of independence of errors was therefore met.

4.9.5 Determinants of willingness to pay for improved Soil Conservation Practices

Having tested for the assumptions of multiple regressions, and having established that they were met in the case of this study; multiple regression analysis was therefore conducted. Results presented in Table 4.26indicate that five of the eight hypothesized socio-economic factors were significant predictors of willingness to pay for improved soil conservation practices. Farm income ($p = 0.05$); crop growing ($p< 0.001$); family involvement ($p = 0.002$); and highest level of education achieved ($p< 0.001$) are positive and significant explanatory variables of willingness to pay for improved soil conservation practices. On the contrary mode of working on the farm ($p = 0.012$) is found to be a negative and significant predictor of willingness to pay for improved soil conservation practices. Farm equipment ($p = 0.055$); livestock reared ($p = 0.081$); and occupation of the farmer ($p = 0.405$) are found not to significantly explain the willingness to pay for improved soil conservation practices. The adjusted R-squared value is 0.555 which implies that the selected socio-economic factors jointly accounted for about up to 56 percent of the variation in willingness to pay for improved soil conservation practices. In addition, all the variance inflation factors (VIF) were found to be less than 2.0 confirming that there was no threat of multi-collinearity of the independent variables used in the regression model.

Table 4.25: Determinants of willingness to pay for improved soil conservation practices in Kaplamai

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-2.966	1.335		-2.221	.028		
Farm Income	0.082	0.041	0.150	2.000	.047	0.709	1.411
Farm equipment	0.512	0.265	0.134	1.933	.055	0.839	1.192
Crop growing	1.302	0.324	0.342	4.012	.000	0.553	1.807
Livestock reared	-0.381	0.217	-0.140	-1.755	.081	0.633	1.579
Family involvement	0.390	0.121	0.241	3.218	.002	0.715	1.398
MW	-0.314	0.124	-0.183	-2.530	.012	0.765	1.307
EL	0.601	0.158	0.318	3.815	.000	0.577	1.733
F O	-0.277	0.332	-0.064	-0.834	.405	0.682	1.466
R				0.785			
R^2				0.617			
Adj.R^2				0.555			
Durbin-Watson				1.713			

The significant standardized coefficients above indicate the following: a 1% increase in farm income is likely to result in a 0.150% increase in willingness to pay; that a 1% increase in crop growing is likely to lead to a 0.342% increase in willingness to pay; that a 1% improvement in family involvement is likely to result in a 0.241% increase in willingness to pay; that a 1% increase in mode of working on the farm is likely to result in a 0.183% decline in willingness to pay; and that a 1% increase in level of education is likely to result in a 0.318% increase in willingness to pay. Besides, on the basis of t-values, crop growing with a t-value of 4.012 is the main predictor of willingness to pay. This is followed with level of education with t-value of 3.815; family involvement with a t-value of 3.218; mode of working on farm with t-value of -2.530; and farm income with a t-value of 2.000 respectively.

CHAPTER FIVE

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of Main Findings

This chapter provides the summary, conclusion and makes recommendations on the basis of study findings. First and foremost, the chapter gives brief summary of the study results and finally draws conclusions from the study findings before recommendations. The research findings in chapter 4 form the basis for this chapter. The initial part covers the role of socio-economic variables in the soil conservation policies among smallholders in Kaplamai division. Policies and strategies to be undertaken to improve soil conservation form the later part of the chapter. To conclude, the nature of further research to counter knowledge gaps in soil conservation technologies is discussed.

5.2. The key findings of the study

Soil and water erosion continues to be the major problem in Kaplamai division despite the substantial effort that farmers have made in adopting some of the soil and water conservation practices. This indicates that the farmers highly recognise the benefits of soil conservation practices. Farmers are also aware of the causes and control measures of soil and water erosion. Despite the many soil conservation programmes by the government, farmers still lack adequate technology on how to use appropriate soil and water conservation practices.

The results of the descriptive analyses suggest that both men and women participated in theimplementation of soil and water conservation practices. Establishment of the terraces and cut off drainswas a male dominated activity but women concentratedon planting of trees and crops(Table 4.4).The answers to question (19) of the questionnaire indicated that although both men and women had access to the farm resources, women had little or no access. Gender mainstreaming is therefore crucial in soil and water conservation technologies.

Based on stated objectives, research questions, hypothesis and employment of various techniques of data collection and analysis, the study came up with the following: Adoption rates of contour ploughing, bare terraces, tree lines/hedge, cut of drains, infiltration ditches and stone lines were 99.1, 57.8, 56, 39.7, 6.5, and 1.7% respectively. The difference in adoption rates between males and females for every soil conservation technology were similar or very minimal. However, most of the respondents perceived low fertility and crop yields (92.7%), sedimentation of users (19.0%), and carrying away of planted seeds and seedlings (50%) as problems resulting from soil degradation.

A logistic regression analysis was conducted to predict adoption of six soil conservation measures: bare terraces, contour ploughing, stone lines, cut-off drains, tree lines/hedges, and infiltration ditches for 116 households. This was done using the level of education, decision making, household size, willingness to pay, crops grown, farm equipment and farm size.

Education level of the household members (Educ. Level) was positively associated with the adoption of bare terraces, contour ploughing, stone lines, cut off drains and infiltration ditches. Education level significantly influenced the adoption of bare terraces, contour ploughing and cut off drains. This suggests that the use of bare terraces, contour ploughing and cut off drains are knowledge based and those household members' with high education are more likely to adopt them.

Decision making was positively associated with the adoption of bare terraces, cut off drains and stone lines. It is however, negatively associated with contour ploughing but significant. Decision making significantly influenced the adoption of bare terraces, stone lines and cut off drains. This means that where both male and female smallholder farmers make decisions, they are more likely to adopt bare terraces, stone lines and cut off drains.

Crop growing was positively associated with bare terraces, contour ploughing, and cut off drains and stone lines. Crop growing significantly influenced the adoption of bare terraces; contour ploughing, cut off drains and infiltration ditches. This implies that farmers who grow maize, beans, tea, are more likely to adopt bare terraces, contour ploughing, cut off drains and infiltration ditches since these practices reduce water runoff on their farms.

House hold size was positively associated with bare terraces, contour ploughing, stone lines, cut off drains and infiltration ditches. Household size significantly influenced the adoption of bare terraces, contour ploughing, stone lines, cut off drains and infiltration ditches. This supports the fact that the ratio of household members who provide farm labour was positively related to the probability of adopting bare terraces

5.3 Determinants of willingness to pay for improved Soil Conservation Practices

Farm income, crop growing, family involvement and highest level of education achieved are positive and significant explanatory variables of willingness to pay for improved soil conservation practices. On the contrary mode of working on the farm was found to be negative and significant predictor of willingness to pay for improved soil conservation practices. The selected socio-economic factors jointly accounted for about up to 56 percent of the variation in willingness to pay for improved soil conservation practices. In addition, all the variance inflation factors (VIF) were found to be less than 2.0 confirming no threat of multi-collinearity of the independent variables used in the regression model.

On the basis oft-values, crop growing was the main predictor of willingness to pay. The level of education, family involvement, mode of working on farm and farm income are all significant explanatory variables of soil conservation practices by the farmers in the study area.

5.4. Conclusions

Most sample respondents both males and females adopted contour farming and just a few adopted other soil conservation measures on the basis of their various socio-economic characteristics. Economic explanations to soil conservation practices were not enough because most households did not reflect economic imperators in their decisions to adopt soil conservation practices. However, the main economic constraints, perceived by both men and women for low adoption and less use of soil conservation practices were: - in descending order; lack of finance, limited labour availability, too labour intensive, small land size and insecure land tenure. Sex of the household member was important in determining whether there existed any significant difference in household ranking of socio-economic constraints to soil and water conservation

Although individual households integrated some soil conservation practices in their farming practices, it is quite unlikely that they can ensure a soil conservation outcome that is socially efficient as outlined by Adam Smith's "invisible hand". Most soil conservation technologies are labour intensive and require a lot of financial inputs and the effort should have been more worthwhile if the upstream and other land users engaged in similar activities at the same time. Majority of the farmers adopted one type of soil conservation measure, especially contour farming and had terraces but still got soil erosion related problems, such as carrying away planted seeds and seedlings, low fertility and low crop yields due to run off from upstream farms.

5.5. Recommendations

An effective soil conservation strategy that requires a concerted effort from both the farm households and the central government should be put in place. This is because there are a myriad of socio economic factors that influence the adoption of soil conservation decisions at the farm, regional and national level. To achieve effective soil conservation practices, a number of macro and micro level issues must be addressed. Policies that create environment that facilitates conservation of the soil, minimise labour and financial constraints as well as improve formal education will encourage adoption of soil conservation practices such as contour farming, bare terraces and cut of drains. .

5.5.1 Policies and strategies for improving soil conservation practices

In most projects even those that have been in Kaplamai, women's huge knowledge of soil conditions, appropriate agricultural methods, knowledge of trees, wood and water quality has not been taken into account. Women therefore, must always be involved in development schemes, right from the start. They ought to participate in decision making process. The consequences for women should always be explicitly taken into account. The soil conservation practices such as cut-off drains and terraces have very high initial investment costs, slowly emerging benefits and commonly faced with market failures like downstream effects from soil erosion. In view of all these, it's only an appropriate institution that can reconcile public and private interests in the management of soil and water resources.

It is however, emphasised that since Kaplamai division experiences high levels of soil erosion in its hilly parts, an effective soil conservation strategy should be encouraged. The strategy chosen should also involve the farmers in identifying priorities, analysing problems and devising solutions. A participatory or “farmer first” approach to development is the only one likely to bring long term benefits to Kaplamai division. Although incentives to carryout conservation have generally not been successful, the government should create economic incentives through a variety of policy investments at various levels: - farm, regional and national. Economic incentives will increase efforts, but responsiveness will depend on other factors, such conservation related attitudes and institutional arrangements. Farm level incentives like on-farm demonstrations (education) of soil conservation technologies, supply of necessary farm inputs such tree seedlings should be encouraged but with a follow up on progress.

5.6 Area for Further Research

There are several knowledge gaps in soil erosion and conservation and hence the need for more micro-economic research on responses of farmers to soil erosion and incentives to adopt many soil conservation practices. Understanding of the variability would facilitate development of soil conservation practices that are more adoptable by farmers and explain what kinds of farmers adopt which kind of soil conservation measures.

Since the purpose of soil conservation is to reduce soil loss, there is need to measure the efficiency of each of the adopted soil conservation practices and hence, the need for empirical analyses of adequacy and efficiency of the adopted soil conservation practices in controlling erosion.

Finally, there is need for further research on appropriate combination of different soil conservation practices including water harvesting from roof catchments, whilst considering varied socio-economic and biophysical circumstances of farmers. There is need to integrate farmers knowledge, practices and expenses during technology development, since low adoption of soil conservation practices is partly due to in-appropriate recommendations. Greater participation of farmers both male and female in the research process will suffice.

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APPENDIX 1: QUESTIONNAIRE

Study of Factors Influencing Adoption of Soil Conservation Practices in Kaplamai Division of Trans Nzoia East District, Trans Nzoia County. Kenya.

The purpose of this study is to establish the socio-economic factors influencing adoption of soil and water conservation practices in the households of Kaplamai division and find out if members of the household will be willing to pay for properly conserved soils. I therefore request your co-operation in answering the following questions. Your honest responses will go a long way in assisting me to draw reasonable conclusions and recommendations. May I also assure you that the information you provide will be treated with strict confidentiality.

SECTION A: GENERAL INFORMATION

I) Questionnaire Number ii) Date 2009

Location...................... IV) Sub-Location....................... v) Village......................

SECTION B: FARM-FARMER CHARACTERISTICS AND SOIL CONSERVATION

1. How do you rate the gravity of soil erosion on your farm?

   Very Serious..( )

   Serious ....( )

   Low..( )

   Very low ....( )

   Non-existent..( )

2. How do you rate the gravity of soil erosion on farms neighbouring you?

Very Serious..( )

Serious ....( )

Low...( )

Very low ....( )

Non-existent... ( )

3. What problems do you experience on your farm that you partly or entirely attribute to soil erosion?

Low fertility and crop yields..( )

Sedimentation of users ....( )

Carrying away planted seeds and seedlings...( )

4. Which soil conservation measures do you know of?

a) Bare terraces... ( )

b) Grassed terraces ....( )

c) Grassed strips ....( )

d) Agro forestry...( )

e) Contour ploughing...( )

f) Stone line...( )

g) Tree lines/hedges...( )

h) Cut-off drains. ....( )

I) Infiltration ditches..( )

5. Which of the soil erosion control measures in Question 4 above do you practice?

(Tick the appropriate ;)

(a) Bare terraces ....( )

(b) Contour ploughing. ....( )

(c) Stone lines...( )

(d) Cut of drains. ....( )

(e) Tree lines/hedges ....( )

(f) Infiltration ditches ....( )

6. If only some of the soil erosion control measures known to the farmer are practised as indicated by the response question 5 above, what prevents or constrains you from practising all? Rank the constraints from the most serious one (Rank 1) to the least important (Rank 7)

CONSTRAINT	RANK
Limited labour availability	( )
Lack of finance /too expensive	( )
Too Labour intensive..	( )
Too risky..	( )
See no need for it..	( )
Small land size..	( )
Insecure land tenure.	( )

7. Please rank the following possible personal contributions to soil conservation practices on your household farm. Start with the highest contribution (Rank 1) to the lowest one (Rank 5)

   A provision of labour ....( )

   Supervision of soil conservation work ....( )

   Provision of finance..( )

   General support to the spouse ....( )

   Advise..( )

8 How much time do you devote to soil conservation activities?

   A lot of time ....( )

   Enough time ....( )

   Little time..( )

   Very little time ....( )

   No time ....( )

9. The government has always assisted farmers in construction of terraces, cutting of drains, planting trees etc. aimed at conserving soils through the catchment approach" or otherwise. Tick the nature of government assistance you have received regarding soil conservation.

a) Technical advice ....( )

   b) Survey of terrace layout...( )

   c) Provision of labour ....( )

SECTION C: FARM RESOURCE ASSESSMENT

10. Farmers have various goals in farming including food security, profit, income maximization and soil conservation. Select your main goals in farming from the list below and rank them from the most important (I) to the least important

GOAL	RANK
Earning cash income	( )
Family Food Security	( )
Reduce income and food variability	( )
Soil conservation	( )
Leaving time for farm activities	( )
Gain status in the community	( )

11. Which crops do you grow on your farm?

Crop Type	Main Purpose
(E.g. Maize)	(E.g. sale, subsistence, control erosion)

....…………………......

....………………

....………………

12. Which type of livestock do you rear on your farm?

Livestock types, type of produce e.g. Milk, main purpose (sale, subsistence)

………………………………………………………………………………………………

13. Which of the following farm tools do you own on your farm? (State the number in the space provided)

a) Hoes..( )

b) Spades..( )

c) Wheelbarrow..( )

d) Panga ....( )

e) Specify ....( )

14. Have you had any contact with the agricultural extension agent in the last 6 years?

YES ....( )

NO.. ( )

15. If YES state the extension messages given: Also mark + in the space provided for practices adopted by the farmer

Fertilizer..( )

Terrace ....( )

Composting ....( )

Manure use...( )

Agro forestry.. ( )

Tree/ Hedge establishment ....( )

Biomass transfer ....( )

16. What are your sources of labour for soil conservation?

Hired .... ( )

Family .... ( )

17. How many members do you have in your family including yourself?

----

18. How many family members are involved in farming activities?

ADULT 18- 60 YEARS

Female Male Child<18yrs

I) Work on farm part/time .... ( )

ii) Work on the farm full time .... ( )

iii) Employed off farm .... ( )

19. Given that farm resources are a major component in soil conservation activities, how would you rate the level of your own control of access to

a) Land

Very Great Control... ( )

Great Control.. ( )

Limited Control .... ( )

Very Limited Control .... ( )

No Control .... ( )

b) Credit Facilities

Very Great Control...( )

Great Control.. ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

(c) New technologies

Very Great Control.. ( )

Great Control.. ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

d) Extension services

Very Great Control.. ( )

Great Control.. ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

e) Access to income

Very Great Control... ( )

Great Control .... ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

20 Given that farm resources are a major component of soil conservation activities,

How would you rate the level of your (Male/female's) control of access to?

a) Land

Very Great Control .... ( )

Great Control... ( )

Limited Control .... ( )

Very Limited Control... ( )

No Control...( )

b) Credit Facilities

Very Great Control.. ( )

Great Control .... ( )

Limited Control.. ( )

Very Limited Control .... ( )

No Control .... ( )

c) New technologies

Very Great Control.. ( )

Great Control .... ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

d) Extension services

Very Great Control.. ( )

Great Control .... ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

e) Access to income

Very Great Control.. ( )

Great Control .... ( )

Limited Control... ( )

Very Limited Control .... ( )

No Control .... ( )

SECTION D: WILLINGNESS TO PAY QUESTIONS

21. Soil erosion is one of the major problems affecting farmers in Kaplamai division of Kenya. Both the Colonial Government and the Post-independence Kenya Government have assisted farmers in construction of terraces, cut-off drains, planting of trees etc. conserving the soil through the catchment approach or otherwise. The donor body thus the Swedish International Development Authority (SIDA) together with the Kenya Government are in the process of gradually winding up donor funded projects, soil conservation being one. Suppose a new organisation called Kaplamai Environment Conservation Group (KECG) was formed and it was decided that farmers willing to contribute a service charge to the organisation will continue to receive material and advisory assistance for the soil conservation. The funds collected from the annual service charge will be used to defray transport, personnel and material expenses.

Now would you be willing to pay anything in terms of service charge per year towards soil conservation measures?

Yes...( )

No.. ( )

22. If NO, which of the following best describes your reason.

a) Not willing to place any value on soil conservation practices ....( )

b) Has no enough information on soil conservation practices ....( )

c) Cannot afford to pay for conservation of soil.......................................( )

d) Not interested in participating in the survey .... ( )

e) Practice of soil conservation has no value .... ( )

23. If YES, what is the maximum amount of service charge per year to the KECG will you be willing to pay for soil conservation practices?

SECTION E: SOCIO-ECONOMIC AND DEMOGRAPHIC PROFILE

24. Sex of the Farmer:

Male .... ( )

Female .... ( )

25. Occupation of the farmer

a) Full time farmer.. ( )

b) Part-time farmer .... ( )

26. Highest level of education achieved

a) None .... ( )

b) Primary .... ( )

c) ‘O' Level .... ( )

d) ‘A’ Level .... ( )

e) University/College-/-post Graduate .... ( )

f) Post-Graduate.. ( )

27. What is the size of your farm? .... Acre(s)

28. How did you acquire this parcel(s) of land you farm?

a) Inherited .... ( )

b) Purchased .... ( )

c) Leased .... ( )

29. What is the system of land tenure?

Individual .... ( )

Family .... ( )

Communal .... ( )

30. What is your average net monthly cash income (Tick appropriate income bracket and indicate the actual amount if possible).

Farm income (Kshs.) (From sale of farm produce)	Off-farm income (Kshs.) (From activities e.g. teaching, petty business)
0-500	0-1500
501-1000	1501-3000
1001-1500	3001-4500
1501-2000	4501-6000
2001-3000	6001-7500
3001-3500	7501-9000
3501-4000	9001-10500
4001-4500	10500-12000
4501-5000	12001-14500
Over 5000	Over 14500

31. Who makes decision for the family as regards soil conservation activities?

Male.. ( )

Female .... ( )

Maleand Female .... ( )

Father-in law .... ( )

THANK YOU FOR YOUR CO-OPERATION GOD BLESS YOU