EVALUATION OF WILLINGNESS TO ACCEPT AND ADOPT CLEAN DEVELOPMENT MECHANISM PROJECTS AMONG SMALLSCALE FARMERS IN NJORO DISTRICT, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfillment for the Requirements of the Master of Science Degree in Agriculture and Applied Economics of Egerton University

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DECLARATION AND APPROVAL

DECLARATION

I declare that this thesis is my original work and to the best of my knowledge has not been presented for any degree at any other university.

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Sign: -------------------------

Date-------------------------

APPROVAL

This work has been prepared under our supervision and submitted to Graduate school for examination with our approval as university supervisors.

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DEDICATION

I dedicate this work to my parents Mr. Edward Ayuya and Mrs. Margaret Ayuya, brother and sisters Hildah, Hillary, Sheillah and Laurah for their sincere support.

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ABSTRACT

Carbon markets are developing world wide with the major aim of environmental protection and poverty alleviation in developing countries. Some carbon sequestration projects have been started in Kenya though it is still not yet a vibrant investment in spite of the available suitable biophysical land. Njoro district has no such project regardless of being affected by deforestation. One inevitable result has been the unpredictable rainfall pattern constituting overall climate change, increased surface run off, the low water levels in river Njoro, loss of biodiversity and the increased poverty in the region. It is still not clear if such projects are to be initiated, the small-scale farmers would be willing to accept and adopt them. There was need therefore, to assess the willingnes of small scale farmers to accept and adopt carbon trade tree project in order to understand farmer's decision making process. The study used multi-stage sampling procedure to select 150 small-scale farmers in Njoro district. Both primary and secondary data sources collected using observations and interviews with the help of a semi-structured questionnaire. Data analysis was done using descriptive statistics, ordinal logit model and the double hurdle model using STATA computer programs. The results indicated that 29% of the farmers practiced tree planting/agro-forestry as the voluntary CDM practice in the study area. On the level of awareness the result indicates that 58% of the farmers were not aware of the project, 23% were aware and correct and 19% of the farmers were aware but wrong signifying low levels of awareness of the CDM project among farmers. Gender, household size, farm debt, attitude towards risk, farm size, land tenure, availability of voluntary CDM and perception of the technology were found to influence the willingness to accept the project. Further, age, extension contacts, attitude towards risk, land tenure and perception towards the technology influenced on the extent the farmer is willing to adopt. The study therefore, recommends policy interventions in increasing awareness, improved training through extension services on agro-environmental programmes, formation of agro-environmental self help groups by farmers and creation of strategies that would improve socio-economic conditions of smallholder farmers in Kenya. Through this, adoption of carbon tree trade would be successful consequently increasing carbon sinks and increased smallholder farm income hence poverty reduction and sustainable development.

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LIST OF ABBREVIATIONS

C	**-**	Carbon
CCX	**-**	Chicago Climate Exchange
CDCF	**-**	Community Development Carbon Fund
CDM	**-**	Clean Development Mechanism
CO_2	**-**	Carbon dioxide
Cop	-	Conference of the Parties
ETS	**-**	Emission Trading Scheme
EU	**-**	European Union
GHGs	**-**	Green House Gases
GoK	-	Government of Kenya
IET	-	International Emission Trading
IPCC	-	Intergovernmental Panel on Climate Change
JI	-	Joint Implementation
Km	-	Kilometres
NGOs	-	Non-governmental Organizations
PCF	-	Prototype Carbon Fund
TAM	-	Technology Acceptance Model
TIST	-	The International Small Group Tree Planting Program
USAID	-	United States Agency for International Development

CHAPTER ONE

INTRODUCTION

1.0 Background information

For decades, there has been evidence of growing accumulation of greenhouse gases (GHGs) in the upper atmosphere leading to changes in climate, particularly increases in temperature. The greenhouse gases are released into the atmosphere from human activities as they harness environmental resources. However, while developed nations are currently responsible for the vast majority of emissions, it is the least developed countries which are feeling the greatest impact (Toulmin *et al*., 2005). It is extensively acknowledged that a drastic cut in emissions of GHGs is required to the tune of 50–80% globally by 2050 if at all changes in climate have to curbed. An estimated 13 million hectares of tropical forest are destroyed yearly, resulting in extinction of 14 000–40 000 species and emission of 2.1 Gt of carbon which forms 17% of total anthropogenic emissions of greenhouse gas (Rogner *et al*., 2007). If the trend in GHGs emissions is not controlled, it is predicted that global welfare will reduce up to an amount equivalent to the reduction in the per capita consumption of 20% representing the greatest and widest market failure Stern (2007).

The Kenya Forest Working Group (2006) reported that the depletion of forests is of great concern for environment and development in many developing countries, Kenya not being an exception. Unsustainable use of forests has resulted in severe environmental problems; especially land degradation, desertification and general loss of productive potential in rural areas. Soil degradation has been the cause of declining yields in parts of many countries especially on lands where poorest farmers attempt to wrest a living. Deforestation has also affected water catchment areas and destroyed watersheds, affecting the quantity and quality of the water supplies they contain. In some cases, deforestation has resulted in unprecedented floods and droughts leading to loss of life and damage to properties as a result of climate change. Kenya's forest cover has sunk to as low as 1.7%, which is way below the internationally recommended 10% (Kenya Forest Working Group, 2006).

Under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (1992), signatory countries made a commitment in reducing carbon emissions to the atmosphere and to increase rates of carbon removal and storage from the atmosphere. The Protocol's Clean Development Mechanism (CDM) provides that countries which emits carbon above agreed-upon limits to purchase carbon offsets from countries and organizations that uses biological means to absorb or reduce greenhouse emissions (IPCC, 2000). The CDM policies are currently applied in afforestation and reforestation projects, but carbon sequestration in agricultural soils has also been considered. Markets promoted by CDM for carbon sequestration are developing in many parts of the world. The carbon markets could be either allowance based which allows the trading in emission allowances under cap-and-trade regimes (an example is the EU emissions trading scheme ETS) or project based allowing trading in sequestration (IPCC, 2000; Ringius, 2002).

In the last decade the importance of carbon sequestration and trading as mechanisms to enhance both environmental protection and poverty alleviation in developing countries has increased considerably. It is expected that the CDM offered by the Kyoto Protocol could result in natural resource conservation and enhanced income and food security benefits for producers in the developing world (IPCC, 2000; Woomer *et al.*, 2004). By this way it contributes to reducing rural poverty by providing payments to farmers and organizations who adopt carbon sequestration technologies in line with the environmental services they offer as agreed by the CDM by developing active sinks in their farms (Smith and Scherr, 2002).

Rohit *et al*. (2006) extensively reviewed 19 carbon sequestrations and trading projects among 16 countries in Africa and found that seven projects are based in Kenya (specifically in Nyeri district and some parts of western Kenya), Uganda or Tanzania started following a multi-sector approach. This indicates that East Africa has the span of diverse agro-ecological zone and land uses preferred by international carbon investors. The region has a great expanse of land with the necessary biophysical characteristics suitable for carbon sink in soil and vegetation via afforestation and reforestation projects (Ringius, 2002). The projects aim to generate additional benefits to carbon sequestration; such as biodiversity conservation, improved energy situation and improved farm income. Major developmental benefits for local communities from these projects include an increased number of timber and non-timber forest products from regenerated forests, employment opportunities from forestry activities, and increased incomes from the sale of carbon credits (Rohit *et al*., 2006). In Kenya, specifically Nyeri District, through the International Small Group and Tree Planting Program local farmers receive regular payments on the basis of the number of trees they can manage on their lands (http://www.tist.org). These examples demonstrate that carbon sequestration projects have the potential to achieve improved livelihoods and sustainable development in Kenya.

Njoro district boasts of the expansive Njoro watershed which is the main source of water of Lake Nakuru that supports diverse biological resources of global, regional and national importance. However, deforestation and land use change in the vital water shed continues to alter the hydrological regime of several rivers and streams in the district, Njoro river not being an exception (Ngugi *et al*., 2003). Land cover change analysis carried out by Baldyga *et al*. (2004) shows significant loss in upland forests in the river Njoro water shed due to the removal of the plantation forests. In addition to these losses the average surface run off due to land use change has increased greatly over the years. Thus there is an agent need to control such changes and efforts made to preserve and restore the terrestrial and biological biodiversity in the district for improved ecological health and sustainable development.

1.2 Statement of the problem

Deforestation in Njoro district has increased considerably over the years. This is evident in several locations such as Mutukanio, Naishi, and Nessuit where area ranging from 10 percent to 100 percent of forest land has been deforested and converted into agriculture. One inevitable result of such change in the district has been the unpredictable rainfall pattern constituting overall climate change. In addition there is increased surface run off, low water levels in river Njoro, loss of biodiversity and the increase poverty in the region (Walubengo, 2007).

One of the ways of addressing these problems arising from climate change in the district is the embracing of CDM projects. The CDM projects increase the carbon sinks and provide income through purchase of carbon credits. It is not clear why the farmers in the district have not engaged themselves in these projects to address these problems and therefore, the need to assess their willingness in taking up such a project initiative. There is urgent need to analyse the decision to accept and adopt CDM practices within the existing socioeconomic and institutional arrangements.

1.3 The general objective

The general objective of this study was to evaluate the willingness to accept and adopt clean development mechanism projects among small-scale farmers in Njoro district in order to contribute towards understanding farmer's decision making process when adopting CDM project initiatives.

1.3.1 Specific objectives

1. To identify and describe the various voluntary CDMs practiced by smallholder farmers in Njoro district Kenya.
2. To assess the level of awareness of carbon trade initiatives in order to determine the socioeconomic and institutional factors that influence the level of awareness of carbon tree project.
3. To assess the factors that influences the willingness to adopt and the extent of adoption of carbon trade tree project in order to identify areas of policy intervention.

1.4 Research questions

1. What are the voluntary CDM practiced by farmers in Njoro district?
2. What are the socioeconomic and institutional factors that influence the level of awareness among the small-scale farmers?
3. What are the socioeconomic and institutional factors that influence the willingness to accept carbon trade tree project by the small-scale farmers?

1.5 Justification of the study

Kenya aims to provide its citizens with a clean, secure and sustainable environment by the year 2030. To attain this, the country has set goals such as increasing forest cover from less than three percent of its land base at present to four percent by 2012 (G.o.K, 2007). Furthermore the country ratified the 1992 Framework Convention on Climate Change, and thus has the duty to promote the conservation and enhancement of sinks and reservoirs of all greenhouse gases, including forests through afforestation projects. The carbon trade tree project has emerged through the CDM as a way of combating climate change through biodiversity conservation and ecological restoration. Carbon sequestration projects offer economic and environmental benefits which are particularly relevant for Africa, the world's poorest continent. Kenya needs increased investment to support poverty alleviation and infrastructure development. With a high dependence on land and forests for subsistence, the country also requires effective strategies to combat the growing threat of widespread natural resource degradation. Accordingly, efforts to mitigate climate change through carbon sequestration projects could bring in money both to raise local incomes and regenerate natural resources (Kituyi, 2002).

With the country having been greatly deforested in the last two decades and currently undergoing the pain as a result of climate change through floods and droughts, the condition needs to be addressed for the sake of improved livelihood and sustainability. Thus the study generates imperative information that will explicate the understanding of the factors influencing the potential rate and intensity of adoption, helping organizations involved in the technology development and transfer to ensure their efficiency and effectiveness in attaining their objectives. This will further help rural development planners in setting priorities for investment resource allocation and the formulation of rural development programs aimed at increasing farmers' income. Furthermore, few studies have been done on the willingness to adopt tree carbon trade project.

1.6 Scope and limitation of the study

The sample was made up of small-scale farmers in Njoro district where the population comprised of farmers with less than 20 hectares. The sampling units were households from the chosen three divisions in the district which includes Mauche, Kihingo and Njoro. The variables regarding institutional, human assets, land characteristics, demographic and technology are only selected variables and do not necessarily mean that all variables are included. The decision on whether to adopt and the rate was assumed to be separate where the farmer was first to make the decision of whether or not to adopt and then make a decision of the extent of adoption. The district is still new and there was possibility of inadequate information since most information available is of the larger Nakuru district.

1.7 Definition of terms

Carbon sequestration: a situation when there is transfer of atmospheric CO_2 into long-lived pools and keep it stored securely so that it is not immediately re-emitted back to atmosphere.

Household: is defined as an independent male or female producer and his dependants who must have lived together for a period not less than six months. The members are answerable to one person as the head and share the same eating arrangement.

Livelihoods: refers to a means of living, especially of earning money to feed oneself in terms of trees, agricultural crops and/or animals on the same land management unit in some form of spatial arrangement or temporal sequence.

Socio economic effects: are indicators looking at both social and economic conditions relevant to the well being of the farmer.

Clean Development Mechanism (CDM): a way to reduce atmospheric carbon by locking them in plants and soil through the process of carbon sequestration.

Voluntary CDM: farmer's involvement in tree planting, strip cropping, zero tillage, terracing, mulching, cover cropping and application of manure including any other soil conservation measure.

Tree farming: farmer's involvement in planting of trees in the farm for either commercial or farm use above a quarter of an acre

CHAPTER TWO

LITERATURE REVIEW

2.1 Carbon sequestration mechanism

Carbon sequestration has been defined differently in many studies. For instance carbon sequestration has been defined by Hutchison *et al.* (2007) as the persistent increase in carbon storage either in soil, plant or in the sea. Bernoux *et al*. (2006) has defined carbon sequestration as the amount of carbon that can be additionally stored in an agro-ecosystem where as Lal *et al.* (2003) has defined it as the ''transfer atmospheric CO_2 into long-lived pools and keep it stored securely so that it is not immediately re-emitted back to atmosphere''. This study adopts the definition by Lal *et al.* (2003). Various recommended land management techniques are used to facilitate the increase of carbon in the soil (Janzen *et al*., 2001) and they range from increasing energy supply and use, use of environmental friendly technologies, increase use of renewable and nuclear energy systems, fuel switching from coal and oil to natural gas, capturing the and using methane from coal mines and land fails to avoiding deforestation and improved agricultural activities. An important option highlighted in this study is carbon sequestration in sinks such as plant biomass and soil. Despite Africa contributing least to climate change debate it is to likely experience the most impacts which is being worsened by continued deforestation mostly through illegal logging.

The African continent has a great potential and suitable land which could be used for carbon sequestration projects (Jindal *et al.*, 2006). Further Kituyi (2002) notes that with the region having high dependence on land and forest for subsistence there is a growing threat of natural resource degradation and hence carbon sequestration may offer economic and environmental benefits in Africa. In the farmer environment carbon sequestration can take place through trees (terrestrial) or through soil carbon sequestration. Albrecht and Serigne (2003) estimated a potential C sequestration in tropical agro-forestry systems of 95 t C ha^-1 (varying widely between 12 and 228 t C ha^-1. Variability in C sequestration can be expected in areas with high Complex agro-ecosystems, depending on factors such as vegetation age, structure, management practices, land uses and landscape. Figure 1 illustrates how the carbon mechanism operates in agro-ecosystem**.**

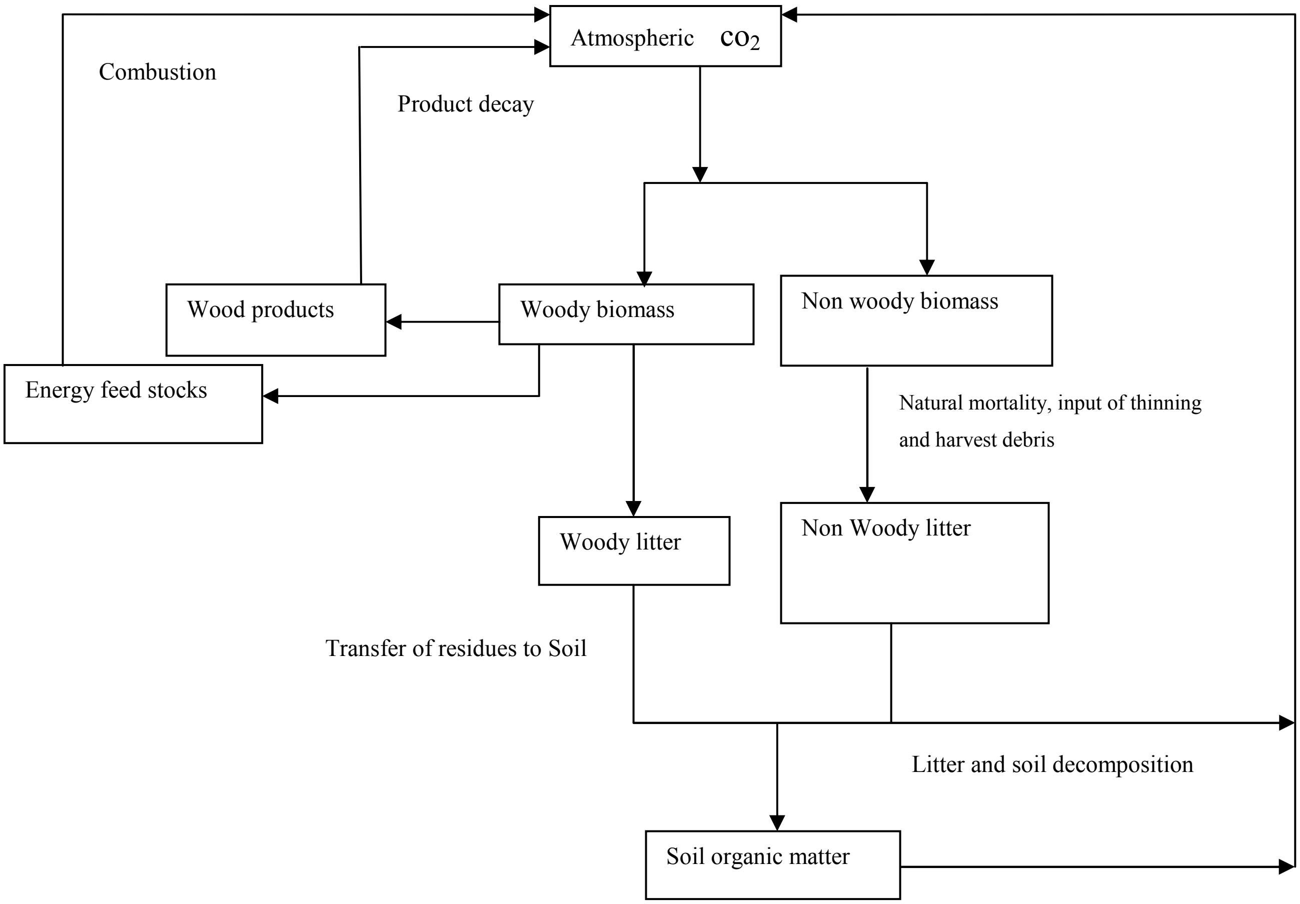

Figure 1: Carbon sequestration mechanism

Source: Dewar and Cannell (1992)

Atmospheric carbon-dioxide is taken by trees and is fixed it in woody biomass made up of branches, stems and woody roots and also in non-woody parts consisting of foliage and fine roots. The wood biomass is converted to wood products and energy feed stocks .upon combustion the energy feed stocks it again releases carbon to the atmosphere while the wood products eventually decompose with time aerobically and anaerobically releasing also carbon to the atmosphere. Woody and non-woody litters are received by the forest floor continuously as the trees reach their natural mortality, harvesting or thinning stages (Anil *et al.*, 2004). Micro-organisms decompose the litter releasing also co_2 into the atmosphere with the remaining part being transferred to soil organic matter.

2.2 Carbon trading, the Kyoto protocol and the CoP 15 climate change talks

Kyoto protocol marked a significant step in impeding the effects of climate change and the various roles played by Greenhouse gases (GHGs) resulting from deforestation, burning of fossil fuels as well as GHGs from other sources. Since its birth the protocol has aimed at reducing emissions below the 1990 levels by 2008 to 2012 by adopting aggressive strategies. The protocol resulted in several economic mechanisms including Joint Implementation (JI), International Emission Trading (IET) and the CDM (Baranzini *et al*., 1998). Baranzini and Hamwey (1999) estimated that overall market offset could reach as high as 850- 1500 million metric tonnes of carbon annually which translates to a market value of between 24 to 37 billion dollars making a market size of 11-25% of the anticipated total emission of the developed and economies in transition countries(Annex 1 countries) . This will be attained through conservation efforts, alternative energy and new technologies mainly through CDM policies.

CDM has emerged as one important way to reduce atmospheric carbon by locking them in plants and soil through the process of carbon sequestration. Baranzini *et al*. (1998) notes that this can be achieved through planting trees or through soil conservation which accrues with benefits such as improved farm income through increased productivity thus food security, soil conservation, watershed protection and maintaining biodiversity integrity. Additional benefits would be through the carbon credits by the sales of certified emission reduction units which is critical for the development of the developing countries. This is cited under Article12, section 5c (United Nations Third Conference of the Parties of the Framework Convention on Climate Change, 1997).

CDM stipulates that any carbon sequestration project initiated must be able to show that its emission reduction activities are above and beyond what would be achieved without the project and that leakage of the carbon has not occurred anywhere in the economy. CDM also allows developed countries to purchase or trade in GHGs offsets either through excess quota allocations or from projects set up in developing countries. Chichilinsky (1996) found that industrialized countries which account only 20%of the world population is responsible for 20% of the world’s carbon emissions thus the need to counteract the imbalance while reducing emissions of GHGs at the same time. Enhancing carbon sequestration through carbon trading related payments is important in Africa for the farmers to adopt land management practices that enable the buildup of carbon pools where agriculture is the major source of livelihood characterized by low productivity and food insecurity (Sanchez, 2002). The markets for carbon are increasing at a promising rate and substantial amounts of carbon are being traded in both Kyoto and non-Kyoto signatory countries. Sanchez further notes that CDM sequestration projects are majorly funded by the World Bank where all CDM projects have to be registered with the Executive Board of the World Bank, monitored and independently reviewed to ensure the success of the programme.

Lecoq and Capoor (2005) categorized carbon markets as consisting of two types of transactions; project based transaction and trade in emission allowances. Project based transactions occurs when a buyer directly invests in carbon sequestration or emission reduction programs and gets emission credits in return. For example a company paying money to a local community to practice agro-forestry and the claiming carbon sequestration credits in return. Trade in emission allowances involve trading in carbon offset regimes that have evolved in many parts of the world such as the European Union Emission Trading Scheme (EU-ETS) under the Kyoto Protocol and voluntary markets such as the Chicago Climate Exchange (CCX) in the United States. In summary the carbon market can still be subdivided into again four transactions in the Table 1.

Table 1: Type of transactions in the carbon market

	Trade in Emissions Allowances	***Project Based Transactions***
Kyoto-Compliant	Trade in carbon offsets under European Union Emission Trading Scheme, UK – Emission Trading System	All Clean Development Mechanism and Joint Implementation Projects
Voluntary, not for compliance under Kyoto	Trade in emission reductions on Chicago Climate Exchange, NSW Greenhouse Gas Abatement Scheme	Voluntary Reduction Projects, such as Carbon Sequestration Projects in Africa

Source: *Rohit et al*. (2006).

The 15th Conference of the Parties (CoP15) and the 5th Conference of the Parties served as the Meeting of the Parties to the Kyoto Protocol (COP/MOP5) in Copenhagen marked the culmination of two years of negotiations under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC) and the Bali Roadmap. The Copenhagen climate change talks held in December 2009 acknowledged the importance of reduced emission of GHGs from deforestation and forest degradation, and the role of conservation technologies in developing countries. The decision was met of the effective engagement of the local indigenous people and local communities in projects geared towards reduced emission and the increased absorption of the GHGs in the developing countries by the developed countries (http://unfccc.int/files/na/application/pdf/cop15_ddc_auv.pdf.)

2.3 Carbon sequestration in Africa

This section majorly relies on the work done by Rohit *et al*. (2006) on status of carbon sequestration in Africa where 19 carbon sequestration projects operating in 16 countries was expansively reviewed in Africa. They found out that 7 out of the 19 projects were situated in East Africa states – (Kenya, Uganda and Tanzania). The projects followed a multi sector approach with the aim of winning more than one goal. A good example is the case Sustainable Energy Management project in Burkina Faso where the project offers carbon sequestration benefits through non-carbon energy sources such as photovoltaic by encouraging the local community to abandon wood fuel and charcoal as energy source.

Various organizations are involved in funding carbon investment in Africa. The World Bank has done an enormous work by launching three carbon funds which support eight carbon sequestration projects through the Prototype Carbon Fund (PCF), Community Development Carbon Fund (CDCF), and Bio-Carbon Fund. Other organizations are United States Agency for International Development (USAID) FACE Foundation and the European Union. Most of these projects are undertaken through bilateral agreements by the government or national agencies and the private sector- international and local NGOs and projects being jointly implemented by research institutions or universities (Rohit *et al.*, 2006).

Rohit *et al.* (2006) found that 13 projects were found in East Africa and has the potential of sequestering 35.23 million tonnes of CO_2 which will be sold to the international carbon market. This implies that commercialization of the projects is still low in Africa. Success of the projects has been reported in parts of Africa. Examples include Plan Vivo project in Uganda and the Nhambita community project in Mozambique where credit to private firms in Norway and

United Kingdom based companies respectively and sharing the benefits with the local farmers. In Kenya there are The International Small Group and Tree Planting Program (TIST) in Nyeri and Western Kenya Integrated Ecosystem Management Project in some parts of western Kenya (http://www.tist.org , www.carbonfinance.org).

2.4 Determinants of technology acceptance and adoption

Various technology acceptance and adoption studies have been carried out in different parts of the world in order to understand farmers decision making criteria to enhance diffusion of different technology. Dimitropoulos and Kontoleon (2009) studied the determinants of wind-farm investment in the Greek Aegean Island using the Random parameter logit model or Mixed logit model because it allows the accounting for preference heterogeneity across households within a random utility modeling framework. They concluded that institutional factors affect the local acceptance of technology-cooperation with municipal authorities and local representatives and also that physical location of the farm affects the wind power investment hence the need to carefully consider the distinctive characteristics of the regions before planning wind power installation. Nowak and Korsching (1983) in their study also stress the importance of institutional factors in enhancing farmer's uptake of agro-environmental initiatives. Phiri (2007) and Ross *et al.*, (2004) studied the role of credit in the adoption and use of improved dairy technologies and concluded that credit provision as an institutional factor provides the necessary capital which facilitates the farmers potential to afford a given technology and maintain its usage

De Steur *et al*. (2009) investigated consumer willingness to accept and purchase genetically modified rice with high folate in Shanxi province in China and found out that acceptance of genetically modified rice is positively influenced by consumers perception and the importance of socio-demographic indicators in influencing, knowledge acceptance and intention to purchase. Albrecht and Serigne (2003) stressed the importance of strengthening the demorgraphic capabilities especially education level which holds an important role in the success of any technology adoption. Jera and Ajayi (2008) assessed the potential adoption of fodder bank technology as a means of improving dairy production among smallholder farmers in Zimbabwe, as well as assessing the socioeconomic factors affecting the adoption. It was found that among the socioeconomic variables, dairy herd size, land size and years of membership with dairy association exhibited positive influence to adopt fodder technology.

Nankhumwa, (2004) assessed the determinants of soil conservation technologies and found out that smallholder farmers usually follow stepwise decision making process where first, they decided whether to participate or not and later decide making on the extent of adoption. The study observed that factors that affect adoption were different from factors that affect the extent of adoption. However, the study established that farmers' decision to adopt marker riding technology was primarily influenced by knowledge, age of household head, labour availability and the level of erosion. The factors that significantly affect the extent of the adoption were farm profitability, farm inputs, land size, labour availability and the production assets owned by the farmer. Similar findings were found by Hynese *et al*. (2009) where they modelled habitat conservation and participation in agri-environmental schemes using a spatial micro simulation approach and realised that land classified as having been greatly deforested and experiencing high levels of soil erosion are associated with the habitat types likely to be protected under the agri-environment programme and such schemes are taken by farmers with ease because of their consequent results.

Sattler and Nagel (2009) analysed the factors affecting farmers' acceptance of conservation measures in North-eastern Germany using descriptive statistics and calculating a conservation acceptance index. The findings showed that despite the assumption that farmers decisions are mostly accounted by economic rationality, costs are not important factor but there are a number of factors that are more important like risks, effectiveness or time and effort necessary to implement a certain conservation measure. Greiner *et al*., (2009) in their study concluded that risk attitude of farmers towards region-specific 'best management practices' should be assessed first during the initial design before the dissemination and promotion of such technology development. Best management practices are conservation practices aimed at reducing diffuse source pollution from agricultural lands as a result improving end-of-catchment water quality.

2.5 Theoretical and conceptual framework

2.5.1 Theoretical framework

This study was informed by the theory of random utility as developed and used by Greene (2003) (see the model below). Following these, the decision to adopt the carbon tree project is denoted by $\tau = 1$ and $\tau = 0$ for non adoption carbon tree project. The underlying utility function, which ranks the preference of the ith individual is given by $U(Z_{\tau i}, F_{\tau i})$. Utility depends on $Z_{\tau i,}$ a vector of personal attributes (for example age, education, income and occupation) and farm characteristics and $F_{\tau i}$, a vector of management characteristics (for example perceptions and attitude towards risk) associated with specific initiatives.

$$U_{\tau i} = \gamma_t D(Z_{\tau i}, F_{\tau i}) + e_{t i} \quad \tau = 1,0\,; \; i = 1........n \quad \text{..(1)}$$

The relation in (1) does not restrict the function D to be linear. The utilities $U_{\tau i}$ are random, and the ith individual adopt the carbon tree project if U_{1i} is > U_{0i} or if the no observable random variable $y_i^* = 0$. The probability that $y_i^* = 1$, in other words, that the individual adopt the carbon tree project can be written as a function of the independent variables:

$$P_i = \Pr\,(y_i^* = 1) = \Pr(U_{1i} > U_{0i})$$

$$= \Pr[\gamma_1 \; D_i(Z_{\tau i}, F_{\tau i}) + e_{1i} > \gamma_0 D_i(Z_{\tau i} F_{\tau i}) + e_{0i}]$$

$$= \Pr[e_{1i} - e_{0i} > D_i(Z_{\tau i}, F_{\tau i})(\gamma_0 - \gamma_1)]$$

$$= \Pr[\varepsilon_i > D_i(Z_{\tau i}, F_{\tau i}) = D(X_i^1 \beta) \text{..(2)}$$

Where, P_i = the probability of i^{th} individual adopting the carbon tree project

ε_i = $e_{1i} - e_{0i}$ is a random disturbance term,

$D(X_i^1 \beta)$ = the cumulative distribution function for ε_i evaluated at $X_i^1 \beta$

Equation (2) cannot be estimated directly without the knowledge of the form of D. The distribution of D depends on the distribution of the random term ε_i .If ε_i is normal, then D is a cumulative normal function, and if ε_i is uniform, then D is triangular (Phiri, 2007).

Napier and Napier (1991) argue that individuals develop perception and attitude towards other people and things within the boundaries of anticipated personal beliefs and costs to be derived from the contact with them. Positive perception will be observed on activities that yield net benefits to the individuals and the community while those that generate net losses will be perceived negatively. Contemporary exchange theory asserts that farmers would seek the best value they can derive from participating or the intentions to participate in environmental conservation (Napier *et al*., 1986). Napier and Napier (1991) augments the theory by illustrating as farmers seek to maximize their profit from their enterprises, they tend to choose environmental conservation techniques that offer at least as much, in terms of the socio-economic and environmental benefits as they get from the various alternative activities.

Farmer's participation in environmental conservation differs depending on their socio-economic and demographic background. For example, some farmers might be concerned about the degree of land degradation and would prefer to undertake conservation measures while others would not. Therefore, acceptance and adoption of conservation measures, such as the CDM mechanisms, involves a combination of individual farmer characteristics and organisational characteristics which influence the awareness which culminates into decision making regarding farmers behaviour (Napier *et al.,* 1986).

2.5.2 Conceptual framework

In a farm environment farmers are faced with a variety of intertwined factors which influence their decision making in view of maximizing the profits from the competing enterprises in the farm. In general farmers are likely to allocate land to forestry if its net benefits are greater than with no tree enterprise. Smallholder farmers have different personal characteristics which include farmers' education, age, household size, land ownership, farm leverage, farming income and non-farm income which greatly affects farmers' decision making. Institutional factors which include farmers contact with extension personnel and membership to a group also affects the productivity and enterprise choice in the farm. Both factors are knotted since the influence one another and they have a great influence on the level of awareness. The farmer's characteristics, institutional factors, level of awareness together with the existing voluntary CDM mechanism influences the farmers' decision (willingness) to accept and adopt the CDM project (Figure 1). Thus subject to resource, technical, personal and policy constraints, farmers select from the alternative investments opportunities that fit their circumstances , accounting for both the net returns and risk. The outcome includes climate change mitigation, biodiversity conservation, soil erosion mitigation and increase in farm profitability and income leading to poverty reduction. Figure 1 shows the representation of the factors that can influence a farmer's decision to accept and adopt CDM project in the study area.

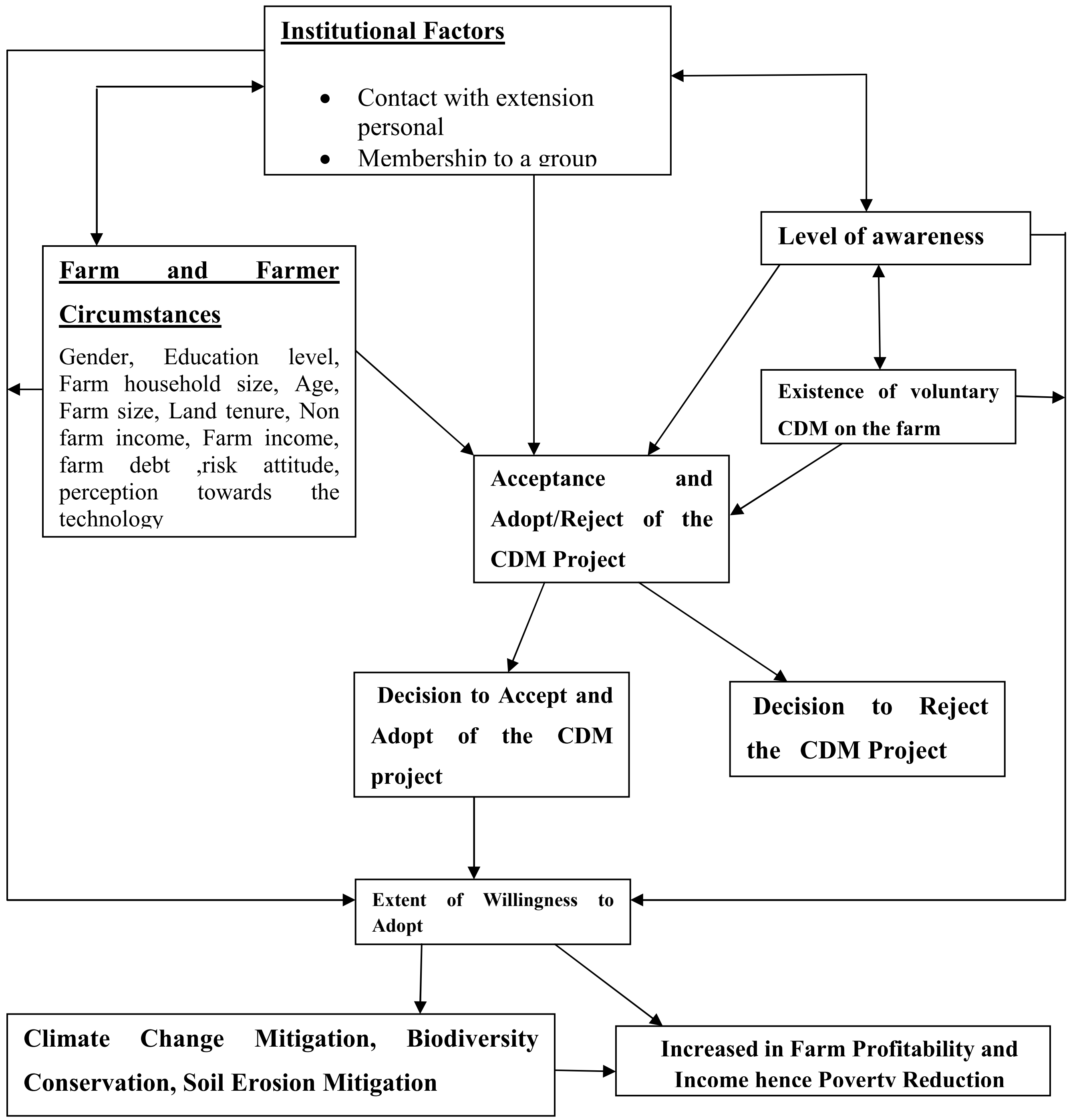

Figure 2: Conceptual framework

Source: Literature review

CHAPTER THREE

METHODOLOGY

3.1 Study area

Njoro district is located in Nakuru County on the eastern edge of the Mau Forest Complex, the largest single forest block in Kenya. The area lies between the Mau forest and Lake Nakuru National Park, a world famous flamingo habitat. Njoro stands at an altitude of 1,800 m (6,000 ft) above sea level and has a mild climate. Temperatures range between 17–22° C, while the average annual rainfall is in the region of 1,000 mm. Njoro's economic and environmental resources include crops and trees on farms, livestock, and a small amount of water and riverine forest. In the past, the region was covered with forests but due to the expansion of agriculture and the general population growth, these have receded. Over the years the Njoro district has grown to be an important centre in agricultural research, education and development. The district has Kenya Agricultural Research Institute (KARI) and is home to Egerton University located 5 km south from Njoro town. Njoro is currently a district on its own in Rift Valley province (Walubengo, 2007). The map of the study area is as shown in Figure 3.

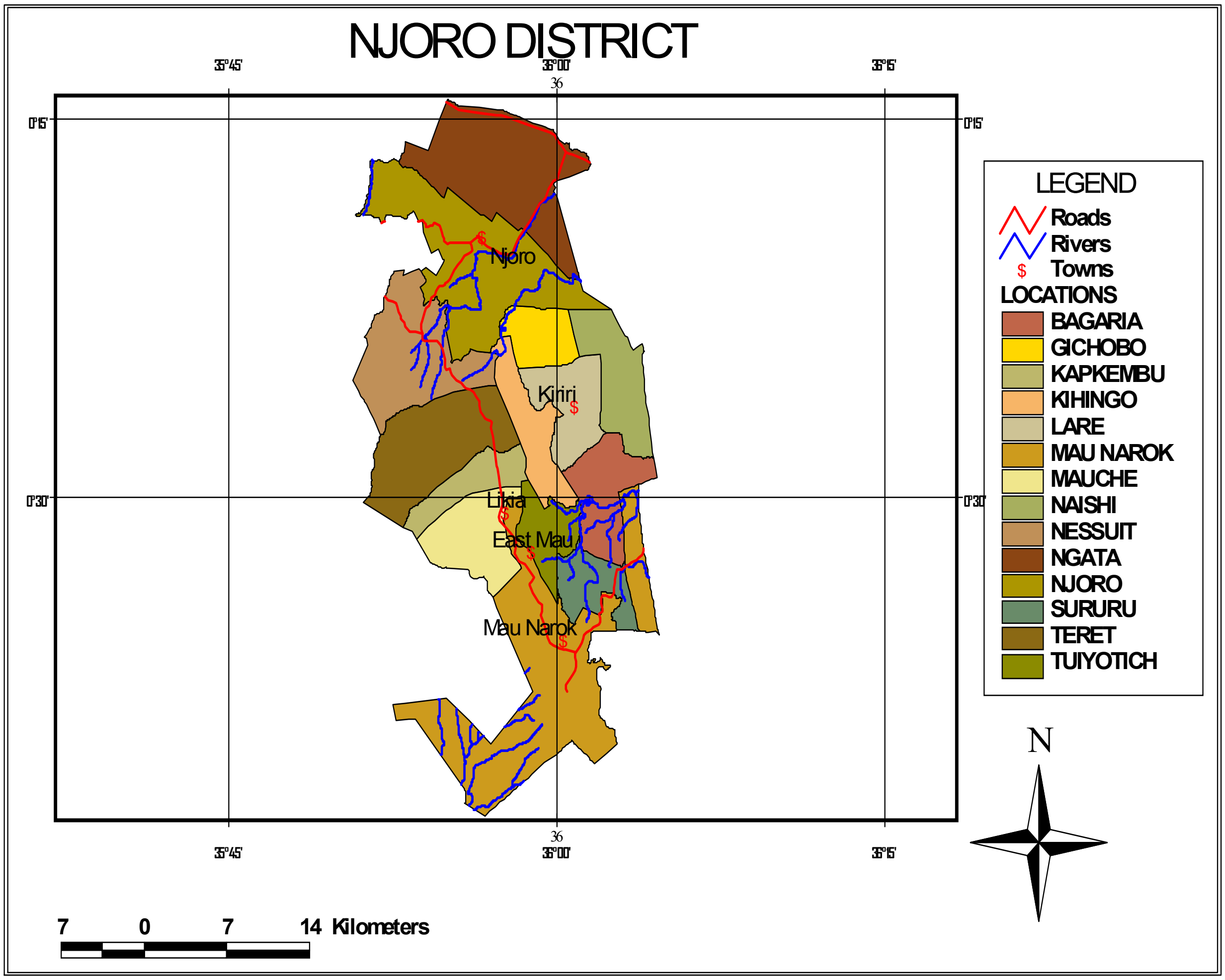

Figure 3: Map of Njoro District

Source: Author

3.2 Sampling design

Multistage sampling procedure was used to select the respondents. The first stage involved random selection of three divisions from the five in the district (Njoro, Kihingo, Lare, Mau-Narok, and Mauche. Then second stage employed simple random sampling to select the number of farmers from each of the three divisions. A sample of 150 farmers was selected from the population of the small-scale farmers in the district. The required sample size was determined by proportionate to the number of households sampling methodology (Anderson *et al.,* 2007).

$$n = \frac{pqZ^2}{E^2} \quad (3)$$

Where; n = Sample size; Z= confidence level (α=0.05); p = proportion of the population containing the major interest q = 1-p E= allowable error. Since the proportion of the population is not known, p= 0.5, q= 1-0.5=0.5, Z= 1.96 and E = 0.08. This resulted to a sample of approximately 150 respondents.

3.3 Data collection and analysis

This study used both primary and secondary data collection. Primary data was sourced through interviews with the help of semi-structured questionnaire that were administered to smallholder farmers. The data was analyzed using STATA and SPSS computer programs.

3.3.1 Analytical framework

Objective 1

The objective was analyzed using the descriptive statistics. This involved the use of percentages, tables, graphs and mean to describe the various voluntary CDM activities present in the farming system at the time of the study.

Objective 2:

The second objective used the ordered logit model to determine the socio-economic and demographic variables that affects the awareness of the carbon trade projects among small-scale farmers. The ordered logit regression model allowed the parallel regression assumption results from assuming the same coefficient vector β for all comparisons in the N-1 equations. Melissa and Bryman (2004) modelled the ordered logit model as follows;

$$\ln \Omega_{y\leq m}(x) = \tau_m - x\beta$$

Where

$$\Omega_{y\leq m}(x) = \frac{pr[y\leq m|x]}{pr[y>m|x]} \quad \text{.........(4)}$$

The model has an advantage of removing the restriction of parallel regression by allowing β to vary for each of the J-1 comparisons. That can be illustrated by

$$\ln \Omega_{y\leq m}(x) = \tau_m - x\beta$$

For m=1,…, J-1

Equation 4 was written in terms of odds as;

$$\ln \Omega_{y\leq m}(x) = exp[\tau_m - x\beta] \quad \text{.........(5)}$$

For m=1… J-1

The predicted probabilities for the model were computed by solving these equations resulting in:

$$pr(y=1|x)=\frac{exp(\tau_1-x\beta_1)}{1+exp(\tau_1-x\beta_1)}$$

$$pr(y=j|x)=\frac{exp(\tau_j-x\beta_j)}{1+exp(\tau_j-x\beta_j)}-\frac{exp(\tau_{j-1}-x\beta_{j-1})}{1+exp(\tau_{j-1}-x\beta_{j-1})} \qquad \text{For j=2,… J-1}$$

$$pr(y=j|x)=1-\frac{exp(\tau_{j-1}-x\beta_{j-1})}{1+exp(\tau_{j-1}-x\beta_{j-1})} \quad \text{……………………………………………….. (6)}$$

To make sure that the $pr(y=j|x)$ is between 0 and 1 it must be the case that $\tau_j - x\beta_j \geq \tau_{j-1} - x\beta_{j-1}$. If this is constraint was not imposed during estimation, it is possible that the predicted probabilities can be negative or greater than 1 (Melissa and Bryman, 2004).

The empirical model that was estimated will be as follows;

Y_i =α+β_1 Locfarm+ β_2Grumemb +β_3Age +β_4Educ+ β_5Exten +β_6 Gend + β_7Soinfo + β_8 Extrefarm+ε …………………………………………………………………………....(7)

The variables in the model and their explanation are shown in Table 2.

Table 2: Variables of the ordered logit model

Explanatory Variables	***Explanation***	***Hypothesized relationship***
Locfarm	Location of the farm to the nearest trading centre measured using a likert scale. 1= <1km, 2= 1-5 km,3= >5km	+
Grumemb	The farmers involvement in group activities(dummy; Yes=1 or otherwise)	+
Age	Age of the household head(years)	+
Educ	Education level of the household head (1= Not gone to school; 2= primary;3= secondary; 4= college, 5= university)	+
Exten	The number of contacts with extension officers in a year(continuous)	+
Gend	Gender of the household head (dummy; Male=1or o if otherwise)	±

Soinfo	Source of information on new technologies by the farmer	±
Extrefarm	Existence of tree farming 1/4 an acre of trees) in the farm(dummy; Yes=1 or otherwise)	±

Where Y_i is the level of awareness measured in a likert scale of 1 = not aware, 2 = aware but wrong, 3 = aware and correct, the scale was adopted from a study by Briz and Ward (2009) on consumer awareness of organic products in Spain.

0bjective 3:

Double-hurdle model was used in this case to determine the factors that influence the willingness to adopt and the extent of adoption of carbon trade tree project in order to identify areas of intervention. Note that contingent valuation method could also be used but it is limited because it could not analyze the second part of the extent of potential adoption. Two step Heckman model could also be applied where it allowed the correction of selection bias on non-randomly selected samples but in this case we assumed the sample was randomly selected. Consequently the double hurdle model was adopted. The model allowed for the application of the empirical model to study :(i) whether or not a farmer was willing to participate in the carbon tree project (a dichotomous choice), and (ii) the extent the farmer was willing convert land to the project (a continuous variable). In the study it was expected that not all households were willing to participate in the project thereby resulting in some observations being zero. Therefore, the standard Tobit model formulated by Tobin (1956) and used widely in adoption studies modeling was conveniently adopted.

The model was originally formulated by Cragg (1971) and applied in many studies including Yen and Jones (1997). The double-hurdle model assumed that farmers make two sequential decisions with regard to willingness to participate and the extent to which they are willing to enroll in the project. Each of the two hurdles were conditioned by the household's socio-economic characteristics and variety-specific farmers' characteristics. Different latent variables were used to model each decision process in the double-hurdle model, with the probit model determining the probability that a household was willing to participate in the project and a Tobit model determining the extent of adoption. Langyintuo and Mungoma (2008) specified the model as;

$y^*{}_{i1} = w'_i \propto +\mu_i$ Decision to participate in the project

$y^*{}_{i2} = x'{}_i\beta + \mu_i$ Extent of adoption

$y^*{}_i = x'{}_i\beta + \mu_i$ If $y^*{}_{i1} > 0$ and $y^*{}_{i2} > 0$ ………………………………………………….. (5)

Where $y^*{}_{i1}$ was a latent variable describing the farmer's decision to participate in the project and $y^*{}_{i2}$ was a latent variable describing the extent of adoption (or the number of trees farmer was willing to plant trees), and $y^*{}_i$ is the proportion of the farm the farmer was willing to plant trees (or dependent variable) while μ_i and μ_i are the respective error terms assumed to be independent and distributed as μ_i~N (0, 1) and $\mu_i \sim N(0, \delta^2)$. Yen and Jones (1997) allowed for heteroscedasticity and a non-normal error structure (Jensen and Yen, 1996; Yen and Jones, 1997) estimated the model using the maximum likelihood of the form:

$$L(\propto, \beta, h, 0) = \prod\nolimits_0 \left[1 - \emptyset(W_i' \propto)\emptyset\left(\frac{x_i'}{\delta_i}\right)\right] \times$$

$$\prod\nolimits_1 \left[((1 + \theta^2 y_i^2)^{-1/2})\emptyset(W_i'\alpha)\alpha_i^{-1}\emptyset\left(\frac{T(\theta y_i) - x_i'\beta}{\sigma_i}\right)\right] \quad \text{……………..} \ (6)$$

To assess the impact of the regressors on the extent of adoption, it was necessary to analyze the marginal effects of the selected variables. According to Jensen and Yen (1996) the extent of adoption conditional on willingness to participate in the carbon tree project is of the form;

$$E(y_i|y_i > 0) = \emptyset\left(\frac{x_i'\beta}{\sigma_i}\right)^{-1} \int_0^\infty \left(\frac{y_i}{\sigma_i\sqrt{1+\theta^2 y_i^2}} \emptyset\left(\frac{(T(\emptyset y_i) - x_i'\beta}{\sigma_i}\right)\right) dy_i \quad \text{………………………………} \ (7)$$

The empirical model for the model is shown below

Discrete choice model (Probit)

PART (yes/no) = $\beta_0 + \beta_1$ (EDU) $_i$ + β_2 (FSIZE) $_i$ + β_3 (AGE) $_i$ + β_4 (GEND) $_i$ + β_5 (HHSIZE) $_i$ + β_6 (LANDTEN) $_i$ + β_7 (FARMINC) $_i$ +β_8 (NONFARMINC) $_i$ + β_9 (EXTEN) $_i$ + β_{10} (VOLUCDM) $_i$ + β_{11} (AWANESS) $_i$ + β_{12} (GRUMEMB) $_i$ + β_{13} (PERCE $_i$ + β_{14} (ATTISK) $_i$ $+ \varepsilon_i$

Outcome equation (Tobit)

Enroll share = $\beta_0 + \beta_1$ (EDU) $_i$ + β_2 (FSIZE) $_i$ + β_3 (AGE) $_i$ + β_4 (GEND) $_i$ + β_5 (HHSIZE) $_i$ + β_6 (LANDTEN) $_i$ + β_7 (FARMINC) $_i$ +β_8 (NONFARMINC) $_i$ + β_9 (EXTEN) $_i$ + β_{10}

(VOLUCDM) $_i$ + β_{11} (AWANESS) $_i$ + β_{12} (GRUMEMB) $_i$ + β_{13} (PERCE $_i$ + β_{14} (ATTISK) $_i$ $+ \varepsilon_i$

The variables used to estimate in the double hurdle model are described in the Table 3.

Table 3: Variables in the double hurdle model

Variable	*Explanation*	*Expected sign of variables*
Dependent variables		
Participate	Farmers willingness to accept the project(dummy)	
Enroll	Percentage of the farm willing to enroll(continuous)	
Independent variables		+
Age	Age of the household head(years)	
Educ	Education level of the household head (1= Not gone to school; 2=primary; 3= secondary; 4=college, 5=university)	+
Gend	If the decision maker is male or female (dummy; Male=1or o if otherwise)	$\pm$
Hhsize	The number of dependants in the family (continuous)	$\pm$
Farmsz	The size of land the farmer practices farming (hectares)	+
Landten	If the farmer has title deed (dummy; Yes=1 or otherwise)	+
Farminc	The income derived from farming per year(Kenyan shillings)	$\pm$
Non-farminc	The income derived from other source other than farming (Kenyan shillings)	$\pm$
Exten	The number of contacts with extension officers in a year (continuous)	+
VoluCDM	The existence of any voluntary CDM activities practiced by the farmer (Dummy; Yes=1 or otherwise)	+
Awaness	The degree of awareness of the carbon trade tree	+

	project(1=aware and correct,2= aware and incorrect 3= not aware)	
Grumemb	The farmers involvement in group activities(dummy; Yes=1 or otherwise)	+
Perce	Perception towards the technology proxied by level of importance of trees to the farmer(1=Not important,2=Important;3= Very important)	+
Attisk	Farmers attitude towards risk(1= Risk seeking 2=Risk neutral 3= Risk averse	-
Farmdebt	The amount of farm debt outstanding by 1/2/2010 (continuous)	±

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Farm and farmer characteristics

This study assessed the farm and farmer characteristics in order to elaborate the farmer conditions. The result is presented in Table 4. In terms of age the mean number of years of potential adopters was found to be 50.49 years and the mean for those who were not willing to adopt was 63.32 years. The youngest potential adopter was found to have 19 years and the oldest was 85 years but those who were not willing to adopt was 23 years for the youngest farmer and 90 years for the oldest. On overall the mean age was 53.40 years and the youngest farmer was 19 years and the oldest 90 years. Age of the household head plays an imperative role in the uptake of new technologies. This may be attributed to the failure of the older farmers to embrace new ways of doing things and thus still continue the old ways of doing things (Langyintuo and Mulugetta, 2005). Amsalu and De Jan (2007) further argues that younger farmers have a longer planning horizon and are likely to undertake agro-environmental measures.

The mean of the household size was found to be 4.12 members for those who were not willing to adopt and 7.22 members for those who were willing to adopt. Overall, the mean was 6.52 members which is slightly above the Kenya's national mean figure of 5 members per household (CBS 2005). The smallest household size had 2 members and the highest had 18 members. Further, the results indicate that that those who were willing to adopt had a bigger household size compared to potential non adopters. Household size has been linked to the availability of "own" farm labour in adoption studies. Amsalu and De Jan (2007) found out that household size had a significant and positive effect among the determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. The argument was that larger households have the capacity to relax the labour constraints required during the introduction of new technologies.

Table 4: Farm and farmer characteristics by willingness to adopt

		Variables	*N*	*Mean*	*Std. deviation*	*Minimum*	*Maximum*
Willingness to adopt	**No**	Age	34	63.32	18.17	23	90
		Household size	34	4.12	2.48	2	12
		Farm size	34	2.65	1.61	0.30	7
		Contacts with extension	34	1.26	1.81	0	6
		Income from farming	34	14410.88	40160.78	0.00	227800
		Farm debt	34	9511.77	20249.84	0.00	70000
	Yes	Age	116	50.49	14.59	19.00	85.00
		Household size	116	7.22	2.973	2.00	18.00
		Farm size	116	5.00	4.20	0.30	20.00
		Contacts with extension	116	1.54	2.04	0.00	7.00
		Income from farming	116	28701.78	50024.53	0.00	339000
		Farm debt	116	20826.60	61492.85	0.00	400000
Overall		Age	150	53.40	16.32	19.00	90.00
		Household size	150	6.52	3.15	2.00	18.00
		Farm size	150	4.46	3.15	0.30	20.00
		Contacts with extension	150	1.48	1.99	0.00	7.00
		Income from farming	150	24462.51	48214.94	0.00	339000
		Farm debt	150	18263.45	55062.92	0.00	400000

Source: Field Survey, May 2010

Farm size had an overall mean of 4.46 hectares with the farmer having the smallest size of land owing 0.30 hectares and the highest owing 20.00 hectares as indicated in Table 4. The potential adopters had relatively bigger size of land indicated by the mean of 5.00 hectares compared to potential non- adopters who had a mean of 2.65 hectares. The effect of land size on adoption of conservation agriculture in past studies has been that small sizes of land hinder adoption since farmers fear lose of agricultural land and large tracts of land encourages adoption due to the larger capacity in terms of resource base (Gebremedhin and Swinton, 2003).

The potential adopters were found to have a mean of 1.54 contacts with a minimum of 0 contacts and a maximum of 7 with extension officers as shown in Table 4. The potential non adopters had a mean of 1.26 with a minimum of 0 contacts and a maximum of 6 contacts with extension officers. Overall, the mean was 1.48 contacts with a minimum of 0 contacts and maximum of 7 contacts. The number of contacts with extension officers was a proxy for access to information and thus according to the innovation diffusion theory it contributes to the awareness and subsequent adoption of the innovation (Dolisca, *et al*., 2006).

Income from farming was found to have overall mean of Ksh.24, 462.51 for the year 2009 with the least having Ksh.0.00 and the highest having Ksh. 339,000.00. Generally the low income levels was a result of the unfavourable weather conditions that was experienced in the study area during the year 2009 which affected agricultural activities. Note that that the potential non-adopters had lower farm income with a mean of Ksh. 14,410.88 compared to potential adopters who had a mean of Ksh.28,701.78. Income from farming plays a role of financing the uptake of new agro- environmental innovation. Serman and Filson, 1999 argue that high farm income improves the capacity to adopt agricultural innovations as they have the necessary capital to jumpstart the innovation. Farm debt had an overall mean of Ksh. 18,263.45 with the lowest having Ksh. 0.00 and the highest having Ksh. 400,000.00. The potential non-adopters had a mean farm debt of 9511.76 and the potential adopters had a mean of Ksh.20,828.60.

Table 5 presents the results of the level of education of the household heads in Njoro. Only 16.7% of the respondents did not go to school implying that 83.3% of the respondents accessed formal education. However, majority of them attained primary and secondary education while very few attained tertiary and university level education. Among the potential adopters, those who attained no formal education (not gone to school), primary and secondary were 13.8%, 34.5% and 37.9% respectively while those who attained college and university education were 10.3% and 3.4% respectively. On the contrary, 26.5% of potential non-adopters attained no formal education, 34.5% primary education, 37.9% secondary education, 10.3% college education and finally 3.4% attained university education. The low percentage of farmers had tertiary education and university education and this can be attributed to the fact that farmers with higher levels of education have a tendency of involving themselves in other off-farm activities as education their level increases. Vink and VIlijoen(1993) concluded that low education level is the most limiting factor in the uptake of innovation among small scale farmers.

Table 5: Education level of household head

			Education level of household head					*Total*
			Not gone to school	**Primary**	**Secondary**	**College**	**University**	
Willingness to adopt	**No**	Frequency	9	17	6	1	1	34
		%	26.5	50.0	17.6	2.9	2.9	100.0
	Yes	Frequency	16	40	44	12	4	116
		%	13.8	34.5	37.9	10.3	3.4	100.0
Total		Frequency	25	57	50	13	5	150
		%	16.7	38.0	33.3	8.7	3.3	100.0

Source: Field Survey, May 2010

Gender and group membership also had the potential to influence the decision on acceptance and adoption and the results are presented in Table 6 indicates that among the potential non-adopter 38.2% were male and 61.8%% were female. On the other hand potential adopter comprised of 52.6% male and 47.4 % female. Support for participation in the project initiative is stronger among male farmers. Similar results were found by Newmark *et al*. (1993) who found that female-headed households usually see the forest activities as a means of meeting basic needs like firewood and as a support mechanism for increasing self-reliance while on the contrary male-headed households view the forest activities as a source of revenue creation and earning power.

Table 6: Gender and group membership percentage distribution

		Variables		*Frequency*	*Percent*
Willingness to adopt	**No**	Gender	Male	13	38.2
			Female	21	61.8
		Group membership	No	25	73.5
			Yes	9	26.5
	Yes	Gender	Male	61	52.6
			Female	55	47.4

	Group membership	No	60	51.7
		Yes	56	48.3

Source: Field Survey, May 2010

Another institutional support for participation in the project that was considered in this study was group membership. Among the potential non-adopters73.5% of the respondents did not involve themselves in group activities while 26.5% were involved. Among the potential adopters 51.7% did not involve themselves in group activities compared to 48.3% who did. The role of organizational membership in generating support for uptake of new innovation is that of information sharing and resource mobilization and higher market bargaining power (Shiferaw et al., 2006).

Off-farm income can have influence on willingness to adopt the CDM project was also considered and the results are presented in Table 7 and indicates that 64.7%, 14.7%, 17.6% 0% and 2.9% of the respondents had <5000, 50001-10000, 10001-15000 15001-20000 and >20000 Ksh. respectively among the potential non-adopters. Among the potential adopters 59.5% had <5000, 17.2% had 5001-10000, 8.6% had 10001-15000, 2.6% had 150001-20000 while 12.1% had >20000. The influence of off-farm income in the adoption of new technologies is derived from the fact that income earned can be used to finance the uptake of new innovation (Amsalu and De Jan 2007).

Table 7: Off farm income percentage distribution

Willingness to adopt			*Frequency*	*Percent*
No	Off farm income	<5000	22	64.7
		5001-10000	5	14.7
		10001-15000	6	17.6
		15001-20000	0	0
		>20000	1	2.9
Yes	Off farm income	<5000	69	59.5
		5001-10000	20	17.2
		10001-15000	10	8.6
		15001-20000	3	2.6
		>20000	14	12.1

Source: Field Survey, May 2010

The location of the farm results are presented in Table 8.

Table 8: Location of the farm percentage distribution by willingness to adopt

willingness to adopt			*Frequency*	*Percent*
No	Distance	<1km	7	20.6
		1-5km	18	52.9
		>5km	9	26.5
Yes	Distance	<1km	20	17.2
		1-5km	69	59.5
		>5km	27	23.3

Source: Field Survey, May 2010

The results in Table 8 indicate that the majority of the households were located at a distance to the nearest trading centre of 1-5 km both for potential non-adopters and potential adopters. There were more potential adopters (59.5%) compared with 52.9% for potential non adopters. However, among the potential non-adopters and adopters few respondents were located <1km from the nearest trading centre since those within 1 km are more influenced by commercial (business) inclination than tree farming. Location from the trading centre here plays a role of a proxy for information access and the potential market for the purchase of farm inputs including tree seeds and tree seedlings.

Results for the farmer's attitude towards risk are presented in Table 9. In terms of potential adopters, the most farmers were risk neutral (38.8%), risk takers (34.5%) and risk averse farmers (26.7%). Majority of potential non-adopters were risk neutral comprising of 82.4% while risk neutral and risk takers were 8.8%. Risk aversion champion farmers to reluctantly adopt new innovations on trial basis, unlike the risk taking farmers who would adopt the new innovation on much more greater scales (Baidu-Forson, 1999).

Table 9: Risk attitude percentage distribution

Willingness to adopt			*Frequency*	*Percent*
No	Risk attitude	risk averse	28	82.4
		risk neutral	3	8.8
		risk taking	3	8.8
Yes	Risk attitude	risk averse	31	26.7
		risk neutral	45	38.8
		risk taking	40	34.5

Source: Field Survey, May 2010

4.1.1 Land tenure and tree farming

Land tenure plays an important role in agro-environmental initiatives and the results are presented in Table 10. Majority of potential non-adopters held land without title deed with only 26.5% of them having title deeds. On contrast, 91.4% of potential adopters held land with title deeds with only 8.6% with no title deed. Land tenure provides the farmer with ownership and user rights which are necessary in long term projects and collateral which allows the farmer to access credit facilities to fund the investment (Mwirigi *et al*., 2009). Neoclassical economic theory confirms this by suggesting that, *ceteris paribus*, reduced risk and longer planning horizons would enhance expected returns and encourage more investment. Land tenure security and stability personify both of these attributes hence would enhance the extent of adoption of the carbon tree trade project (Arellanes and Lee (2001). Brännlund(2009), argued that higher level of land use right security favours investments in forest conservation because of the future profit for the farmer and his family.

Table 10: Land tenure percentage distribution

		Variables		***Frequency***	***Percent***
Willingness to adopt	**No**	Land tenure	With no title deed	25	73.5
			With title deed	9	26.5
	Yes	Land tenure	With no title deed	10	8.6
			With title deed	106	91.4

Source: Field Survey, May 2010

4.1.1.1 Types of trees

The respondents were asked to rank the top three trees in terms of numbers in the farm. The comprehensive results are presented in Appendix 2 while the graphical representation as shown in Figure 3. The results indicated that the tree that was highly ranked as number one was *Grevillea robusta* by 41.13% of the respondents and was followed by *Eucalyptus sp*. (24.79%) and *Cypressus lusitanica* (18.57%). The most common tree ranked as number two was still *Grevillea robusta* (37.19%) of the respondents and was followed by Eucalyptus ssp and *Cypressus lusitanica* by 24.79% and 17.36% respectively by the respondents. *Cypressus lusitanica* was ranked as the most common in rank three by 28.05% followed by *croton megalocarpus* and *grevillea robusta* both by 15.85% of the farmers. Major conclusion from the results the top most three trees overally in the study area are *Grevillea robusta, Eucalyptus sp* and *Cypressus lusitanica* . Similar results were found by Walubengo (2007). *Grevillea robusta* is favoured by most farmers because it has positive interaction with crops in the sense that it does not lower productivity (note it also adds nutrients to the soil) and also because of its quick regeneration after pruning. It supplies the residents with firewood, shade and timber.

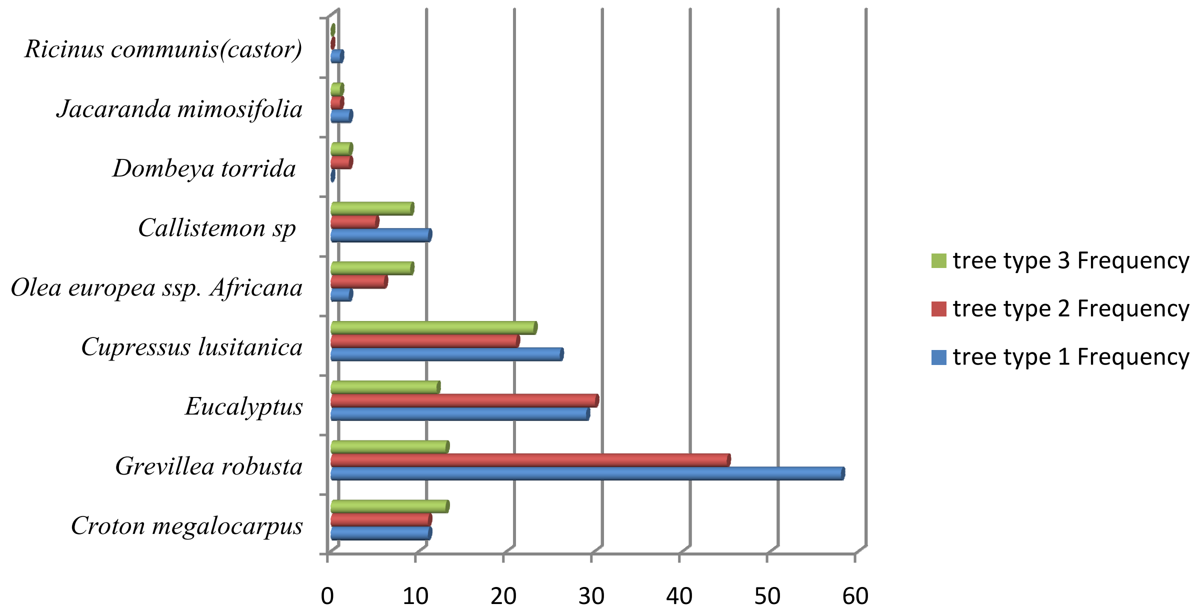

Figure 4: Top three trees in the study area

4.1.2 Voluntary CDMs practiced by smallholder farmers

The voluntary CDMs that were found to be practiced by farmers included tree planting/agro-forestry strip cropping, zero tillage, mulching, application of manure, cover cropping, terracing and water conservation and harvesting. These practices enhance either terrestrial or soil carbon sequestration. Agro forestry as a strategy has been proposed as a carbon sequestration strategy by Nair *et al*., 2009 and its potential depends on a number of site-specific biological, climatic, soil, and management factors. The practices per division were summarized in the Table 11 together including the calculated chi- square statistics.

There is a significant relationship between the adoption of CDM practices and the location in terms of the division of residence in the study area. This is as shown by the calculated chi-square value of 25.117 (significant at 5% level since the critical value of 22.36 is less than the calculated value of 25.117 and probability value of 0.033 is less than 0.05). Certain CDM practices are highly adopted in certain divisions as compared to others. For example, tree planting /agro forestry is best adopted in Kihingo and least adopted in Njoro, strip cropping is best embraced in Kihingo and least embraced in Njoro, zero tillage is best adopted in Lare and Kihingo and least adopted in Njoro. Lare has embraced terracing and application of manure than Njoro and Kihingo because of the steep slope experienced in the area accelerating soil erosion and thus the need to control soil erosion and improve soil fertility by the application of manure.

Table 11: Distribution of voluntary CDM practices used by farmers

			DIVISION			***Total***
			Njoro	**Lare**	**Kihingo**	
PRACTICE	Tree planting/ Agro forestry	Frequency	26	27	38	91
		%	28.6	29.7	41.8	100.0
	Strip cropping	Frequency	10	15	19	44
		%	22.7	34.1	43.2	100.0
	Zero tillage	Frequency	3	5	5	13
		%	.9	1.6	1.6	4.1
	Terracing	Frequency	9	19	2	30
		%	30.0	63.3	6.7	100.0
	Mulching	Frequency	7	4	9	20
		%	35.0	20.0	45.0	100.0
	Cover cropping	Frequency	4	1	2	7
		%	57.1	14.3	28.6	100.0
	Application of manure	Frequency	21	30	30	81
		%	25.9	37.0	37.0	100.0
	Water conservation and harvesting	Frequency	4	13	14	31
		%	12.9	41.9	45.2	100.0
Total			84	114	119	317
%			26.5	36.0	37.5	100.0

Calc. χ^2 = 25.117, Crit. χ^2 = 22.36, df = 14, P - value = 0.033
Source: Field Survey, May 2010

Majority of farmers (29%) practiced tree planting/ agro forestry. The reason that may be attributed for this is mainly due to the farmer practice of integrating trees in their farms as an energy crop and provision of timber for sale or to be used in farm construction activities.

Application of manure was practiced by 26% of farmers and mainly for the purpose of increasing soil fertility and reducing the high costs of purchasing inorganic fertilizers. Strip cropping was practiced by 14% of the farmers mainly to reduce the effects of soil erosion. Water conservation and harvesting was practiced by 10% of farmers to provide water for domestic use and irrigation during dry seasons. Terracing was practiced by 9% of the farmers where they planted napier grass on the terraces for the purposes of livestock feed and to help control soil erosion. Mulching was practiced by 6% of farmers to help improve the moisture content of the soil during the seasons of inadequate rainfall and dry seasons. Zero tillage and cover cropping was practiced by 4% and 2% of farmers respectively. The low adoption of these practices may be attributed to the need to loosen the soil to enhance easy management of crops for the case of zero tillage and the limited availability and inadequate knowledge of the cover crops in the study area.

4.1.3 Level of awareness of carbon trade initiatives and sources of information on carbon tree project

Farmer awareness on the existing and upcoming agro-environmental initiatives plays a pivotal role in their adoption. Awareness of the Carbon tree trade project was measured on a likert scale as; aware and correct, aware and wrong and not aware and the results are shown in Figure 5. The result indicates that 58% of the farmers were not aware of the project, 23% were aware and correct and 19% of the farmers were aware but wrong. The implication of these results is that there is low awareness of the project and hence might affect the acceptance and subsequent adoption. Awareness campaigns are important in making information available to farmers to enable them make informed judgment before embracing new initiatives.

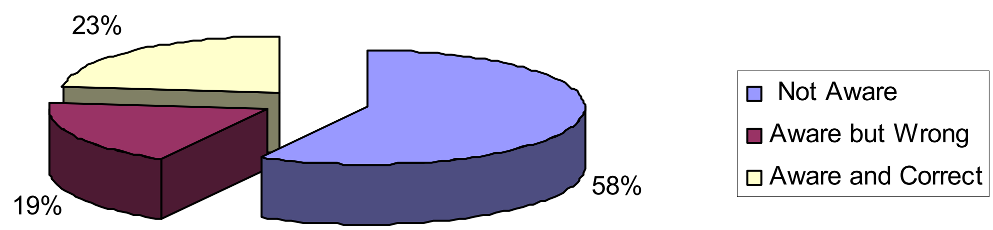

Figure 5: Level of awareness

Source: Field Survey, May 2010

The main information source on new technologies is presented in Table 12. The results reveal that 42.7% of the respondents acknowledged that the main source of information is from neighbours followed by newspapers at 19.3%. Extension officers came third at 12.7% and field days, 12%. Information source from relatives, self help groups and cooperatives was 7.3%, 4.7% and 1.3% respectively. The implication of the results is that there is a strong social capital among the farmers and thus an approach that can be used to create awareness is to involve the model farmers and the communication can trickle down to the rest of the society.

Table 12: Source of information on new technology

Main source of information	***Frequency***	***Percent***
From neighbours	64	42.7
Via extension officers	19	12.7
Self help groups	7	4.7
Field days	18	12.0
Cooperatives	2	1.3
Via newspapers and television	29	19.3
Via relatives	11	7.3
Total	**150**	**100.0**

Source: Field Survey, May 2010

4.2 Determinants of awareness of carbon tree trade project

This section presents results of ordered logit regression model, which show effects of a set of independent variables influences the dependent variable which is scored. The ordered logit model is used because the dependent variable and the values of each category have a meaningful sequential order. Further the independent variable should be treated and analyzed as the ordered categorical data. The ordinal logit model was estimated using maximum likelihood estimation method. The results of the maximum Likelihood estimation are shown in Table 14 and reveals that two coefficients are significant at 1%, two coefficients are significant at 5% and two coefficients are significant at 10%. The log likelihood for the fitted model was -100.96373 and the log likelihood chi-squared value of 112.27 indicates that all parameters are jointly significant at 5%. Pseudo R^2 of 0.3052 was also above the statistical threshold of 20% confirming that the levels of awareness were attributed to the covariates considered in the model.

Age of the household head had a negative and significant influence on awareness. These results indicate that older farmers lack receptivity towards newly introduced technologies and thus they are more contented with their old ways of doing things. Similar argument was advanced by Langyintuo and Mulugetta (2005) in their study to model agricultural technology adoption. The argument here is that younger household heads would be more willing to search and have greater mobility thus will have a positive influence on awareness of new agricultural technologies than older household heads. The major implication of this is that two different programmes could be established to target the young household heads and the older household heads as the two group depict different level of awareness and would probably require different modes of information dissemination.

Table 13: Ordinal logit model results

Variables	**Coefficient Estimates**	**Standard Error**	**Z**	**P>|z|**	**Estimated coefficient (log odds ratio)**
Age	-0.0261	0.0127	-2.05	0.040**	0.9742
Gender	0.1728	0.4204	0.41	0.681	1.1886
Existence of tree farming	0.7894	0.4364	1.81	0.070*	2.2021
Education level	-0.4005	0.2219	-1.80	0.071*	0.6699
Extension	0.6588	0.1198	5.50	0.000***	1.9324
Group membership	1.5192	0.4358	3.49	0.000***	4.5685
Location of the farm	0.1896	0.3206	0.59	0.554	1.2088
Source of information	0.2000	0.0970	2.06	0.039**	1.2214

Log likelihood =-100.96373; log likelihood χ^2 = 88.72; Pseudo R^2=0.3052; ***, **, * significant at 1%, 5% and 10% respectively.

Source: Field Survey, May 2010

Existence of tree farming in the farm also positively and significantly influences the awareness of the Carbon tree trade projects. The possible explanation for this inclination is that most of the farmers started tree farming in their farms after learning the potential benefits of such enterprises and thus should be aware of the Carbon tree trade project. Further, such group of farmer could be used to raise the awareness and their respective plots may be used as demonstration plots to locals which may eventually lead potential success of such projects. The farmers have also the required skills and such farmers could be targeted first.

Group membership positively and significantly contributes to awareness of farmers on the carbon tree trade project as individuals in groups are easily influenced by their acquaintances than those in isolation. They get to exchange ideas and learn about the benefits of various upcoming technologies. Group members also may easily organize and receive training on diverse agro-environmental issues that influences the awareness of the Carbon tree trade project in view of sustainable agricultural production.

Moreover, education of the farmers has a negative impact on the awareness of the project. These results are inconsistent with the expectation since education provides farmers with more information pathways. Higher level of formal education equips farmers with more knowledge and skills hence facilitate the awareness of the innovation (Faturoti *et al*., 2006). However this can explained by the reason that as the farmers education increases there is a tendency of the farmer to learn technologies related to off-farm hence having less awareness on pertinent issues in agricultural and agro-environmental innovations.

Extension services positively and significantly influenced the level of awareness of the carbon trade tree project .This is because extension services provide information, knowledge and skills that enable farmers to be aware and use the technology. Extension services plays a central role of providing support for institutional mechanisms designed to support the dissemination and diffusion of knowledge among farmers and demonstration of gains from new technologies (Baidu-Forson, 1999).The main source of information on new technology had a positive impact on the level of awareness. As discussed earlier, the main source of information for most farmers was from neighbours and thus this variable has a major role in enhancing the level of awareness. Targeting such an information source may be important since the farmers are in constant contact with other farmer.

4.3 Factors influencing willingness to accept and the extent to adopt tree carbon trade project

4.3.1 Factors influencing willingness to accept tree carbon trade project

To identify the factors influencing the decision to accept the project the probit model was estimated and the results presented in Table 14. The Probit model was estimated using the random effect maximum likelihood estimation method (random effect models have an assumption that individual effect is uncorrelated with all other explanatory variables). The results of the maximum Likelihood estimation are shown in Table 14 and reveals that two variables are significant at 1%, three variables are significant at 5% and three variables are significant at 10%. The log likelihood for the fitted model was -24.1478 and the log likelihood χ^2 value of 112.27 indicates that all parameters are jointly significant at 5%. Pseudo R^2 of 69% was also above the statistical threshold of 20% confirming that the willingness to accept carbon tree trade project were attributed to the covariates considered in the model.

Table 14: First hurdle econometric results

Variable	*Marginal effects/elasticity*	*Standard error*	*P>|z|*
Age	-0.0003	0.0153	0.378
Gender	-0.0272	0.5359	0.500**
Existence of tree farming	-0.0178	0.57914	0.238
Education level	0.0093	0.30159	0.238
Extension	0.0019	0.17884	0.680
Level of awareness	-0.0099	0.46882	0.417
Group membership	0.0067	0.62159	0.677
Household size	.0055	0.1103	0.057*
Farm debt	-3.35e-07	7.22e-06	0.074*
Attitude towards risk	0.0218	0.33819	0.013**
Farm size	0.0120	0.1575	0.007***
Land tenure	0.2518	0.58398	0.000***
Farm income	-2.18e-07	7.56e-06	0.153
Nonfarm income	-0.0034	0.27439	0.629
Availability of voluntary CDM	0.3221	1.05219	0.054*
Perception of the technology	0.0297	0.47065	0.015**
Constant		2.40551	0.300

Log likelihood =-24.1478; log likelihood χ^2 = 112.27; Pseudo R^2=0.69; ***, **, * significant at 1%, 5% and 10% probability respectively.

Source: Field Survey, May 2010

The probability of females accepting the project is 2.72% higher than males, all other factors held constant. This implies female headed families have a higher probability of accepting the projects. Female farmers in the region view the project as a solution to the existing energy crisis in the region as well as complementing their farm income through the earnings from carbon credits. These results however, differ with those of Malton (1994) and Adesina (1996) who concluded that men are more willing to participate in conservation agriculture than women as a result of gender based wealth differences. This result however proves positive since women in the country forms the majority of the population undertaking farming activities, though they face socially conditioned inequities in the access, use and the control of household resources (Adesina *et al*., 2000). Narrowing the gender gap in this case may be achieved through collective action complemented by the necessary extension services.

The effect of farm size was found to be positive and significant. A 1% increase in farm size increases the probability of accepting the project by 0.012% all else held constant, suggesting that the larger the farms the more likely the farmer is willing to accept the tree trade project. The interpretation for this is that the larger the farm the more the farmer flexibility in their decision making, more opportunity to use new practices on a trial basis and more ability to deal with risk. This also offers the farmer greater access to discretionary resources. Similar results were found by Nowak (1987) who stated that the smaller farms have lower levels of diversification of land use, as competition and conflicts arise since there is a limitation to the number of uses applicable on the piece of land unless the uses are complementary.

In line with prior expectations, household size has a positive significant with a 1% increase in household size the willingness to accept the project decision increases by 0.006%, all else held constant. This is implied by the idea that the larger the family size the more "own farm" labour is available to adopt the technology. Tree planting in the farm requires substantial labour and so the farmer decision to accept such a project may be influenced by the availability of family labour proxied by the house hold size. Amsalu and Jan de (2007) also found household size had a significant and positive effect on determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. Croppenstedt *et al*., 2003 argue that a large household accords the farmer fewer labour shortages at peak times and hence more likely to adopt agricultural technology and use it intensively.

The results show that farm debt has a negative significant effect on the decision to accept the carbon tree trad e project. A 1% increase in farm debt decreases the probability of acceptance by 3.35e-07%. The reason behind this is because the Carbon tree trade project takes a little longer before the farmer starts to reap benefits and thus the higher the farm debt the more unlikely the farmer would be willing to accept the Carbon tree trade project. The farmer will thus opt for more short term investment that could yield immediate income to repay the farm debts rather than long term investments like tree planting.

As expected, land tenure had a positive significant effect with having land rights increasing the probability of acceptance of the project by 25.18%, all other factors held constant. Land tenure provides farmers with full rights of land ownership and usage thus influencing the decision to participate in tree carbon trade project. Land ownership with title deeds accords the farmers the right to usage (security of tenure) thus creating an incentive to the farmers to adopt new, long term and even riskier technologies. Similar results were found by Arellanes and Lee (2001) where they concluded that farmers with security of tenure were four times likely to employ more of the new techniques due to security of land access and usage.

Availability of voluntary CDM as expected had a positive and significant increasing the probability of the decision to accept the tree trade project. The reason behind this was because farmers who have practiced voluntary CDM have the hand on experience and have at least benefited from the various voluntary CDM practices in the farm. The influence of the general perception towards the carbon tree trade technology was found to have a positive and significant effect increasing the probability of the decision to accept the carbon tree trade project by 2.97% with a 1% change in the perception level, all other factors held constant. Farmers who perceived the trees as an important investment were expected to accept the tree trade objective as a mitigation measure against climate change since they find it as a positive investment.

4.3.2 Factors influencing the extent of willingness to adopt

Table 15: Second hurdle econometric results

Variable	*Marginal effects*	*Standard error*	*P>|t|*
Age	-2.3432	1.1875	0.051*
Gender	-27.8378	38.9845	0.476
Existence of tree farming	12.4507	41.1743	0.763
Education level	19.3012	20.7602	0.354

Extension	-22.7305	11.9724	0.060*
Level of awareness	26.1569	29.9130	0.383
Group membership	37.1103	44.2893	0.404
Household size	8.5086	6.2155	0.173
Farm debt	-0.0003	0.0003	0.382
Attitude towards risk	39.6278	23.6868	0.097*
Farm size	-5.8826	5.6928	0.303
Land tenure	144.113	52.4967	0.007***
Farm income	0.0003	0.0005	0.470
Nonfarm income	9.9932	14.7440	0.499
Availability of voluntary CDM	107.6538	77.5803	0.168
Perception of the technology	65.0551	31.9142	0.043**
Constant		173.7548	0.30

Log likelihood =-789.92557; log likelihood χ^2 = 60.54; R^2=0.369; ***, **, * significant at 1%, 5% and 10% probability level respectively.
Source: Field Survey, May 2010

The second stage of the double hurdle model measures extent of adoption among the potential adopters of the carbon tree trade project. The random effect censored regression model (Tobit model) was applied in order to be consistent with the Random effect Probit model. The number of observation that was censored was 34 and the uncensored observations were 116. Results indicate that the log likelihood for the fitted model was -789.92557 and the log likelihood chi-squared of 60.54 indicated that all parameters are jointly significant at 5%. R^2 of 36.9% was also above the statistical threshold of 20% confirming that the extent of willingness to adopt the tree Carbon project were attributed to the covariates considered in the model. The share which was used as the dependent variable was generated as the ratio between the number of trees the farmer was willing to plant and the farm size. Land tenure was significant at 1% level, perception towards the technology was significant at 5% and age, extension and attitude towards risk were significant at the critical 10% level.

Age of the household head had a negative significant influence with a 1% increase in age decreasing the probability of the extent the farmer is willing to adopt the carbon trade project by 2.34%. The possible explanation for this is that older farmers lack receptivity towards newly introduced technologies. This argument was also advanced by Langyintuo and Mulugetta 2005.

Baidu-forson(1999) concluded that the negative influence of age is due to the changing life cycle effect on the farmer since as farmers grow older they gain more experience in farming through learning by doing. The plausible explanation in this case is that older people are risk averse and depicts the character of failure to change their old ways of doing things. The younger household heads are more receptive in the extent they are willing to try out new agricultural technologies (conservation agriculture) because of their risk taking character than older household heads who are risk averse. However, these results were inconsistent with those of Maddisson (2006), Nhemachena and Hassan (2007) and Ashenafi (2007), who argued that as farmers get older they tend to intensify the adoption of new technologies in their farming business as a result of more years of farming experience, higher capital accumulation and large family sizes as a source of family labour.

As expected land tenure had a positive significant influence on the extent of adoption. Land tenure has a positive significant influence on both the willingness to accept and the extent of adoption of the Carbon tree trade project. This was due to the reason that land tenure provides the farmer with ownership and user rights which are necessary in long term projects like tree farming. The other reason is the land tenure (title deed) provides the farmer with the required collateral and thus can access credit facilities to fund the investment. Credit facilities will meet the initial capital requirement and enable the farmer to increase the number of trees through establishment of tree nurseries, land preparation and the labour requirements. Neoclassical economic theory confirm this by suggesting that, *ceteris paribus*, reduced risk and longer planning horizons would enhance expected returns and encourage more long term investment. Land tenure security and stability personify both of these attributes hence would enhance the extent of adoption of the carbon tree trade project.

Perception towards the technology has a positive significant influence on the extent of adoption. The reason behind the inclusion of perception here is that technology characteristics–within potential user's context model in which the characteristics of the technology underlying land users' agro-ecological, socioeconomic and institutional contexts play a central role in the extent of adoption decision process. The possible explanation here is that farmers who perceive the technology as beneficial to them would adopt the Carbon tree trade project more than those whom their perception is negative or indifferent.

The result also shows that attitude towards risk both influence the decision on willingness to accept and the extent of adoption. The explanation is that farmers who are risk taking would be willing to adopt the project to a larger extent than those who are risk averse. Risk averse farmers would espouse the project reluctantly on trial basis unlike the risk taking farmers who would adopt the new innovation on much more greater scales. The significant risk attitudes on the extent of adoption of conservation technologies are similar with earlier findings of Baidu-Forson, 1999 in Niger .The higher the level of risk aversion the lower the level of potential adoption of carbon tree project. However, the elasticity of attitude towards risk from the Tobit suggests that if the Carbon tree project demonstrated risk reduction characteristics it should be possible to improve the potential intensity of adoption of the project.

Extension services have negative significant influence on the level of potential intensity of adoption of the innovation. This result is inconsistent with results of earlier studies (Baidu-Forson, 1999, Faturoti *et al*. (2006) and Mazvimavi and Twomlow, 2009). The negative effect of extension contacts implies the more the farmer has contacts with extension officers they tend to reduce potential intensity of adoption. However, intensive discussions with farmers on the kind of extension services they receive revealed that agricultural extension services are more focused on intensifying crop and livestock production at the expense of agro-environmental initiatives like tree planting. The results pinpoint the importance of tree planting and other climate mitigation measures to mitigate against the effects of climate change should also be given due attention in the extension scheme to positively influence farmers' conservation decision in the study area.

CHAPTER FIVE
CONCLUSIONS AND RECCOMENDATIONS

5.1 Conclusions

The study aimed to characterize the existing voluntary CDM practices, assess the level of awareness of the carbon tree trade project and to further identify and quantify factors that influence adoption of carbon trade tree project in Njoro district, Kenya. The region has experienced high rates of deforestation resulting in unpredictable rainfall pattern constituting overall climate change, increased surface run off, low water levels in river Njoro, loss of biodiversity and the increase poverty in the region. Voluntary CDM practices in the study area includes; tree planting/agro-forestry, application of manure, strip cropping, terracing, zero tillage, cover cropping, mulching and water harvesting. 29% of the farmers practiced tree planting/agro-forestry as the voluntary CDM practice in the study area. The reason that may be attributed for this is mainly due to the farmer practice of integrating trees in their farms as an energy crop and provision of timber for sale or to be used in farm construction activities Results further concludes that there is a significant relationship between the adoption of voluntary CDM practices in the three divisions indicated by the calculated chi-square value of 25.117.

On the level of awareness the result indicates that 58% of the farmers were not aware of the project, 23% were aware and correct and 19% of the farmers were aware but wrong. This signifies low levels of awareness of the CDM project among farmers. From the study, six variables were found to significantly affect the level of awareness. Extension services, existence of tree farming, group membership and source of information on new technologies were found to positively influence the level of awareness while age and education level of the household head negatively and significantly affected the level of awareness. Age had a negative influence because older farmers tend to be conservative in their approach of doing things. Education level had also a negative influence since most educated farmers tend to be aware of technologies regarding off- farm activities ignoring most farming technologies. The positive effect of group membership to awareness was attributed to information sharing among the group members while the existence of tree farming positively influenced awareness because of the prior knowledge of the farmers about the environmental benefits of trees. Extension services and the source of information positively influenced awareness since they play central role of providing support for institutional mechanisms designed to support the dissemination and diffusion of knowledge among farmers.

The decision on willingness to participate was found to be influenced by eight variables (gender, household size, farm debt, attitude towards risk, farm size, land tenure, availability of voluntary CDM and perception of the technology). Farm size had a positive influence on the decision to participate because it offers the farmers flexibility during decision making while the positive influence of household size is due to availability of "own farm" labour. Gender had a positive influence on decision to adopt as male household have a tendency to try riskier and long term projects unlike female household heads. Attitude towards risk provided an incentive to participate due to the quest for risk takers to undertake new initiatives. Land tenure positively influenced the decision to participate since title deed present full rights to land and usage allowing investment in long term investments. However, farm debt had a negative influence in the decision to adopt since most of the land obligations are short term and thus investment in long term projects like tree farming/ agro-forestry would derail loan repayment. Availability of voluntary CDM and perception of the technology provided an incentive to participation.

Five variables were significant in influencing the extent of willingness to adopt. Attitude towards risk, land tenure and perception towards the technology had a positive influence on the decision to accept and the extent of participation. Age and extension services had a negative influence. A key thing to note here is the negative effect of extension contacts implying that the more the farmer has contacts with extension officers they tend to will reduce potential intensity of adoption. However, discussions with farmers on the kind of extension services they receive pointed out that agricultural extension programmes are more focused on intensifying crop and livestock production at the expense of other agro-environmental initiatives like on tree planting for carbon sequestration. The results pinpoint the importance of tree planting to mitigate against the effects of climate change should also be given due attention in the extension scheme to positively influence farmers' conservation decision in the study area.

5.2 Recommendations

A wide range of agro-environmental policies have been used to manage the problem of deforestation and the impact of climate change. Carbon trading is one of them and rapidly expanding globally (provided in the CDM of the Kyoto Protocol of 1992) which offers an attractive economic opportunity for subsistence farmers in developing countries, the major practitioners of agro-forestry/tree planting, for selling the carbon sequestered through agro-forestry/tree planting activities to industrialized countries (Nair *et al*., 2009). The study has drawn attention to information that can guide policy towards influencing tree farming in recognition of its potential benefits for clean, secure and sustainable environment by the year 2030. To attain this, the country had set goals such as increasing forest cover from less than three percent of its land base at present to four percent by 2012. As such, there is need to increase forest productivity by expanding the farming of forest products. Therefore, the study has made the following recommendations. Tree farming has the potential to be accepted and adopted in the district and would play an important role especially in climate change mitigation by providing potential sinks for carbon sequestration. Other potential positive externalities incorporated in the package include is the provision of wood products hence reducing the pressure on the existing protected and unprotected forest land while helping in alleviating the energy "crisis" prevalent in the country. Carbon tree trade project could be adopted by the policy makers as a strategy to reverse the decline of forest resources and take advantage of the increasing returns provided by the joint production of forest and agricultural products.

Tree farming has not taken up in the region primarily because of the low levels of awareness of agro-environmental initiatives. Attention should be given to create awareness to avail information to the farmers on the importance of the environment in line with the theme of environmental sustainability. Enhancement of information exchange mechanisms(for example seminars, field days and trainings), establishment of mechanisms for the exchange of technology-based innovations between communities /sub-regions and other stakeholders whilst designing decision making tools are necessary to transform the availed information into knowledge for the farmers to adopt the initiative.

A policy targeting collective action through enhancing community level agro- environmental groups could be vital in enhancing forest farming. The groups would involve the use joint establishment of tree nurseries, pooling together the necessary capital required and providing efficient training opportunities for the members on forest farming. Such efforts at forming community level farmer organization is in view of coalescing into a wide network as communities will unite in response to threats to their livelihood like climate change problems. Nevertheless, such institutional framework should recognize the community member's culture and trust to facilitate a smooth entry point to the existing multicultural society.

There is urgent need to incorporate the issue of climate change in the countries extension system to enhance the farmer's participation in payment for environmental services programmes such as Carbon trading. Attention should also focus on younger farmers and farmers with lower education levels since they were willing to adopt the project intensively and thus providing employment opportunities.

The government should also ensure that farmers have security of tenure through provision of title deeds to create an incentive for adoption of agricultural technologies and thus help in environmental protection and increased farm income. Title deeds will motivate the farmer to undertake long term investments in the farm like tree farming.

5.3 Further research

The main intention of the study was to determine the state of awareness and the potential of introducing tree farming in the study area as a climate change mitigation measure and improve farm income hence poverty reduction. However the study proposes future research:

1. To determine the existing tradeoff between agricultural productivity and tree farming for the farmers practicing it. There is need to evaluate potential impact of such a project on the current farming practices taking into consideration that the challenge for African agriculture is how to significantly improve agricultural productivity, in view of reducing poverty levels while ensuring environmental health is maintained for good socio-economic development.
2. To identify management practices that are appropriate for smallholder and community forestry, including and defining effective local institutional arrangements for enhancing outcomes from smallholder and community forestry. Proper governance of the individual forestry is critical when mobilising and equipping small scale farmers and farmers' agro-environmental organizations in enhancement of sound environmental stewardship.

REFERENCES

Adesina, A.A., 1996. Factors affecting the adoption of fertilizers by rice farmers in Côte d'Ivoire. *Nutrient Cycling Agroecosystem*. 46: 29–39.

Adesina, A.A., Mbila, D., Nkamleub, G.B. and Endamana , D. (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon Agriculture. *Ecosystems and Environment* 80: 255–265

Albrecht, A. and Serigne, T.K. (2003). Carbon sequestration in tropical agro-forestry systems. *Agriculture Ecosystems and Environment* 99: 15–27.

Anderson, D. R., Sweeny, J.D., Williams, T.A., Freeman, J. and Shoesmith, E. (2007). *Statistics for Business and Economics*. Thomson Learning.

Anil, B. and Gauri, S.G., (2004). Trees for carbon sequestration or fossil fuel substitution: the issue of cost vs. carbon benefit. *Biomass and Bioenergy* 27:41-55.

Amsalu, A. and De Jan G. (2007). Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecological economics* 61: 294 – 302.

Arellanes, P. and Lee, R. D., (2001). The Determinants of Adoption of Sustainable Agricultural Technologies. Evidence from the Hillsides of Honduras. Department of Applied Economics and Management, Cornell University, Ithaca, NY, 14853, USA.

Ashenafi G., (2007). Triticale Crop and Food Security, and Determinants Influencing the Adoption of Triticale: Example from the Amhara Region, Ethiopia "Utilization of diversity in land use systems: Sustainable and organic approaches to meet human needs" University of Kassel, Department of Development Economics and Agricultural Policy, Germany Tropentag, October 9-11, 2007, Witzenhausen.

Baidu-Forson, J., (1999). Factors influencing adoption of land-enhancing technology in the Sahel: lessons from a case study in Niger. *Agricultural Economics* 20: 231-239

Baldyga, T.J., Miller, S.N., Shivoga, W.A. and Gichaba, C.M. (2004). Land cover change detection in the river Njoro watershed: a landscape in transition. Proceedings of the 57th annual meeting of the society for range management, January 24th-30th, 2004. *Salty lake city*, UT.

Baranzini A., Batruch C., Grubb M.J. and Perkaus J., (1998). International emissions trading under the Kyoto Protocol: rules, procedures and the participation of domestic entities and international academy of the environment. Climate Change in the Global Economy Programme.

Bernoux M., Feller C., Cerri C., Eschenbrenner V. and Cerri, C.E.P., (2006). Soil carbon sequestration in agricultural soils. Soil erosion and carbon dynamics. CRC Press, Boca Raton, pp. 13–22.

Bränlund, R.., Sidibe, A. and Gong , P.(2009). Participation to forest conservation in National Kabore Tambi Park in Southern Burkina Faso. *Forest Policy and Economics* 11: 468–474

Briz, T. and Ward R.W., (2009). Consumer awareness of organic products in Spain: An application of multinominal logit models. *Food Policy* 34: 295–304.

CBS (2005). Geographic Dimensions of Well-Being in Kenya. Who and Where are the Poor; A constituency Level Profile Volume II. The Legal Press Kenya Limited, Nairobi, Kenya.

Chichilinsky, G. (1996). An axiomatic approach to sustainable development. *Social Choice and Welfare* 13 (2): 231–257.

Cragg, J. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica* 39: 829-844.

Croppenstedt, A., Demeke, M. and Meschi, M.M.,(2003). Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia. *Review of Development Economics* 7 (1): 58–70.

De Steur, H., Gellynck, X., Storozhenko,S., Liqun, G., Lambert , D., Straeten, D.V. and Viaene, J.(2009). Willingness-to-accept and purchase genetically modified rice with high folate content in Shanxi Province, China. *Appetite* 880 1–8.

Dewar, R.C. and Cannell, M.G. (1992). Carbon sequestration in the trees, products and soils of forest plantations: an analysis using UK examples. *Tree Physiology* 11:49–71.

Dimitropoulos, A. and Kontoleon, A. (2009). Assessing the determinants of local acceptability of wind-farm investment: A choice experiment in the Greek Aegean Islands. *Energy Policy* 37: 1842–1854.

Dolisca, F., Carter, D. R., McDaniel, J.M., Shannon, D.A. and Curtis, M. J., (2006).Factors influencing farmers' participation in forestry management programs: A case study from Haiti. *Forest Ecology and Management* 236, 324–331.

Faturoti B. O., Emah G. N., Isife B. I., Tenkouano A. and Lemchi J., (2006).Prospects and determinants of adoption of IITA plantain and banana based technologies in three Niger Delta States of Nigeria. *African Journal of Biotechnology* Vol. 5 (14), pp. 1319-1323, 16 July 2006. ISSN 1684–5315 © 2006 *Academic Journals* http://www.academicjournals.org/AJB

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

Genev, H. R. and Baranzini, A., (1999). Sizing the global GHG offset market. *Energy Policy* 27 (3):123–127.

Greene, W., 2003. *Econometric analysis*, 5th edition. Prentice Hall Publishers, Upper Saddle River, NJ.

Hutchinson J.J, Campbell, C.A., and Desjardins, R.L. (2007). Some perspectives on carbon sequestration in agriculture. *Agricultural and Forest Meteorology* 142: 288–302.

Hynesa, S., Farrelly, N., Murphyc, E., and O'Donoghuea, C. (2009). Modelling habitat conservation and participation in agri-environmental schemes: A spatial microsimulation approach. *Ecological economics* 66: 258-269.

IPCC (2000). Land Use, Land Use Change and Forestry. A special report of the IPCC, Cambridge University Press, Cambridge.

Janzen, H.H., Desjardins, R.L., Angers, D.A., Boehm, M.M., Campbell, C.A., Carter, M., Gibb, D., Gregorich, E.G., Kaharabata, S.K., Lemke, R., Masse´, D., McAllister, T., McConkey B.R., and Smith, P. (2001). Mitigation practices for agricultural land in Canada: A summary of 'expert opinion'. Unpublished internal report of Agriculture and Agri-Food Canada, 13 pp.

Jera R. and Ajayi O.C, (2008). Logistic modeling of smallholder livestock farmers' adoption of tree-based fodder technology in Zimbabwe. *Agricultural.economics*, Vol 47:No 3.

Kenya Forest Working Group (2005). Changes in Forest cover in Kenya's five "water Towers" 2003-2005(www.kfwg.org accessed on 3/10/2009).

Kituyi, E. (2002). Attracting Clean development Mechanism Projects: Prerequisites for African Governments in Clean Development Mechanism. African Centre for Technology Studies, Nairobi, Kenya. Volume 1, Number 1, July 2002.

Lal, R., Follett, R.F. and Kimble, J.M., (2003). Achieving soil carbon sequestration in the United States: a challenge to the policy makers. *Soil Science* 168: 827– 845.

Langyintuo. A.S. and Mungoma, C., (2008). The effect of household wealth on input market participation in southern Africa (Forthcoming, Food Policy). Staff Paper, Department of agricultural Economics, Purdue University. West Lafayette, Indiana, USA.

Langyintuo A. S and Mulugetta M., (2005). *Modeling Agricultural Technology Adoption Using the Software STATA*. International Maize and Wheat Improvement Center (CIMMYT) Training manual no. 1/2005 (part two). PO Box MP 163, Mount Pleasant, Harare, Zimbabwe.

Maddison, D., 2006. The perception of and adaptation to climate change in Africa. CEEPA. Discussion Paper No. 10. Centre for Environmental Economics and Policy in Africa. University of Pretoria, Pretoria, South Africa.

Matlon, P.J., 1994. Indigenous land use systems and investments in soil fertility in Burkina Faso. In: Bruce, J.W, Migot-Adholla, S.E. (Eds.), Searching for Land Tenure Security in Africa. Kendall/Hunt Publishing Company, Dubuque, Iowa, USA, pp. 41–69

Mazvimavi, K. and Twomlow S., (2009). Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. Agricultural Systems 101: 20–29.

Melissa, H. and Bryman, A., (2004). *Hand book of data analysis*. 1st edition Sage publication limited, London.

Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries- Draft decision -/CP.15 http://unfccc.int/files/na/application/pdf/cop15_ddc_auv.pdf.-accessed on 10/02/2010)

Mwirigi, J.W., Makenzi, P.M. and Ochola, W.O.(2009) Socio-economic constraints to adoption and sustainability of biogas technology by farmers in Nakuru Districts, Kenya. *Energy for Sustainable Development* 13: 106–115

Napier, T., Carter, M.V. and Bryant, E.G., (1986). Local perceptions of reservoir impacts: A test of vested interests. *Community Psychology* 14 (1): 17–37.

Napier, T.L. and Napier, A.S. (1991). Perceptions of conservation compliance among farmers in a highly erodible area of Ohio. *Soil Water Conservation*. 48 (3): 220–224.

Nankhumwa, T.O. (2004).Dynamics costs of soil degradation and determinants of adoption of soil conservation technologies by smallholder farmers in Malawi. PhD Thesis, University of Pretoria.

Nhemachena, C. and Hassan, R., (2007). Micro-level analysis of farmers' adaptation to climate change in Southern Africa. IFPRI Discussion Paper No. 00714. International Food Policy Research Institute, Washington, DC.

Newmark,W.D., Leonard, N.L., Sariko, H.I., Gamassa, D.M., (1993). Conservation attitudes of local people living adjacent to five protected areas in Tanzania. *Biol. Conserv*. 63 (2): 177–183.

Ngugi, F.M., Shivoga, W.A., Muchiri, M. and Miller, S. (2003). Effects of land use changes on bird composition along River Njoro: A watershed of Lake Nakuru. Unpublished journal.

Nowak, P.J., 1987. The adoption of conservation technologies: economic and diffusion explanations. *Rural Sociology*. 42: 208–220.

Nowak, P.J. and Korsching, P.J., (1983). Social and institutional factors affecting the adoption and maintenance of agricultural BMPs. In: Schaller, F., Bauley, H. (Eds.), Agricultural Management and Water Quality. Iowa State University Press, Ames, IA. pp. 349-373.

Phiri, H. (2007). The role of credit in the adoption and use of improved dairy technologies in Malawi: A Case of Central and Northern Milk shed Areas. MSc Thesis, Bunda College, Lilongwe, Malawi.

Ramachandran Nair P.K, Mohan Kumar.B., and Vimala D. Nair. (2009). Agroforestry as a strategy for carbon sequestration. *Journal of Plant Nutr. Soil Sci*. 172, 10–23

Ringius, L. (2002). Soil carbon sequestration and the CDM: opportunities and challenges for Africa. *Climatic Change* 54: 471–495.

Rogner, H.H., Zhou, D., Bradley, R., Crabbé, P., Edenhofer, O., Hare, B., Kuijpers, L. and Yamaguchi, M. (2007). Introduction to Climate change 2007: mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom. 22 pp.

Rohit J., Swallow B. and Kerr J. (2006). Status of carbon sequestration projects in Africa: Potential benefits and challenges to scaling up. WP 26 Nairobi. World Agroforestry Centre.

Ross, F., Fiona, A., Humphries, S., Claire, M., Stuart, M. and Nigel, L., (2004). The technology acceptance model and use of technology in New Zealand dairy farming *Agricultural Systems* 80 (2004):199–211.

Sanchez, P.A. (2002). Soil fertility and hunger in Africa. *Science* 295:2019– 2020

Sattler, C. and Nagel U.J., (2009). Factors affecting farmers' acceptance of conservation measures: A case study from north-eastern Germany. *Land Use Policy* 27:70–77.

Serman, N. and Filson, G.C., (1999). Factors affecting farmers' adoption of soil and water conservation practices in Southwestern Ontario. In: Paper Presented at the Fourth Biennial Conference of the International Farming System Association, Guelph, Ontario, Canada.

Shiferaw , B., Obare, G. and Muricho, G.(2006). Rural institutions and producer organizations in imperfect markets: Experiences from producer marketing groups in semi-arid Eastern Kenya. CAPRI working paper 60. Also jointly released as ICRISAT socioeconomics and policy Working paper seriesNo. 23 Patancheru, Andhra Pradesh.

Smith, J. and Scherr, S.J., (2002). Forest carbon and local livelihoods: Assessment of opportunities and policy recommendations, CIFOR Occasional Paper no. 37, Bogor Barat, Indonesia.

Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge University Press, Cambridge.

Studenmund, A.H. (1997). *Using Econometrics- A practical Guide*. New York: Harper Collins.

Tobin, J., (1956). Estimation of relationships for limited dependent variables. *Econometrica* 26: 24-36

Toulmin, C., Huq, S. and Rockstrom, J., (2005). Africa and Climate Change. International Institute for Environment and Development, Sustainable Development Opinion, London

United Nations Third Conference of the Parties of the Framework Convention on Climate Change (1997). Kyoto Protocol to the United Nations Framework Convention on Climate Change. United Nations, December 10.

Walubengo, D. (2007). Community-led action to use forestry in building resilience to climate change: a Kenyan case study Njoro Division, Nakuru District, Kenya .Forest Action Network.

Wilhelm, T.N. (1998). Transfer and adoption of Technology: The Case of Sheep and Goat in QwaQwa. Ph. D. Dissertation. University of Orange Free State, Ontario, South Africa.

Woomer, P.L., Toure´, A. and Sall, M. (2004). Carbon stocks in Senegal's Sahel transition zone. *Journal of Arid Environments* 59: 499–510.

Yen, S. and Jones, A. (1997). Household consumption of cheese: an inverse hyperbolic sine double hurdle model with dependent errors. *American Journal of Agricultural Economics* 79: 246–251.

APPENDIX 1: FARM/HOUSEHOLD QUESTIONNAIRE

The purpose of this study is to assess the willingness to accept and adopt clean development mechanism projects among small scale farmers in Njoro district, Kenya.
You have been identified as a useful informant to assist us (Egerton University) to achieve this mission. Your participation is voluntary and you are assured that the information you provide will be treated with confidentiality and used for the sole purpose of research. Kindly respond to the queries below. If you need more writing space you can attach more paper.

Section A: General Information

Questionnaire serial number [………]

A.1 District [………………………………………………........].

A.2 Division [……………………………………………………]

A.3 Location [……………………………………………………]

A.4 Enumerator name [………………………………………….]

A.5 Date of interview [………………………………………….]

A.6 **Name of the household head**……………………………………**Age/year of birth** ………..

Section B: Household inventory, Institutional and Farmer Characteristics

B.1 **Gender** of the household head 1=Male [ ] 2=Female [ ]

B.2 How many persons have been living in the household for at least the six months? (**household size**)?

Household members	**Number**
Men	
Women	
Children	

Total	

B.3 What is the **education level** of the household head? (*Tick appropriately)* 1= Not gone to school [ ]; 2= primary [ ]; 3= secondary [ ]; 4= college [ ]; 5= university [ ]

B.4 Are you a member of any of the following any **community groups** and what are the benefits you derive from the group?

Group	*Tick the group*	Benefits
Self help group		
Religious groups		
Cooperatives		
Business group		
Advocacy group e.g. HIV, Disabled groups		
Others(*specify*)		

Codes for the Benefits

1. Information 2.Advice 3.Credit and savings 4.Merry go round 5.Others (specify)…………………

B.5 Do you have **access to credit** facilities? Yes [ ] No [ ] [**If no skip to B.8]**

B.6Have you ever borrowed money to use in the farming business? Yes [ ] No [ ]

B.7 If yes, name the source of the credit and the amount outstanding by 1/4/2010?

Source of credit……………………. **Amount outstanding**…………………………………….

B.8 **Attitude towards risk**: which of the following situations will you choose in your farming operations?

Enterprise A will give you a profit of Ksh 100,000 in two out of the ten years and in the other eight years Ksh0 (High profit, high Risk)	1
Enterprise B will give you a profit of Ksh 30,000 in six out of the ten years and in the other four years Ksh0 (Medium profit, medium Risk)	2

Enterprise C will give you a profit of Ksh 20,000 in eight out of the ten years and in the other two years Ksh0 (Low profit, low Risk)	3

B.9 What is the total land size now in acres? ………………………..

B.10 Of the total land can you tell us what you grow in the plot(s) and the number of acres under each enterprise? What is the tenure of each parcel of land (in case having several parcel of land)?

Plot/ parcel	Land use	Acres	Land tenure
1			
2			
3			
4			
5			

Land use: 1= Crop production 2= Animal feed cultivation / Grazing 3= Housing 4=Tree planting 5= others (specify)……………………

Land tenure: 1=owned with title deed 2=owned without title deed 3= Rented 4=owned by parents 5=Communal/ government/ cooperative

B.11 Do you receive **extension services** in the farm last year? Yes [ ] No [ ][**If no skip to B.13]**

B.12 How many times in the last one year and from which extension providers? Number of times in a year…………. 1= Government extension workers [ ] 2= private extension workers [ ] 3=NGOs/ developmental agencies [ ] 4= Others (*specify*)………………………………………

B.13 What is the name of the **nearest trading** centre? …………………………………………...

B.14 What is the distance of the farm from the nearest trading centre in kilometers? ....

B.15 Of the 5 most important **enterprises in the farm** provide the yield (both for home consumption and for cash) in the last one year together with its unit price

Enterprises in the farm	Yield				Unit price
	For home consumption	Units	For cash	Units	
1.					
2.					
3.					
4.					
5.					

B.16 What is your perception on the profits derived from agricultural activities? 1. No profits [ ] 2. Medium profits [ ] 3.High profits [ ]

B.17 Do you have any other source of income apart from farming i.e. **off-farm income**?

Yes [ ] No [ ] **[If no skip to C.1]**

B.18 If yes, it falls in what range per month?

1= Less than 5,000 [ ] 2= 5,001-10,000 [ ] 3= 10,001-15,000 [ ] 4=15'001-20,000 [ ] 5= >20001[ ]

Section C. Voluntary Clean Development Mechanism (CDM) Projects

C.1 Which of the following practices do you carry out in your farm to conserve the soil and environment in general? (**Voluntary Clean Development Mechanism** that you practice in your farm)- *the enumerator should carefully fill the section and if possible he/she should be shown by the farmer the practice .Voluntary CDM projects includes all soil conservation measures as highlighted below plus many others*).

Tree planting/ Agro-forestry [ ] Strip cropping [ ] Zero tillage [ ] Terracing [ ] Mulching [ ] Cover cropping [ ] Application of manure [ ] Water conservation and harvesting [ ] Others *(please specify*)……………………………………………………..

C.2 In your opinion do you think the practice stated in C1 above is important in the farm? 1. Not important [ ] 2.Important [ ] 3. Very important [ ]

C.3Please provide the motivation behind your practice for the answer C1? 1. Controlling soil erosion [ ] 2. Climate change mitigation [ ] 3. Improve soil fertility [ ] 4. Others *(specify)*………….. …………………………………………………………………………

Section D: Awareness of Carbon Tree Trade Project

D.1 Have you ever heard/ have knowledge of farmers planting trees to clean the atmosphere (absorb carbon) and get paid? (Carbon trade tree project?) Yes [ ] No [ ] [**If no skip to D4]**

D.2 If yes in D.1, where did you get the information? 1.Media [ ] 2. Seminar [ ] 3.NGO [ ] 4. Friend/relative 5 Others *(Specify)*……………………………………………………………….

D.3If yes, please describe how the project operates;
………………………………………...
....
....

If not aware, the enumerator should take the responsibility to explain and the enumerator should rank the level of awareness of the farmer as: 1 = aware and correct [ ],

2 = aware but wrong [ ], 3 = not aware [ ]

D.4 Do you practice tree farming in your farm? (*The farmer should have at least ¼ of an acre under trees also note that it may not be a solid ¼ acre but the number of scattered trees could count to ¼ acre – and the effect could be the same*) Yes [ ] No [ ] **[if no skip to D.9]**

D.5 Please give the name of the trees planted in the farm in order of the most frequent to the least? (*Write the name of the tree even if it is given in vernacular language*)

1. …………………………... 2. ………………………………. 3. ……………………………….

4.…………………………… 5. …………………………………6.………………………………...

D.6 What is the number of trees in the farm? Number of trees……………………...

D.7 Where do you source the planting materials for the trees? 1=Own nursery [ ] 2= private company [ ] 3= government [ ] 4=NGO [ ] 5=Others (*specify*)…………………………………..

D.8 What is the main reason(s) for practicing tree farming? 1 = Market requires [ ] 2= High returns [ ] 3= Climate suitability [ ] 4= Soil control [ ]5. Others (*specify*)…………………

D.9 If no, what is the main reason(s) for not practicing tree farming?

1. Land constraint [ ] 2. Lack of seedlings [ ] 3. Inadequate market of trees [ ] 4. Low returns [ ] 5. Others (*specify*)…………………………………………………….

D. 10 How do you learn about new technologies/ ways of improving farm income?

1. From neighbours [ ] 2.Via extension officers [ ] 3. Self help groups [ ] 4. Field days [ ] 5. Cooperatives [ ] 6. Via newspaper and televisions [ ] 7. Via relatives [ ] 8.Others (specify)……………………………….

Section E. Willingness to Adopt Carbon Trade Tree Project

E.1 Suppose an NGO or government initiates/starts a project of planting trees to clean the environment (carbon sequestration) in Njoro district, where you will be paid for the trees you would plant in your farm and allowed to harvest at most 40% of the trees of which you plant yearly, would you be willing to adopt the project. Yes [ ] No [ ]

Please give the reasons for participating /not participating in such tree planting project;

1……………………………………………………………………………………………………

2……………………………………………..…………………………………………………

E.2 If yes, please how much of your land would you be willing to convert to tree farming and the number of trees you would be willing to plant in the area to be set aside for the project.

Area…………. Number of trees…………….

E.3 In your opinion what would you consider as the important factors to be considered before such tree planting projects starts?

1…………………………………………………………………………………………………

2………………………………………………………………………………………………

End.

Thank you for your cooperation!!!!!

APPENDIX 2: DETAILED RESULTS FOR TREE TYPES

Tree type	Rank 1	Frequency	Rank 2	Frequency	Rank 3	Frequency
Croton megalocarpus	11	7.86	11	9.09	13	15.85
Grevillea robusta	58	41.13	45	37.19	13	15.85
Eucalyptus sp	29	20.71	30	24.79	12	14.63
Cupressus lusitanica	26	18.57	21	17.36	23	28.05
Olea europea ssp. Africana	2	1.43	6	4.96	9	10.98
Callistemon sp	11	7.86	5	4.13	9	10.98
Dombeya torrida	0	0.00	2	1.65	2	2.44
Jacaranda mimosifolia	2	1.43	1	0.83	1	1.22
Ricinus communis(castor)	1	0.71	0	0.00	0	0.00
	140		121		82	