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Factors Influencing Potential Acceptance and Adoption of Clean Development Mechanism Projects: Case of Carbon Trade Tree Project among Small Scale Farmers in Njoro District, Kenya

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Abstract: The aim of study was to assess the willingness of small scale farmers to accept and the extent of willingness to adopt carbon trade tree project and by so doing to identify and quantify factors that will influence adoption of carbon trade tree project. The study used multi-stage sampling procedure to select 150 small-scale farmers in Njoro district, Kenya. Both primary and secondary data sources collected using observations and interviews with the help of a semi-structured questionnaire. The double hurdle model was used identify the factors that influence the willingness to accept and the extent the farmers are willing to adopt the carbon tree trade project. Findings of the double hurdle model indicate that 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 of improved training offarmers and extension officers 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.

Key words: Carbon sequestration, double hurdle model, willingness

INTRODUCTION

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

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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).

Projects involved in the carbon trading are majorly on large scale. 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 plant and manage on their lands (Rohit *et al.*, 2006). This example demonstrates that carbon sequestration projects have the potential to achieve improved livelihoods and sustainable development in Kenya. Studies on small-scale carbon sinks projects are limited though it is included in the CDM of the Kyoto protocol. The study hopes to bridge the knowledge gap on the potential acceptance of tree planting by smallholder farmers as a CDM project and the potential extent of adoption. The motivation behind the study was the high rate of deforestation experienced in the Njoro district in Kenya which has led to 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 bearing in mind tree farming may be used to reverse the trend (Walubengo, 2007).

As to such, the principal objective of this study was to examine the potential acceptance and extent of adoption of carbon trade tree project; and to further identify and quantify factors that influence potential adoption of carbon trade tree project in rural small-scale multi-enterprise production system in Njoro district, Kenya. This was with the aim of restoring the ecological health of the district as well as improved farmer income through the sale of carbon credits hence poverty level reduction. The following section describes the material and methods used in the study. We then present the result of the double hurdle model to identify the factors that influence the acceptance and the extent the farmers are willing to adopt Carbon tree trade project. The paper concludes with a conclusion and the policy implication for policymakers and other stakeholders and suggestion for future research.

MATERIALS AND METHODS

Research site and data: The study was conducted in Njoro district and data was collected during the months of May and June 2010. Njoro district is one of the districts that make up Rift Valley Province. It lies within the Great Rift Valley and borders four other districts namely; Nakuru North to the North East, Molo to the West, Rongai to the North, Narok to the south. Njoro district borders the eastern edge of the Mau Forest Complex which has been greatly deforestated , the largest single forest block in Kenya The district covers an area of 798.01 km^2 and is located between Longitude 35º45′ and 35º46′ East and Latitude 0º16′ and 1º10′ South. Njoro stands at an altitude of 1,800 m (6,000 ft) above sea level and has a mild climate. Temperatures range between 17-22ºC, while the average annual rainfall is in the region of 1,000 mm and is divided into five divisions namely Njoro, Kihingo, Lare, Mauche, and Mau Narok. The climatic conditions of this area are influenced by altitude and physical features where it receives an average rainfall of approximately 1,270 mm annually. Farmers practice mixed farming where they grow crops and keep animals. The main crops grown in the area are maize, wheat and horticultural crops (Walubengo, 2007).

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*., 2007). One inevitable result of such change in the district has been the unpredictable rainfall pattern constituting overall climate change. 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. CDM project via tree planting can prove vital in restoring the ecological health of the region whilst playing carbon sequestration role. The map of the study area is shown in Fig. 1.

Data for this study were mainly obtained through a household survey that was conducted during the 2009/2010 cropping season using a structured survey questionnaire. A random sample of 150 farm households was included in the survey. Farmers were interviewed using the survey questionnaire. The instrument included questions pertaining to farmers' personal attributes, farm characteristics, socio-economic, institutional factors and technology characteristics. Further, interviews and discussions were held with key informants and groups of farmers.

The model: 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

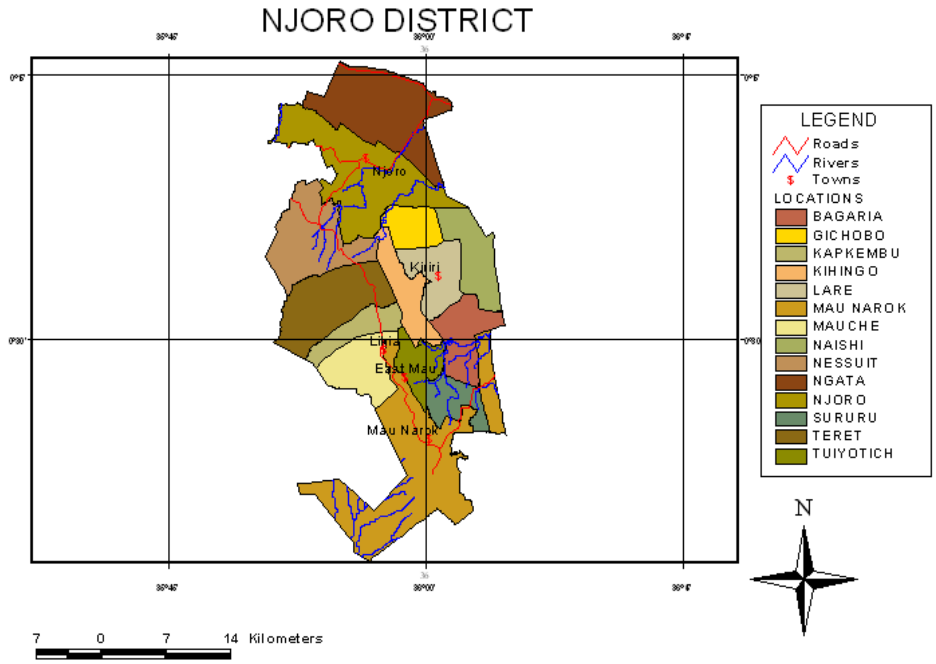

Fig. 1: Location of the study area in Kenya

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:

- whether or not a farmer was willing to participate in the carbon tree project (a dichotomous choice), and
- 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 (1958) 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 assumes 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 is 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:

$$y_{i1}^{*} = w_i^{'}\ \alpha + u_i$$

Decision to participate in the project $y_{i2}^{*} = x_i^{'}\beta + u_i$

Extent of adoption:

$$y_i^{*} = x_i^{'}\beta + u_i \text{ if } y_{i1}^{*} > 0 \text{ and } y_{i2}^{*} > 0 \qquad (1)$$

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 $\mu_i \sim$ N (0, 1) and $\mu_i \sim NN(0,\delta^2)$. 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:

$$L(\alpha,\beta,h,0) = \prod\nolimits_0 \left[1 - \Phi\left(W_i^{'}\alpha\right)\Phi\left(\frac{x_i^{'}}{\delta_i}\right)\right] \times$$
$$\prod\nolimits_1 \left[\left(\left(1+\theta^2 y_i^2\right)^{-1/2}\right)\Phi\left(W_i^{'}\alpha\right)\alpha_i^{-1}\Phi\left(\frac{T\left(\theta y_i\right) - x_i^{'}\beta}{\sigma_i}\right)\right] \qquad (2)$$

Table 1: Variables in the double hurdle model

Variable	Explanation	Measure
Dependent variables		
Participate enroll	Farmers willingness to accept the project	1 = yes, 0 = no
	Extent willing to adopt	Ratio of number of trees willing to plant to the total farm size
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	Gender of the household head	1 = male, 0 = female
Hhsize	The number of dependants in the family	Number
Farmsz	The size of land of the farmer	hectares
Landten	If the farmer has title deed	1 = yes, 0 = no
Farminc	The income derived from farming per year	Kenya shillings
Non-farminc	The income derived from other source other than farming	Kenya shillings
Exten	Contacts with extension officers	Number
VoluCDM	The existence of any voluntary CDM in the farm	1= yes, 0 = no
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	1= yes, 0 = no
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 averse 2 = Risk neutral 3 = Risk taking
Farmdebt	The amount of farm debt outstanding by 1/2/2010	Kenya shillings

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;

$$E\left(y_i \middle| y_i > 0\right) = \Phi\left(\frac{x_i'\beta}{\sigma_i}\right)^{-1} \int_0^{\infty}\left(\frac{y_i}{\sigma i\sqrt{1+\theta^2 y_i^2}}\Phi\left(\frac{\left(T\left(\Phi y_i\right)-x_i'\beta\right)}{\sigma_i}\right)\right)dy_i \quad (3)$$

Empirical analysis and variables: In this study, potential adopter is the farmer who will accept undertaking the tree carbon project in their farm. Hence potential non-adopters include the farmers who reject the project idea. Based on this information, the farmers were classified into two categories as potential adopters and potential non-adopters. Once the response on the decision of acceptance is made by the farmer, further investigation on those who accepted the project was made regarding the extent the farmer is willing to enroll in the project indicated by the number of trees the farmer is willing to plant in his/her farm. Once the number of trees the farmer was willing to plant in the farm was obtained it was further divided by the farm size to get the share which was used as the dependent variable in the second hurdle (Tobit model).

A number of explanatory variables were included in the model though the variables lack consistency in agro-environmental initiatives and payment for environmental services literature. Previous studies have classified the variables as personal, physical, socioeconomic and institutional (Napier *et al*., 1991; Baidu-Forson, 1999; Bekele and Drake, 2003; Dimitropoulos and Kontoleon, 2009; Sattler and Nagel, 2009). The factors considered in the study include the farm and farmer characteristics in addition to other socioeconomic and institutional factors and are summarized in Table 1 together with their measurement. In theory, Feder *et al*. (1985) presented factors that can affect adoption of new technologies and they include; availability of credit, limited access to information, risk attitude, land tenure, farm size, labour availability and unreliable supply of farm inputs.

Age of the farmer imply farming experience and knowledge gained over time and play an integral role in evaluating technology information and attributes (Feder *et al*., 1985; Baidu-Forson, 1999). Older farmers are expected to use their gained farming experience to decide to adopt the carbon tree trade initiative. In contrast, younger farmers have longer planning horizons and are likely to invest more in the project initiative. The role of gender in Kenya and the Sub-Saharan region in general is widely recognized where it is estimated that women supply the agricultural sector with 70-75% of labour force. Women compared to men lack access and control over vital production resources such as land, information, credit and labour (Njeri, 2007). Thus it is expected that male headed household would likely adopt the Carbon tree project in their farm because of control over vital farm resources.

Household size has been linked to the availability of "own/family" farm labour in adoption studies (Amsalu and De Jan, 2007). The argument was that larger households have the capacity to relax the labour constraints required during the introduction of new technologies. It is expected that a larger household size will influence the decision of acceptance because of the availability of labour required during the adoption process. The effect of farm size in acceptance conservation agriculture is no clear. Large land size may reduce the need to practice conservation agriculture (Gebremedhin and Swinton, 2003), while farmers with smaller land size would be discouraged from investing in agro-environmental initiatives because of the potential loss of land. On the other hand, large farm size could be a reflection of greater capacity and potential to encourage the farmers to decide to undertake the project needs including the financial needs (Cramb *et al.*, 1999).

The farmers level of education level is a human capital variable used as proxy to indicate the ability to acquire and process information (Damianos and Skuras, 1996a; Faturoti *et al*., 2006).The number of contacts with extension officers and group membership signify the potential 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 plays a role of financing the uptake of new agro- environmental innovation. Serman and Filson (1999) concluded that high farm income improves the capacity to adopt agricultural innovations as they have the necessary capital to jumpstart the innovation. 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 (Marenya *et al*., 2003; Amsalu and De Jan 2007). The amount of farm debt could hinder acceptance decision of Carbon tree trade project since it takes a little longer before the farmer starts to reap benefits. 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. 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). It is acknowledged that awareness precedes adoption from theoretical literature in the innovation process (Rogers, 1995). If the farmer is aware of the technology it could influence the decision to accept or reject the project.

Perception of the farmer toward agro-environmental initiatives and conservation in general plays an important role in the acceptance decision (Dolisca, *et al*., 2006). It is expected that farmers who would view such initiatives as important would accept the project at a larger extent. The existence of voluntary CDM practices as a factor could also influence the extent as this will indicate the farmers need for environmental conservation and also has the hands on experience on the technologies apart from reaping the benefits of the practice(s).

RESULTS AND DISCUSSION

Double hurdle results:

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 (first hurdle) and the results presented in Table 2. The Probit is 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 are shown in Table 2 and reveals that land tenure and farm size are significant at 1%, gender, attitude towards risk and perception towards the technology are significant at 5% and household size, farm debt and availability of voluntary CDM are significant at 10%. The log likelihood for the fitted model was -24.1478 and the χ^2 value of 112.27 indicates that all parameters are jointly significant at 5%.

The probability of females accepting the project is 0.03% 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 Matlon (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 big portion 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 10% increase in farm size increases the probability of accepting the project by 1.2% 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

Table 2: First hurdle econometric results

Variable	Coefficient estimates	Standard error	P>|z|	Marginal effects/elasticity
Age	- 0.01348	0.0153	0.378	- 0.0003
Gender	- 1.04856	0.5359	0.500**	- 0.0272
Existence of tree farming	- 0.68364	0.57914	0.238	- 0.0178
Education level	0.35614	0.30159	0.238	0.0093
Extension	0.07377	0.17884	0.680	0.0019
Level of awareness	- 0.38087	0.46882	0.417	- 0.0099
Group membership	0.25929	0.62159	0.677	0.0067
Household size	0.21012	0.1103	0.057*	0.0055
Farm debt	- 0.00001	7.22e-06	0.074*	- 3.35e-07
Attitude towards risk	0.84018	0.33819	0.013**	0.0218
Farm size	0.4225	0.1575	0.007***	0.0120
Land tenure	2.18484	0.58398	0.000***	0.2518
Farm income	- 0.00001	7.56e-06	0.153	- 2.18e-07
Nonfarm income	- 0.13268	0.27439	0.629	- 0.0034
Availability of voluntary CDM	2.02923	1.05219	0.054*	0.3221
Perception of the technology	1.14324	0.47065	0.015**	0.0297
Constant	- 5.20721	2.40551	0.300	

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

Table 3: Second hurdle econometric results

Variable	Coefficient estimates	Standard error	P>|t|	Marginal effects
Age	- 2.34322	1.1875	0.051*	- 2.3432
Gender	- 27.8378	38.9845	0.476	- 27.8378
Existence of tree farming	12.4507	41.1743	0.763	12.4507
Education level	19.3012	20.7602	0.354	19.3012
Extension	- 22.7305	11.9724	0.060*	- 22.7305
Level of awareness	26.1569	29.9130	0.383	26.1569
Group membership	37.1103	44.2893	0.404	37.1103
Household size	8.5086	6.2155	0.173	8.5086
Farm debt	- 0.0003	0.0003	0.382	- 0.0003
Attitude towards risk	39.6278	23.6868	0.097*	39.6278
Farm size	- 5.8826	5.6928	0.303	- 5.8826
Land tenure	144.113	52.4967	0.007***	144.113
Farm income	0.0003	0.0005	0.470	0.0003
Nonfarm income	9.9932	14.7440	0.499	9.9932
Availability of voluntary CDM	107.6538	77.5803	0.168	107.6538
Perception of the technology	65.0551	31.9142	0.043**	65.0551
Constant	- 381.8351	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

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 10% increase in household size the willingness to accept the project decision increases by 6%, 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 shown 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 trade 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 0.25%, 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 increases the probability of the decision of accepting the project by 0.3% relative to the absence of the same. 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 with positive perception increasing the probability of the decision to accept the carbon tree trade project by 0.03% relative to the negative perception of the same. 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.

Factors influencing the extent of willingness to adopt: To identify the factors that influence the extent of willingness to adopt the tree farming project the Tobit model was used and the results was presented in Table 3. 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%. 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 unlike the older household heads. However, these results were inconsistent with those of Maddison (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 having title deed increases the probability of the extent the farmer is willing to convert his/her land to tree farming by 144% relative to its absence. 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 (Arellanes and Lee, 2001). 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. Positive perception increases the probability of the extent the farmer is willingness to convert his/her land to tree farming relative to the negative perception of the same .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. A 10% increase in the number of contacts with extension service providers by the farmer decreases the probability of the extent of adoption by 6%. This result is inconsistent with results of earlier studies (Baidu-Forson, 1999; Faturoti *et al.*, 2006; 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, after 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 on tree planting. 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

CONCLUSION

The study aimed to 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. From the study the following conclusions have been made;

- 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.

POLICY RECOMMENDATION

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 four policy recommendations;

- Tree farming has the potential to be accepted and adopted in the district and would play an important role the integration of small-scale farmers in the carbon trading initiatives. 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. Other co-benefits include contribution to farmer’s food security situation and resilience to the impacts of climate change including an important environmental benefit of improved quality and flow of ecosystem services. Such pro-smallholder climate change mitigation policy would require that the investors and producers provided with the necessary incentives to be involved in climate change initiatives.

- A policy targeting collective action through enhancing community level agro- environmental groups could be vital in enhancing forest farming. The groups are important in aggregating farmers to enable the formation tradable amounts of the carbon mitigation pools. 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 in line with transaction cost economics. 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. Note that insecure property rights regarding land have been highlighted by Zhang *et al*. (2008) as the basis of failure of most payment schemes for environmental services. Title deeds will motivate the farmer to undertake long term investments in the farm like tree farming.

The main intention of the study was to determine the state of the potential of introducing tree farming among small-scale farmers in the study area as a climate change mitigation measure and improve farm income hence poverty reduction. However, the study proposes future research;

- To determine the existing tradeoff between agricultural productivity and tree farming for the farmers practicing it
- 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.

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