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# Socioeconomic Factors Affecting Farmers' Awareness of Clean Development Mechanism Projects: Case of Smallholder Forest Carbon Projects

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**Abstract:** The objective of the study was to identify the socio-economic and institutional factors which influence the level of awareness of Clean Development Mechanism (CDM) projects and in so doing to highlight the policy implications for the stakeholders when designing clean development mechanism projects among smallholder farmers. Findings shows that 23% of the farmers were correctly aware of the project and the results of the ordered logit model indicate that age, gender, education level, group membership, existence of tree farming and contact with extension services was found to influence awareness level of smallholder forest Carbon projects. To assist the community to adapt to climate change and produce sufficiently on a sustainable basis and achieve the desired food security under climate change challenges, the study recommends policies to increase awareness of such agro-environmental initiatives and that of extension providers should distinguish their clientele anchored on vital demographic characteristics such as age and gender. If the probability of younger farmers to be aware this initiative is higher, extension communications should be directed to such age group, particularly during initial stages project information dissemination.

**Key words:** Awareness, climate change, communication, smallholder farmers

## INTRODUCTION

In the last decade, the importance of carbon sequestration trading mechanisms to enhance both the protection of the environment and alleviation of poverty in developing countries has been of much debate. This is with the expectation that Clean Development Mechanisms (CDM), a product Kyoto Protocol, yields multiplicative dividends of natural resource conservation, improved farm proceeds and improved food security situation for the participating farming household in developing countries (IPCC, 2000; Woomer *et al.*, 2004). By this way it contributes to fight the problem of rural poverty by paying individual farmers and organizations adopting carbon sequestration technologies in line with the environmental services they offer as agreed by the CDM through developing active sinks in their farms (Smith and Scherr, 2002). Success of the CDM projects calls for aggregate action of individuals to undertake such project initiatives.

Despite the public policy efforts of Clean Development Mechanisms projects it is still not a vibrant investment in Kenya (Government of Kenya, 2010). 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-sect oral 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). In Kenya, specifically Nyeri District, through the International Small Group and Tree Planting Program local farmers are paid regularly depending on the number of trees they planted and taken care on their farms (Rohit *et al*., 2006). This example for instance, indicates the importance of such initiatives in attaining improved livelihoods and sustainable development in Kenya.

However, studies on agro environmental initiatives (Tucker and Napier, 2002; Kleijn and Sutherland, 2003; Marenya *et al*., 2003; Atari *et al*., 2009) have predominantly dealt on the adoption/participation of such initiatives. They have implicitly assumed that the farmer is aware of the initiatives in question. Little or no research has been undertaken on farmer awareness of CDM project via tree planting with a closer look to smallholder farmers' involvement. It is acknowledged that awareness precedes adoption from theoretical literature in the innovation process (Rogers, 2003; Rahman, 2003). The purpose of this study is thus to address these knowledge gap with an exploratory study of awareness. As such the

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objectives of the study were to: Identify the awareness level for clean development mechanism projects among the smallholder farmers, identify the socio-economic and institutional factors which influence the likelihood of awareness and highlight the policy implications for the stakeholders when designing clean development mechanism projects among smallholder farmers in the region. Exploratory study was preferred in this case because little is known about farmers' awareness on Clean Development Mechanism projects and thus no hypotheses were formulated. The following section presents the materials and methods used in the study. Results and discussion follows and finally conclusion and policy recommendation.

## MATERIALS AND METHODS

**Research site:** The study was conducted in Njoro district is located in the wider Rift Valley Province in Kenya. It 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 1,270 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).

**Data:** In order to assess the level of awareness of CDM projects by the smallholder farmers, households were used as the unit of analysis. Interviews were carried out by developing, pretesting and implementing a semi-structured questionnaire, taking into consideration the existing forest issues with the Mau forest. Further information was generated through focus group discussions and interviewing key informants. This was done in the months of May and June 2010. A total of 150 households were selected with a pre-condition of them having 20 ha or less of land to qualify as a smallholder farmer. 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 proportional number of farmers from each of the three divisions. Data collected included a series of demographic, socioeconomic and institutional characteristic of each household. Data was analysed with the aid of STATA software.

**Model:** In order to analyze the influence of socio-economic, institutional and demographic variables on awareness levels of the carbon trade projects among smallholder farmers, the ordered logit model was used. Level of awareness was measured in a likert scale of 1 = aware and correct, 2 = aware but wrong, 3 = not aware as used by Briz and Ward (2009). Thus, despite the ordinal outcomes the distances between the three probable outcomes indicates differences in awareness. 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) modeled the ordered logit model as follows;

$$In\Omega_{y\le m}(x) = \tau_m - x\beta$$

where

$$\Omega_{y\le m}(x) = \frac{pr[y \le m|x]}{pr[y > m|x]} \quad (1)$$

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:

$$In\Omega_{y\le m}(x) = \tau_m - x\beta$$

For m = 1… J-1

Equation 4 was written in terms of odds as:

$$In\Omega_{y\le m}(x) = \exp[\tau_m - x\beta] \quad (2)$$

For m = 1… J-1

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

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

$$pr(y = j|x) = \frac{\exp(\tau_j - x\beta_j)}{1+\exp(\tau_j - x\beta_j)} - \frac{\exp(\tau_{j-1} - x\beta_{j-1})}{1+\exp(\tau_{j-1} - x\beta_{j-1})}$$

For j=2,...J-1

$$pr(y = j|x) = 1 - \frac{\exp(\tau_{j-1} - x\beta_{j-1})}{1+\exp(\tau_{j-1} - x\beta_{j-1})} \quad (3)$$

Table 1: Variables of the ordered logit model

| Explanatory variables | Explanation |
|---|---|
| Dismkt | Location of the farm to the nearest trading centre measured in kilometers |
| Grumemb | The farmers involvement in group activities(dummy; Yes = 1 or 0 if otherwise) |
| Division | The division of study area. (Njoro, Kihingo or Lare) |
| Age | Household head age in years |
| Educ | Years of schooling |
| 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(dummy; Yes = mass media or 0 if otherwise) |
| Extrefarm | Existence of tree farming 1/4 an acre of trees) in the farm(dummy; Yes = 1 or otherwise) |

Table 2: Source of information on new technology

| Main source of information | Frequency | % |
|---|---|---|
| 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 |

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, there are chances that the predicted probabilities could be negative or greater than 1 (Melissa and Bryman, 2004).

**Variables in the model:** In the ordered logit model, a range of explanatory variables were included and are shown in Table 1. Age as a variable was included to reflect the household head individual age in years. The division of the study area was also included with the thinking that there could be differential in the level of awareness among the farmers according to divisions. Thus Lare and Kihingo divisions were included with Njoro division being the reference variable. Education level is included in the model with the idea that education creates awareness. The model further contained the variable Gender as a dummy which takes the code of 1 for male respondents and 0 for female respondents. Group membership and contact with extension service providers are institutional factors which are seen as information dissemination facilitators. Location of the farm to the nearest trading center signifies the access to information like the print media. Source of information is critical during information dissemination and hence was included in the model as either mass media (televisions, radios and magazines) or otherwise. The variables in the model and their explanation are shown in Table 1.

## RESULTS AND DISCUSSION

**Level of awareness:** 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 Fig. 1. 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. The policy implication of this is that awareness campaigns are important in making information available to farmers to enable them make informed judgment before embracing such agro-environmental initiatives. Further results on the association between the divisions in study and the level of awareness revealed no significant relationship (Chi-square of 0.764 and a probability value of 0.943) between them.

**Main information sources of farmers on new technology:** The main information sources on new technologies are shown in Table 2. The results indicate 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.

**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. 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 and the results presented Table 3. A quick glance at the results reveals that two variables are significant at 1%, two variables are significant at 5% and two variables are significant at 10%. The log likelihood for the fitted model was -78.7195 showing that all parameters in the model all significant at 5%. Pseudo $R^2$ of 0.41 was also above the statistical threshold of 20% confirming that the levels of awareness were attributed to the covariates considered in the model.

Table 3: Ordered logit model results

| Variables | Coefficient | Standard Error | Z | p<0.05 | Odds ratio |
|---|---|---|---|---|---|
| Age | -0.0393 | 0.0144 | -2.72 | 0.006*** | 0.9615 |
| Division | | | | | |
| Lare | 0.6029 | 0.5868 | 1.03 | 0.304 | 1.8273 |
| Kihingo | 0.0393 | 0.5334 | 0.12 | 0.903 | 1.0668 |
| Njoro | - | - | - | - | - |
| Gender | -0.8416 | 0.4732 | -1.78 | 0.075* | 0.4310 |
| Existence of tree farming | 1.3180 | 0.5263 | 2.50 | 0.012** | 3.7358 |
| Education level | 0.5734 | 0.2442 | 2.35 | 0.019** | 1.7744 |
| Extension | 0.7246 | 0.1336 | 5.42 | 0.000*** | 2.0640 |
| Group membership | 0.4677 | 0.2441 | 1.92 | 0.055* | 1.5963 |
| Distance to the market | 0.0549 | 0.1361 | 0.40 | 0.687 | 1.0564 |
| Source of information | 0.2785 | 0.5203 | 0.54 | 0.592 | 1.3212 |
| $\alpha_1$ | 1.6227 | | | | |
| $\alpha_2$ | 4.3530 | | | | |
| -2 log likelihood | 78.7195 | | | 0.0000*** | |
| Pseudo $R^2$ | 0.41 | | | | |

*, **, ***: Refers to significance at 10, 5 and 1 percent level, respectively

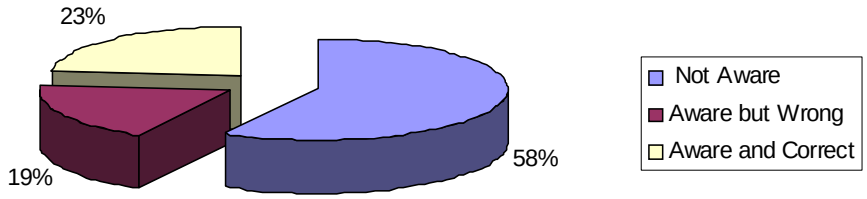


Fig. 1: Level of awareness

The relationship between age of the household head and the level of awareness revealed that a 1 year increase in the age of the household head significantly decreased the odds of the household attaining a higher level of awareness by 0.9615 times. 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. This brings out an essential awareness policy consideration that information providers should distinguish their clientele on the basis of demographic uniqueness such as age. If the probability of younger farmers to be aware this initiative is higher than the older group, then extension provider should direct their messages on such age group, especially during initial stages project information dissemination.

Gender of the household head in relation to level of awareness revealed that the level of awareness of a particular household, ceteris paribus, above any given level will be 0.431 times higher for female headed household than for male headed households. Female farmers in the district 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. 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; Njeri, 2007). Narrowing the gender gap in this case may be achieved through collective action complemented by the necessary extension services.

Existence of tree farming in the farm also positively and significantly influences the awareness of the Carbon tree trade projects. Ceteris paribus, the odds that a household level of awareness will be above any fixed level is 3.7358 times for those households that have engaged themselves in tree farming in the past than those who have not. The 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.

Moreover, education of the farmers has proved to be an important determinant on the awareness of the project. The relationship between level of awareness and education level reveals that a 1 year increase in years of schooling of the head of the household significantly increased the odd of the household attaining a higher level of awareness by 1.7744 times. These results are consistent 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). Further, this can be explained by the reason that as the farmer's education increases there is a tendency for the farmer to learn farming technologies hence having higher levels of awareness on pertinent issues in agricultural and agro-environmental innovations.

The number of extension contacts significantly influenced the level of awareness of the carbon trade tree project. A one unit increase in the contact with extension providers significantly increases the odd of the household attaining higher level of awareness by 2.064 times. 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.

Group membership is an important determinant of awareness of farmers on the carbon tree trade project. For a given level of other regressors, the odds that the level of awareness will be above any fixed level is 1.5963 times higher for households engaging in group activities as opposed to those who don't. This can be explained by the idea that individuals in groups are easily influenced by their acquaintances than those in isolation and thus improving the probability of being aware of such technologies. 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.

## CONCLUSION AND POLICY IMPLICATION

The study aimed at identifying the situation awareness level for clean development mechanism projects among the smallholder farmers and to identify the socio-economic and institutional factors determining awareness by farmers. The importance of awareness as a prerequisite for carbon tree trade should fall in place in order to ensure its successful adoption. As to such it was important to have an in-depth understanding of the overall situational level of awareness of such project initiative to help policy makers and other stakeholders who aim at promoting of the initiative to the smallholder farmers.

Findings indicate 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. However, results revealed no significant differences in the awareness level among the three division of study. The implication of these results is that there is low awareness of the project and hence might affect the acceptance and subsequent adoption. As to such more, a policy implication arises and that efforts need to be done to raise awareness to farmers on environmental initiatives. Agro-environmental information providers should educate the farmers on the initiative. However, farmers' testing of the technology leads to better adoption compared to just mere awareness of them. Considering the time required for trying the initiative it is not possible and hence the need for comparatively quick and less resource demanding options for awareness creation such as extension services and farmer group facilitation.

Results indicate that older farmers lack receptivity towards newly introduced technologies and thus they are more contented with their old ways of doing things. 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. Group membership and extension services as institutional factors has a positive significant relationship implying farmer participation increases the awareness of the project as they exchange new ideas in their meetings. An increase in extension contact between farmers and the extension service providers enhance awareness of this novel technical intervention. The policy implication of this finding is to encourage extension officers to help in the dissemination of agro-environmental initiatives. Further, existence of tree farming has a positive relationship to awareness since the farmers practicing them were probably aware of the importance of the technology intervention demonstrating the need for awareness to catalyse technology innovation.

Considering the results there is need for development of an action plan to create awareness among smallholder farmers and should focus in two priority areas:

- Extension officers should disseminate the knowledge to farmers through the already existing groups and encouraging them to form a major agro-

environmental association for the sake of reducing transaction cost and benefits linked to economies of scale. Knowledge dissemination should not only be based on CDM practices but also on the short run and long run effects of the promoted CDM practice. The associations should be endowed with the necessary technical and managerial capacity.

- Information providers (extension officers) must distinguish their clientele with regard to vital demographic characteristics such as age and gender of the household head. Younger farmers have a higher probability of being more likely aware of new initiatives, it is important that extension provider to focus their communications to such younger age groups during the initial stages of project information dissemination.

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