Exploring demand for forestry in Lake Victoria Basin (Western Kenya): An econometric approach

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Abstract

This paper determines the demand for a forestry program amongst rural households in western Kenya. It is based on a field survey with 277 households, using a stratified random sampling approach. The study follows attribute based method to elicit farmers' preferences. Demand is measured in terms of additional number of trees that a household is willing to plant under different price schedules, including direct economic incentive to plant new seedlings. The mean willingness to plant new trees per household increases from 44 trees when farmers have to pay 10ksh/seedling, to 244 trees when farmers receive a payment of 10ksh/seedling. The paper uses fixed effects, random effects and random effect tobit models to estimate relevant parameters. Hausman specification test is returned insignificant, while implies that random effects specification is not incorrect.

Price of seedlings (negative effect), availability of timber species (positive effect), gender of the respondent (men likely to plant more trees than women), and availability of agricultural labor at the household (positive) were all found to be significant. Increase in price of a seedling by 1Ksh reduced demand by nine seedlings, while addition of an adult who works full-time on the family farm will raise the demand for seedlings by 18. Furthermore, farmers in Yala River basin were likely to plant more trees than those in the Nyando River basin.

Key words:

Kenya, Lake Victoria, demand, tree seedlings, attribute based method.

JEL:

C23, Q23, Q57.

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1. Introduction

This paper estimates the impact of economic incentives and farmer characteristics on demand for a forestry program in the Lake Victoria basin in Western Kenya. Demand is quantified as additional number of trees that a farmer is willing to plant on her farm, while economic incentives are explored in terms of a hypothetical subsidy that farmers could receive for planting each additional tree. The results presented in the paper are based on a survey with local households across Yala and Nyando river basins that contribute a significant proportion of water (and silt) flow into Lake Victoria.
It was conducted in context of the Global Environment Facility funded Western Kenya Integrated Ecosystem Management (WKIEM) project that aims to conserve these river basins through forestry activities with local farmers.

Sediment flow into Lake Victoria due to large scale soil erosion in its catchment is a major concern for ecologists and environmentalists. Recent studies uniformly indicate the occurrence of severe land degradation in important catchment areas such as the Nyando River basin that contributes to growing silt inflow into the Lake Victoria. Land degradation of this magnitude has significant negative impacts on soil fertility and water quality in the surrounding area, resulting in rapid colonization of the lake by water hyacinth and decreased fish and aquatic plant diversity. The economic impact includes reduced fish catch from the lake and escalation in maintenance costs for operating hydroelectric turbines in downstream Uganda (ICRAF and KARI, 2004). Consequently, initiatives such as WKIEM project have focused on reducing silt inflow into the lake by taking up afforestation and reforestation activities in the upper catchment areas. The present study originated from the need to estimate the feasibility of such a forestry program in the area. It had two main objectives – (i) to prepare a socio-economic baseline of the area, and (ii) to estimate the effect of economic incentives and relevant demographic characteristics of farmers on their willingness to plant new trees on their farms. It was conducted in collaboration with the World Agroforestry Center (ICRAF), one of the implementing organizations for the WKIEM project.

The study builds on existing research pertaining to adoption of agroforestry and farm forestry by smallholders in developing countries. These research studies usually analyze whether or not a household will adopt agroforestry practices and factors that determine this choice (Mercer, 2004). For instance, Nkamleu and Manyong (2005) looked at socio-economic factors that affect adoption of agroforestry practices in Cameroon. They found that men were more likely to adopt new agroforestry practices such as live fencing. Other factors that were found significant included the family size (positive impact on adoption), security of land tenure (positive), and agroecological zone (probability of adoption being low in forest margins). Similarly, Franzel (1999) pointed out a strong association between wealth and adoption of agricultural fallows across Kenya and Zambia. Other important factors included in this paper were gender of the farmer and significance of off-farm income for the family. A valuable contribution to this literature is by Pattanayak et al. (2003), who reviewed 120 papers on adoption of agricultural and forestry technology by smallholders. They report five categories of factors that are most significant – preferences, resource endowments, market incentives, biophysical characteristics, and risk and uncertainty. The authors find that although market incentives are important, only a handful of studies consider these factors. Furthermore, only nine percent of the studies analyzed the explicit impact of prices on adoption rates.

This gap in literature on potential role of economic incentives in forestry adoption assumes significance amidst the recent emergence of payments for environmental services (PES). PES pertains to a system of payments or other economic rewards to land stewards in return for providing valuable environmental services such as carbon sequestration and watershed conservation (Wunder, 2005). Within Africa itself, such payments have been used to encourage farmers to invest in farm forestry and in protection of existing forests (Jindal, 2006). However, an objective estimate of the impact of such payments on actual adoption rates in the field or on demand from farmers for new forestry practices is still unknown in most cases. Therefore, a study on effect of direct economic incentives on farmers' willingness to adopt new forestry practices can tie these two different strands of research together. The present paper makes an attempt in this direction by exploring the impact of prices of tree seedlings on farmers' willingness to plant additional trees on their farms. Using this strategy, the paper is able to show a direct relationship between environmental payments (in the form of per seedling subsidy) and supply of conservation (in the form of additional trees that can be planted) in the Lake Victoria basin. The paper also looks at the differential impact of relevant socio-economic characteristics. The methodology adopted is based on attribute based survey methods.

2. Choice of survey methods

Since the objective of this study was to assess farmers' preferences regarding ex ante adoption of new forestry practices (say in terms of additional trees to be planted), it could typically take two forms, i.e. either a contingent valuation type study or an attribute based study. Contingent Valuation Method (CVM) is a survey based methodology for eliciting values people place on goods, services and amenities (Boyle, 2003). In a CVM survey, respondents are asked to state their willingness to pay (WTP) for a good, or their willingness to accept (WTA) compensation to voluntarily give up a good. Both of these are Hicksian consumer surplus measures and the specific context determines which one is used – WTP is used if the respondent does not have the property right over the good in status quo while WTA is used if the respondent has a legal entitlement over the good and is being asked to give up that entitlement (Carson, 2000). For the present purpose, the study could either ask farmers their minimum WTA to plant more trees on their farm (by giving up the option to other crops) or maximum WTP for an upstream afforestation project that reduces soil erosion downstream. However, such a study will need to pre-determine the level of desired environmental service, say the specific number of trees to be planted, while farmers state their WTA (or WTP) for this service. If, on the other hand, the objective is to assess the intensity of environmental service that different farmers are willing to provide, then an attribute based method (ABM) is more appropriate.

The objective of an ABM type study is to estimate respondents' preferences for a divisible set of attributes of an environmental good (Holmes and Adamowicz, 2003).

Respondents can be asked to choose between two versions of an environmental program that differ by attribute levels. Including price as a variable can then help in estimating the economic value of these attributes. For instance, potential participants of a forestry program can be asked to choose between either planting additional timber trees or fruit trees on their farms, with the program assistance varying by which tree species is selected. This will help in determining different levels of environmental service that can be available as well as the total program cost for each of these levels.

The present study therefore incorporated a variant of the ABM to assess the feasibility of a forestry program in Lake Victoria basin by estimating demand for tree seedlings at different price schedules. Farmers were asked to elicit the kinds of tree species and the number of additional trees they would be willing to plant under three different scenarios, one where they would receive free seedlings, two where they had to pay 10 Ksh (Kenyan Shillings)[1] per seedling, and three where they received 10 Ksh per seedling. In each scenario, the farmer would receive the seedling, only the net price varied. One of the important requirements for a stated preference study is to make the scenario realistic for the respondent by clearly specifying the good and reminding her that participation in providing the good is voluntary (Carson et al., 2001). The present study incorporated this feature by presenting realistic price schedules and by reminding respondents that they could decline to plant more trees. Furthermore, respondents were told that payments would only be made six months after the seedlings were planted and on the basis of the actual number of surviving seedlings. Another requirement is to include relevant demographic characteristics of the respondents (Carson, 2000). For the present study, the list of relevant socio-economic variables was adopted from characteristics that have been found to be significant by previous agroforestry studies: gender, age, and marital status of the respondent, total farm land available with the household, ownership status (whether or not household has secure titles), percent land area under food crops, annual expenditure of the household in the previous year (as a proxy for the annual income), total livestock[2] owned by the household, kind of roof on the dwelling, total agricultural labor[3] available at the household, if the household had a member with a permanent job outside the farm, and the geographical location of the farm (see table 1).

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[1] The exchange rate at the time of the study was 75 Ksh = 1US$.

[2] Since the primary purpose was to if this variable was significant in explaining demand for forestry, instead of calculating total livestock units, the study summed up the number of large animals (cows, bulls, sheep, and goats) for each household.

[3] Again, the study used a simple approach of summing up the total number of adults (>16 years) at the household and by applying the following weights for individual members: 0 = no involvement on family farm, ½ = part-time involvement, and 1 = full-time involvement on family farm.

The econometric model estimated by the study can be summarized as:

Demand = for tree seedlings[4]	$\beta 1$ (price) + $\beta 2$ (tree species) + $\beta 3$ (gender) + $\beta 4$ (age) + $\beta 5$(marital status) + $\beta 6$(farm land) + $\beta 7$ (land title) + $\beta 8$ (percent farm under food crops) + $\beta 9$(annual expenditure) + $\beta 10$(livestock) + $\beta 11$(kind of roof) + $\beta 12$(agricultural labor) + $\beta 13$(member with permanent job) + $\beta 14$(geographical location) + Error

It is important to note that within farmer variation is provided by price and choice of tree species, while between farmer variation is provided by other socio-economic variables.

The model was estimated on the basis of a survey with 277 households, conducted from June to August 2005 in western Kenya[5]. These households were selected as per stratified random sampling. The survey was conducted in Nyando and Yala river basins where particular sub-locations were selected as the first level of stratification. The target population for this survey therefore comprised all the inhabitants of the two river basins. The second level of stratification was the selection of the interior most point accessible by car. Three researchers then went in different directions (one along the road and two away from it) to interview the first five households in each direction. Respondents were usually the senior most male or female available in a house. Interviews were conducted as per a survey questionnaire that was administered to all respondents. The survey questionnaire was pre-tested and modified several times to make it realistic and culturally appropriate for the local population. These data were analyzed using STATA software.

3. Brief description of the data

Out of the 277 respondents included in this study, 44.8% were male, 69.7% were married, while 28.2% were either widowed or separated. The average age of the respondent was 46.4 years (see table 1). Most farmers were smallholders with average land ownership per household being 4.9 acres, 53.1% of which was under food crops in the previous year. Only 38.9% of the households had at least one secure land title for different pieces of land they farmed on. The average labor availability per household for farm work was 3.6 units. The average annual expenditure per household was 45,314 Ksh in the previous year with 76.5% of the families living in dwellings with metal roofs. Only one fourth (25.9%) of families had at least one member with a permanent job outside family farm. The respondents were about equally distributed across the two geographical strata with 56.9% respondents being located in Nyando River basin.

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[4] This study assumes one to one correspondence between demand for seedlings and number of additional tree seedlings a farmer is willing to plant under different price schedules. Since farmers get paid only on the basis of actual number of trees planted and protected, it is assumed that farmers will not be able to trade seedlings with others.

[5] In all the survey covered 313 households. However, 36 observations had to be discarded due to missing values and incorrect entries in the database. There is a slight probability that this elimination could be biased against women headed households who could not respond to all the questions. An alternative of assuming mean values for missing observations or of analyzing unbalanced data set were not employed however.

Table 1: Descriptive statistics of variables used in the econometric models
(n = 277)*

Variable	Description	Continuous variable Mean	Continuous variable Std.Dev.	Dummy variable
Price**	Net price per seedling for the farmer (in Ksh). Three price schedules were offered.	0	8.17	
Gender	Gender of the respondent. 1 = male, 0 = female			1 = 44.8%
Age	Age of the respondent in years	46.4	15.48	
Dum_Married	Marital status of the respondent. 0 = not married, 1 = married, 2 = separated/widowed			0 = 2.2% 1= 69.7% 2 = 28.2%
Land	Land owned by the household (in acres)	4.9	5.96	
Dum_Title	Possession of formal land title. 1 = if the household has a title to at least one piece of land 0 = no formal title			1 = 38.9%
Percent foodcrp	Proportion of total land under food crops (in percent)	53.1	25.98	
Annual Exp	Total annual expenditure of the household during previous year (in Ksh)	45,313.8	139,799.7	
Livestock	Total number of large livestock owned by the household	7.1	8.58	
Dum_Roof	Kind of roof on the dwelling. 1 = metal sheets, 0 = thatch/grass			1 = 76.5%
Agri Labor	Total agricultural labor available at the household (units) after accounting for part-time and full-time involvement	3.6	2.06	
Dum_Pmntjob	If a household member has a permanent job 1 = at least one member has a permanent job, 0 = no member has a permanent job			1 = 25.9%
Dum_Block	Geographical location of the farm 1 = Nyando river basin 0 = Yala river basin			1 = 56.9%
Dum_Planttrees	If the household would like to plant additional trees. 1 = yes, 0 = no			1 = 99.6%

*Sample size is 277 for all variables except for Age (n = 275) and Dum_Block (n = 276).
** Price introduces panel effect in the model with three observations/respondent, n = 831

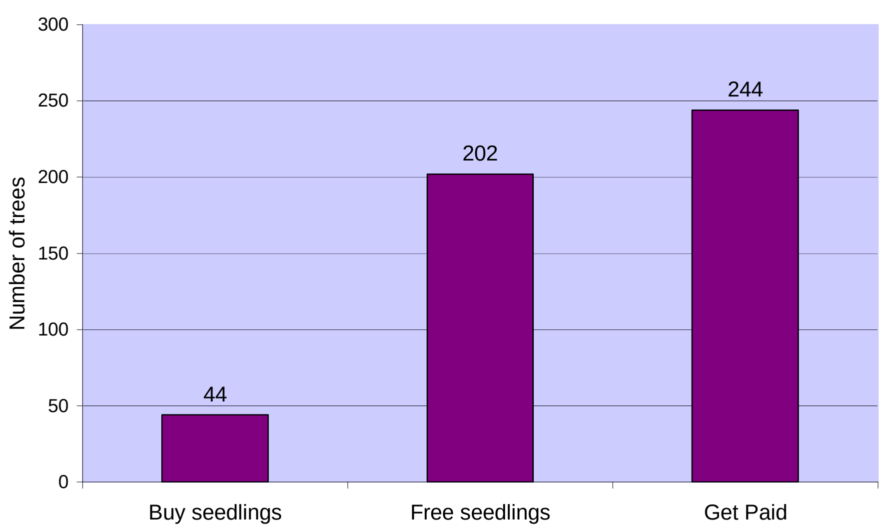
Since each respondent was offered three price schedules, she could decide about the specific mix of tree species in each case and the number of seedlings she wanted to plant. Table 2 shows the mean response under each scenario: when the farmer had to buy seedlings at 10Ksh/seedling, when the farmer was offered free seedlings, and when the farmer was paid 10Ksh/seedling for planting and protecting additional trees.

Table 2: Descriptive statistics of dependent variables
(n = 277)

	Variable	Buy Seedlings (farmers pay 10Ksh/seedling)	Free seedlings (farmers get free seedlings)	Get Paid (farmers get paid 10Ksh/seedling)
Number of seedlings demanded	Mean Std. Dev.	44 115.9	203 425.8	245 493.5
Choice of tree species	Dummy variable (%) 1 = if the respondent chose at least one timber species 0 = if no timber species were selected	1 = 62.1%	1 = 86.2%	1 = 82.3%

If the farmers had to buy seedlings, they were willing to plant an average of 44 seedlings/household. Demand per household increased to 203 seedlings if farmers received free seedlings and further to 245 seedlings/household if they received direct economic incentive to plant additional trees (please see fig 1 below). 62.1% of the household preferred to plant at least one timber tree species when they had to buy seedlings, which increased to 86.2 % when seedlings were available for free. Interestingly, the trend was not monotonic as the willingness to plant timber species reduced to 82.3% when farmers received economic incentives to plant new trees along with free seedlings (table 2).

Fig 1: Mean number of trees under different scenarios



4. Econometric analysis

The econometric model that was estimated under this study was - conditional on a farmer's willingness to participate in a tree planting program, demand for additional seedlings:

$$Y_{iP} = \beta_1 P + \beta_2 X_{iP} + \beta_3 D_i + C_i + U_{ip} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where,

Y_{ip} = No. of trees farmer 'i' is willing to plant at price 'p'.

i = 1,2,3,…..277

P = Price. It takes three values for each respondent: 0 (respondent gets free seedlings), -10 (respondent needs to pay 10Ksh/seedling), and +10 (respondent can get 10Ksh for planting each additional seedling)

X_{iP} = Choice of tree species farmer 'i' makes at price 'p'

$$= \begin{cases} 1 \text{ if farmer selects at least one timber tree species} \\ 0 \text{ if farmer doesn't select any timber tree species} \end{cases}$$

D_i = Observable demographic characteristics for individual 'i'
These include age, gender, marital status of the respondent. Also included are household characteristics – farm land, annual expenditure, Dum_Roof etc.

C_i = Unobservable characteristics for individual 'i'

U_{ip} = Error term

Since almost all respondents were willing to participate in a tree planting program (Dum_Planttrees = 1 for 99.6% respondents), equation (1) can be taken to represent unconditional demand for tree seedlings.

Equation (1) also represents a panel data model with three observations per individual corresponding with three price schedules. The total number of groups (or individuals) was therefore 277 while total number of observations was 831. There are in general, two methods to analyze panel data – fixed effects model and random effects model.

Fixed effects model is based on the assumption that:

$$\text{Covariance } (X_{iP}, C_i) \neq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

This means that fixed effects (FE) works best when there is correlation between observed explanatory variables (X_{iP}) and the unobserved effect (C_i). FE model will provide consistent estimates even when this assumption is incorrect, i.e.

$$\text{Covariance } (X_{iP}, C_i) = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

However, in case equation (3) holds, random effects (RE) model will not only produce consistent results, the estimates will be more precise (Wooldridge, 2002a). The problem however is that some individual specific characteristics remain unobserved (e.g. ability to care for new trees) even after we account for characteristics such as age, gender, marital status, annual expenditure, etc. The solution therefore is to undertake the Hausman specification test (Hausman, 1978).

4.a. Results of econometric analysis

When the model in equation (1) was estimated with all the explanatory variables listed in table 1, many of the variables were found insignificant even at 10% level, even though the overall model was significant. An F-test for the joint significance of 'age', Dum_Married, land, Dum_Title, Percent foodcrp, Annual Exp, Livestock, Dum_Roof, and Dum_Pmntjob could not be rejected. These results were in contrast to results obtained by Nkamleu and Manyong (2005) who found both 'age' and 'land' to be significant. It is, however, likely that many of these variables were strongly correlated with other socio-economic variables that were significant in the present model (gender, Dum_Block), inducing multicollinearity in the model. This was confirmed when dropping some of the socio-economic variables increased the significance of other variables such as Agri Labor. Two variables that were unexpectedly found to be insignificant at the 10% level were farm size and annual expenditure during the previous year.

The results from FE model and RE model (after dropping insignificant variables) are listed in table 3. The Hausman specification test (Hausman, 1978) was conducted with the null hypothesis that FE and RE models produce similar estimates. The test could not be rejected at usual significance level which implies that RE specification of equation (1) is not incorrect. Since about 10% of the observations (84 observations) were left censored at zero, random effects tobit (RE tobit) model was also estimated (column 4). Most variables are of the same sign and within the same range across the three models, which indicates the robustness of these estimates.

In the FE model, the coefficient on price was – 9.014435. This meant that for every 1 Ksh increase in price of a seedling, farmers reduced the number of seedlings they wanted to plant by nine. The corresponding estimate of coefficient on price was of same sign and magnitude from both RE and RE tobit model. The coefficient on Dum_Treespp was 101.8934 in the FE model, with almost similar result from the RE model. This implied that with respect to non-timber tree species, selection of at least one timber tree species, increased farmers' demand for seedlings by 102. The estimate from RE tobit was still higher at 260.

Since the other three variables were fixed for an individual, their estimates were only reported by RE and RE tobit models. Gender of the respondent had a significant effect on willingness to plant trees, with males expected to plant almost 100 more trees than females. Availability of agricultural labor at the household had a positive effect on number of trees to be planted, with each additional unit of labor resulting in 18 additional trees (RE model). Finally, respondents in Yala River Basin (Dum_Block = 0) were willing to plant almost 100 more trees than their counterparts in the Nyando River basin.

Table 3: Estimates of different econometric models

No. of observations = 831
No. of groups = 277

Variable	Coefficients estimated by Fixed Effects	Coefficients estimated by Random Effects	Coefficients estimated by Random Effects Tobit
Price	– 9.014435 *	– 8.974875 *	– 12.81819 *
	(1.178892)	(1.164397)	(1.28851)
Dum_Treespp	101.8934 *	105.8071 *	260.1386 *
	(34.86686)	(29.95947)	(33.39249)
Gender	(dropped)	98.43492 *	96.86032 *
		(37.20235)	(36.06952)
Agri Labor	(dropped)	18.44737 **	14.283 ***
		(8.993604)	(8.926066)
Dum_Block	(dropped)	– 79.1328 **	– 97.4221 *
		(37.20085)	(35.33029)
Constant	85.46342 *	17.1765	-87.01355 **
	(28.34078)	(47.6106)	(45.75452)
	Prob > F = 0.0000 Overall R – sq = 0.0600	Prob > chi2 = 0.0000 Overall R – sq = 0.0969	Prob > chi2 = 0.0000 Log likelihood = – 5612.9736 84 left censored observations 747 uncensored observations

* Significant at 1% ** Significant at 5% *** Significant at 10%
Figures in parentheses are standard errors.

4.b. Dealing with endogeneity

Equation (1) includes two choice variables for the respondent: number of tree seedlings to be planted and the kind of tree species. The model can be seen as a combination of two structural equations:

$$X_{iP} = \gamma_1 P + \gamma_2\, Gender + O_i + E_{ip} \quad \text{(4a)}$$

$$Y_{iP} = \beta_1 P + \beta_2 X_{iP} + \beta_3 D_i + C_i + U_{ip} \quad \text{(4b)}$$

Where:
Equation 4(b) is the same as equation (1), and

X_{iP} = Choice of tree species farmer 'i' makes at price 'p'
= 1 if farmer selects at least one timber tree species
  0 if farmer doesn't select any timber tree species

O_i and C_i are respective unobservables in each structural equation.

The inclusion of gender as explanatory variable in equation (4a) merits some discussion. Nkamleu and Manyong (2005) find that men are more likely to adopt new agroforestry practices than women in Cameroon. Similarly, existing customs amongst local communities in western Kenya dictate that women are not allowed to plant trees, especially timber species on family farms. Since women can only plant a restricted list of species, the effect shows up in their reduced demand for additional tree seedlings in equation (4b), please see table 3 above. This is indeed confirmed by the following estimates from the RE model:

*Selection of timber species = 0.73 * – 0.01 price * + 0.082 Gender ** …………(5)*
(0.026) (0.001) (0.038)

Overall R-sq = 0.0478
No. of observations = 831 No. of groups = 277

** Significant at 1%. ** Significant at 5%.*

As ‘gender’ is a dummy variable (0 =female, 1 = male), equation (5) shows that men were more likely to plant timber species than women. Price had a negative effect, implying that farmers were more likely to ask for timber species when they were provided free seedlings or when they received economic incentive to plant new trees.

However, since the tree species (X_{iP}) was a dependent variable in equation (4a) and an independent variable in equation (4b) there was a strong likelihood that the error terms in the two equations were correlated, i.e. Cov (E_{ip},U_{ip}) $\neq 0$, inducing endogeneity in the system. Endogeneity of tree species (X_{iP}) implies that our estimates from FE and RE models described above were no longer consistent and unbiased. It is therefore an important issue that needs to be addressed.

The present model tried to reduce the threat of endogeneity by including price as an explanatory variable both in equation (4a) and (4b). As per Wooldridge (2002b), allowing for trending variable such as time (in the present model it is price) explicitly recognizes that other explanatory variables are correlated with it. Once the trending variable is included as an independent variable, there is less likelihood for other explanatory variables to be correlated with the error term.

In the case of RE model, it was quite possible that tree species (X_{iP}) was actually correlated with individual specific characteristics (C_i) in equation (4b), thus nullifying the assumption that Cov(X_{iP}, C_i) = 0. As unobservables (C_i) are clubbed with the error term (U_{ip}) in a RE model, this results in Cov(X_{iP}, $C_i + U_{ip}$) $\neq 0$, producing endogeneity in the system. Again Wooldridge (2000a) supports the inclusion of individual specific dummy variables in the model, which controls for a certain amount of heterogeneity that might be correlated with the (time-constant) elements of X_{ip}. The present model incorporated this suggestion by identifying price-constant variables such as ‘gender’, ‘Agri Labor’, and ‘Dum_Block’ in equation (4b). As more and more elements of unobservable (C_i) are identified, it is less likely that Cov(X_{iP}, $C_i + U_{ip}$) $\neq 0$.The Hausman specification test presented above further confirms that the left-over elements in unobservable (C_i) may no longer be correlated with tree species (X_{iP}), such that Cov(X_{iP}, C_i) is indeed = 0.

Finally, after implementing all these strategies, we checked for endogeneity by calculating the correlation between residuals ($\hat{e}_{ip}$) from equation (4a) and those ($\hat{u}_{ip}$) from equation (4b). The estimated correlation coefficient:

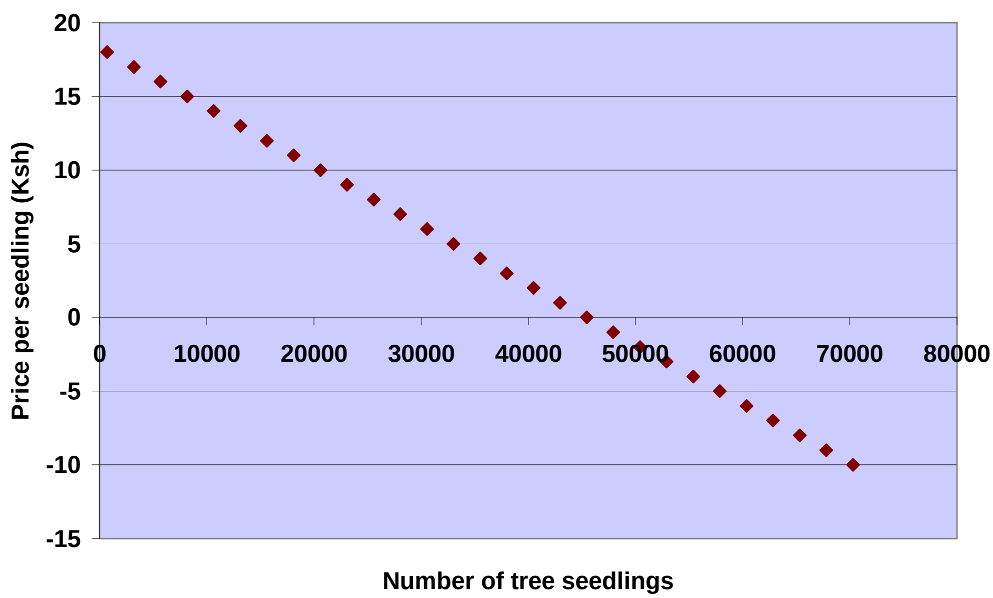
$$\rho(\hat{e}_{ip}, \hat{u}_{ip}) = -0.0027 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

This is very close to zero and therefore there appeared little evidence of endogeneity in the present model[6].

5. Discussion: significance of results

The results presented in this paper confirm that direct economic incentives to land stewards can indeed improve the provision of an environmental service; *ceteris paribus*, farmers in Western Kenya are willing to plant about nine more trees for every Ksh of direct payment to them. Admittedly, the price range covered in this study is limited between +10Ksh/seedling and -10Ksh/seedling, but even within this price range, the effect on demand for seedlings is significant. The partial effect is half of the slope coefficient on Agri Labor, which implies that provision of 2Ksh of economic incentive per seedling has the same effect as adding one adult member to a household who works full time on the family farm. The estimated slope coefficients from RE model (column 3 in table 3) can also be used to construct a demand curve for a forestry program in the study area. Demand is seen in terms of number of additional trees that farmers are willing to plant (and hence the demand for number of tree seedlings), both when farmers receive per tree economic incentive and when they have to pay for seedlings themselves. Fig (2) shows that demand for tree seedlings amongst sampled households (n=277) goes down from 70,000 seedlings at an economic incentive of 10ksh/seedling to less than 10,000 seedlings when farmers have to pay 15ksh/seedling.

Fig 2: Demand for tree seedlings amongst sampled households in Lake Victoria Basin



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[6] A more rigorous treatment of endogeneity can indeed be taken up following an Instrument Variable approach.

These results have a direct significance for ICRAF and other implementing organizations in the region. These organizations can use the results from this study to further explore demand for forestry in the region. For instance, farmers in Yala River Basin are much more likely to plant trees than farmers in Nyando River Basin. Therefore, a forestry initiative in the area such as WKIEM is well advised to begin its activities amongst sub-locations in Yala rather than in Nyando. During this phase, implementing organizations can try to identify factors that constrain adoption of forestry in Nyando and as the program matures, use their experience to introduce appropriate activities in Nyando.

The paper also raises concern for local and international NGOs like ICRAF that support planting of indigenous tree species instead of exotics. The results presented here clearly show that people are more likely to demand timber species such as *Eucalyptus*, *Casuarina equisetifolia*, and *Gravellia pteridifolia* rather than fruit or agroforestry trees. Availability of such exotic timber species also raises their willingness to plant more trees on their farms. Since exotics are associated with long run ecological disaster, research organizations will need to come up with suitable economic incentives to promote indigenous tree species. This may include provision of differential economic incentives, for instance providing higher payment per tree when farmers select indigenous tree species.

6. Conclusion: limitations of the study

The purpose of this study was to assess the feasibility of a forestry program in Lake Victoria Basin by exploring farmers' willingness to plant additional trees on their farms. The study is able to confirm that there exists significant potential for a forestry program in the region, especially if farmers are offered direct economic incentives to take up plantations. It is however, important to note that the per household demand is fairly low – at the usual planting intensity of 2.5m X 2.5m, a household is willing to put less than 0.5 acres of farm land under tree plantations even when it receives a payment of 10ksh/seedling along with free seedlings. To achieve any meaningful impact at the level of the entire basin will therefore require rigorous targeting and extensive enrolment of new households in the program. The study is also able to confirm some results reported by previous agroforestry studies. For instance, women are less likely to choose timber species than men, while families with higher labor availability are more likely to plant new trees.

While these results are encouraging, the study also suffers from several important limitations. The price schedule explored in the survey is rather limited and can only predict demand within a narrow range. Since the purpose of the present study was to explore whether economic incentives have any effect on provision of an environmental service, the answer is unconditional yes. A subsequent study will however, need to explore economic incentives in greater depth by offering more price choices. The present study does not account for endowment effects. For instance, it assumes a one to one correspondence between demand for additional tree seedlings and number of trees that a farmer is likely to plant. It does not deal with the difference in farmers' perception when they get free seedlings versus when they have to pay for them. Finally, endogeneity can be dealt with more rigorously by following instrument variables approach. A subsequent study will *ex ante* need to identify a suitable variable that can help in predicting choice of tree species in equation (4a). Similarly, additional functional forms can be tried out to test the robustness of estimates, for instance using probit and logit specifications.

ICRAF and other research organizations involved in implementing WKIEM project may also like to explore deeper as to why farmers in Yala River basin are willing to plant more trees than those in Nyando river basin. The reasons may be a mix of socio-economic factors as well as geographical characteristics such as quality of soil and average slope of the area.

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