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# Determinants of Rural Households' Decision Making to Forgo Income for Bequeathed Woodlot in Uasin Gishu County, Kenya

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## Abstract

*Forests are an important economic good in providing dependable products by rural households such as fuel wood, food supply, natural insurance and as habitat for pollinators; however, unchecked household characteristics that abet exploitation and/or unsustainable consumption of forest products expose livelihoods of rural households who are forest resource dependants to be at perilous state. Therefore, this study sought to examine demographic and socio economics determinants that influences rural households decision making to forgo income for conservation through bequeathed tree planting in Uasin Gishu County, Kenya. Systematic random sampling technique was applied in selecting samples whereby a total of 234 structured questionnaires were administered to rural household's heads for interview. Results from regression analysis showed that rural households with existing woodlot in their farms and family size were negative and significant at (-2.501, p< 0.05) and (-1.857, p< 0.1) respectively, which suggests to influence the desire for rural households not to forgo income for bequeathed woodlot in their farm, while constructs of dependency level on forest products by rural homes 1.720, p< 0.1, the costs of establishing woodlot at 0.992, p< 0.001 and agro-ecological condition of land at 1.784, p< 0.1, which were positive and statistically significant were likely to influence rural homes to engage in tree planting as insurance venture for the future generation of which $234.19 was the likely annual premium. In conclusion, the critical determinants that influence rural homes' decision making to forego income for bequeathed woodlot informs policy makers, scholars and resource managers on rural households' characteristics needed while formulating strategies and policies needed for up-scaling forests land cover to mitigate climate change effect. However, the positive and statistically significant of stochastic variable from OLS model, which explains variables that were omitted and/or were beyond the scope of this study and remained unobserved, showed influence on rural household decision making to forgo income for conservation stewardship; hence, creating knowledge gap for further investigation..*

**Key words:** ***Livelihoods, woodlot, conservation stewardship, agro-ecological***

## Introduction

Existence of forests underpins ecosystem services as an essential and basic component that largely supports human livelihood on earth (Keenan *et al.,* 2015). However, unsustainable utilization of forests such as irrational excision of land for human settlement and over exploitation of forests resources puts human life at perilous state (Kerr, Vardhan, & Jindal, 2014). That is, the


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marginal reduction of forest lands or forests cover makes the earth to lose its thermostats to sequester heat-trapping gases from industrial emissions such as carbon dioxide; and accumulation of greenhouse gas could result into environmental episodes (Cao Zheng, Scanlon, Liu, & Li, 2013). These unpredictable climatic patterns which include flooding, drought and sometimes heat waves poses a threat to sustainable development goals such as human livelihood, especially on food security, unreliable forest stock flow provisions such as food supply and water, and human health (Keenan *et al.,* 2015).

Kenya's vision 2030 recognises forests protection and forests cover improvement as a driver that will enable the realisation of blue prints. Existences of forests provides sustainable supply of raw material for industries especially with the growing interest in up-scaling entrepreneurial skills to the population from Technical and Vocational Institution and in provisions of forests stock flow services to community; hence, acting as enable on the ambitious big four government agenda. Therefore, there is need to identify influencing households characteristics for the formulation of policies that could motivates resources providers to upscale conservation at private lands to cushion scarce public forests.

## Study Objective

This study sought to find out the influencing determinants of forgone income for tree planting in woodlot. The findings can inform policy makers and resource managers in regard to sound policy formulation aimed at motivating resource providers to upscale tree planting for forest cover improvement

## Literature Review

Hitherto, non market characteristics and absence of property rights on forest ecosystems services globally is blamed to abet over exploitation and degradation of forests especially by adjacent communities to them (Kerr, Vardhan, & Jindal, 2014). As explained by the authors, that in the absence of property rights, and if resource users cooperate to over consume or overexploit with zero or low conservation means, then, forest resources tend to follow unsustainable Nash Equilibrium Path. The most cited degrading human activities which have been described as environmental evils are forest logging, illegal charcoal burning, expansion of land for agricultural activities, poor farming methods and watershed encroachment (Kerr, Vardhan, & Jindal, 2014, and Pant, Rasul, Chetri, Rai, & Sharma 2012). Notwithstanding, overconsumption of forest resources thrives when perverse market incentive structures that disregard Hicksian Compensation measures failed to actualise or yielded no meaningful benefits from consumers (Pant *et al.,* 2012). A Study by Kerr, Vardhan, & Jindal (2014), while expounding the link between poverty and environmental conservation, found that propensity of low income households overconsumed forest resources when household income level declined, implying forest products to communities act as income safe-nets.


 

Despite worrying trends of overexploitation and unsustainable utilization of forest resources, Nordic countries have shown significant increase in forest cover with positive signals of further improvement (Pasco Consultants, 2013). The marginal improvement of forest cover was attributed to the utilisation of economic incentive tools such as carbon credits in trading conservation efforts at private lands. This facilitated Lindhal Financing Mechanism in resource conservation among economic units, only if the economic value of conservation sacrifice from resources provider needed to be determined (Van den Nouweland, 2013). The positive effects of using economic incentives as explained by Pant et al. (2012) supersedes the use of enforcement because the later bears immense costs, breeds conflict with law enforcers and the community, and creates room for law enforcers to corruption. Given that smallholders of land at rural areas engage in forestry-based livelihood and trees in woodlot can easily be valued, hence, the use of foregone income from land utilities as express willingness to pay value in this study could depict economic value (bequest value) of forest services.

Studies by Nuru, Abdallah and Ngaga (2014); and Huang, Shaw, Chien, and Zhao (2015) found that socio-economic determinants (age, educational level, income, gender) and biophysical factors (infrastructure, land size and agro-ecological condition of land) to significantly influence household decision making on farming activities. Another study of Worku, (2017) found that socio-economic factors such as income, age, marital status, household population, land size and land ownership to greatly influence household decision making on investment. From aforementioned constructs that influence households' decision making on tree planting from past literatures, it is clear that determinants that influence households to forego income from land utilities for bequeathed woodlot is lacking, for which this study sought to bridge.

This study sought to find out the influencing determinants of forgone income for tree planting in woodlot. The findings can inform policy makers and resource managers in regard to sound policy formulation aimed at motivating resource providers to upscale tree planting for forest cover improvement.

To conceptualise forgone utilities (income) for tree planting and its constrains, it can be expressed in an equation functions as;

$$\max_{x} U(x) \quad \textit{Subject to household's budget (income)} \qquad (1)$$

Expressed function in equation 1 depicts rational resource maximization, where the components of $(x)$ in the equation function (2) describes various land utilities including expressed conservation through bequeathed woodlot.
That is;

$$x = ((\mathrm{x_i} \ldots \mathrm{x_n}) + \text{ woodlot }). \quad (2)$$

Where; $x$ represents identified agricultural farm crops that households could forego in form of income when they accept to allocate land for bequeathed woodlot, which is an expressed conservation stewardship for future generation, $i \ldots . n$ are specific crops such as wheat, maize, beans and vegetables.

The households' decisions making for resource maximization can be indexed based on constrains which can be defined in an equation functions as;

$$u(y, q) \quad (3)$$

Where; u represents land utilities, while y and q are the constraining factors of income and households aspiration to conserve forest, respectively.

Consequences of forgone income for bequeathed woodlot come with households' income reductions, while forest lands would experience improvement. These consequences can be described in Hicksian equation function as;

$$u = ((y - WTP), q^{+}) \quad (4)$$

Where; u represents utility, $(y - WTP)$ represent subtracted households income from foregone income expressed as WTP and q with superscript (+) representing an additional land cover from bequeathed woodlot, respectively.

## Methods

### *Description of the Study Area*

This study was done during the month of January to March of the year 2019 in Uasin Gishu County, Kenya. Latitudes of study area lies at 0°30'N and 0°55'N, while longitudes lies at 34°50'E and 35°37'E. The temperature varies between 14°C and 24°C, and altitude ranges between 2,700m to 1,500m above sea level with quasi undulating topography with most areas being flat. The mean annual rainfall is 945mm with patterns showing bimodal type of rainfall, where long rains occurring in March to June, and short rains occurs in September to November. Crop farming and livestock rearing are predominantly practiced form of livelihood. The most preferred livestock's reared in the study area are chicken, cattle and sheep, while the popular crops grown by rural households are maize, wheat, beans, fruits and vegetables such as kales and cabbages.

### *Sampling Procedure, Data Collection and Analysis*

Multi-stage sampling was used in selecting sample units where urban areas formed excluded criteria, while systematic random sampling was used in administering questionnaires for data collection. To reflect systematic sampling, reference point was established such as junction of the road and immediate household on the right

hand side from reference point was selected as first respondents. The right hand rule pattern was used in choosing path or route, while subsequent samples were selected from every fifth household. The sample size determination used the following formula;

$$n = \frac{NC^2}{C^2+(N-1)e^2} \text{ (Kothari, 2004)} \quad (5)$$

Where; n represent sample size, N is population size, C is coefficient of variation of (30%), while e is the margin of standard error at 2% confidence level.

The rural households which were the target population were projected from 61.3% proportion from entire households' population of 147,939 of the study area (KNBS, 2010). Therefore, target population was 90,687. Hence, sample determination was;

$$n = \frac{90{,}687(0.3)^2}{(0.3)^2+(90{,}686-1)0.02^2}$$

$$n = \frac{8{,}161.83}{36.36} = 224$$

To compensate non response households, unclear or erroneously entered data and missing data which could invalidate the findings, another 10 household questionnaires to make 234 were added which represented 5% of the required sample size for this study.

Hypothetical market question was formulated in questionnaires which were asking respondents to state the land size that they would allocate for bequeathed woodlot. The land utilities from stated land size necessitated the determination of forgone income, while households' demographics, socio-economic variables and household's characteristics such as age, education level, household size, occupation, income, agro-ecological condition of land, existence of woodlot, distances to the forest, households' expended costs in obtaining forest products, costs of establishing woodlot and total expended costs on utilities by households formed independent variable in this study.

To establish households' foregone income, agricultural outputs ($x_i$) from the foregone crop or compensating costs such as animals feeds equivalent with forgone grazing land was used. The real or relative market price ($p_i$) of the forgone land utilities was used; that's, the ($i^{th}$) crop output from foregone farmland was multiplied with respective market price ($p_i$) to give economic value ($p_i x_i$) as expressed in equation function as follows;

$$\text{Foregone Income} = \sum_i^n \left\{ \frac{(p_i x_i - c_i)_1}{n_i} + \frac{(p_i x_i - c_i)_2}{n_i} + \frac{(p_i x_i - c_i)_3}{n_i} + \dots \frac{(p_i x_i - c_i)_n}{n_i} \right\} \quad (6)$$

Where; $\frac{(p_i x_i - c_i)_2}{n_i}$ represent foregone income from specific farm venture (1, 2, 3.....n) such as wheat, maize, beans, millet, potatoes, vegetables, animal feeds, passion fruits and grazing land.

Existence of large figures and dummies prompted transformation of data into natural logarithms to ease analysis and interpretation from inferential tests;

$$\text{LnForgone Income} = \beta_0 + \beta_1 Ln_{age} + \beta_2 Ln_{Edu} + \beta_3 Ln_{Hpnsz} + \beta_4 Ln_{Occpn} + \beta_5 Ln_{Income} + \beta_6 Ln_{Ldsz} + \beta_7 Ln_{Wdlot} + \beta_8 Ln_{Ldxtics} + \beta_9 Ln_{Distfrst} + \beta_{10} Ln_{Frstpdcts} + \beta_{12} Ln_{Wdcost} + \beta_{13} Ln_{Utilities} + \text{Ln}\varepsilon_i \quad (7)$$

Where; $\beta_0$ - model "intercept"; $\beta_1, \beta_2, \beta_3, \beta_4 \beta_5, \beta_6, \beta_7, \beta_8 \beta_9, \beta_{10}, \beta_{11} and\ \beta_{12}$ are coefficients of determinants, where $age$ – age, $Edu$ – education level, $Hpnsz$ - household size, $Occpn$ –occupation, $income$–income, $Ldsz$ - land size, $Wdlot$ – existence of woodlot, $Ldxtics$ – land characteristics, $Distfrst$ – distance to the forest, $Frstpdcts$ – forest products, $Wdcost$ –cost of establishing woodlot, $Utilities$ – total households utilities and $\varepsilon_i$- error term respectively.

However, binary functions are often difficult to estimate using linear probability model, because the predictor value in OLS model are not constraint to the specific values. Therefore, to give meaningful statistics binary functions was estimated through maximum likelihood methods of Logit model which impose restrictions on the values of independent variables within the probabilities at intervals of 0 to 1. The logit model postulates that the probability of households' to forego income for bequeathed woodlot is a function of households' characteristics. The significances influences of computed probability value (P) from Logit model function closer to 1 reveals the variable to have high probability, while zero or near zero value shows low influencing probabilities to that specific parameter estimator. The probability values from logit model can also be converted into percentages. The logit model function is specified as:

$$p(i) = \frac{e^{\beta n}}{e^{\beta n}+1} \quad (8)$$

Where; $p(i)$ is the probability by households' to forego income for bequeathed woodlot, while $e^{\beta n}$ is the natural logarithms to the power of the coefficients of an exploratory variable.

## Findings

### *Households Socio Economics and Land Use Characteristics*

Table 1 shows selected variables that were used to describe rural households' characteristics. The average age of respondents was 54.96 years, which depicts

fairly elderly population. Out of 234 respondents interviewed, there were more female than male at 57.7% (135) and 42.3% (99) respectively, suggesting the norm in African set up where females often engage in domestic and house chores which make them to be occasionally found at their rural homes, while males who are regarded as household providers are often engage in external household's activities such as farming for their families. This finding concurs with study of African Women Studies Centre, (2014). In regards to education level, majority had moderate education level; hence low skilled manpower, suggesting the need for extension services in regard to conservation knowledge from environmental experts. Also, engagements of household in agricultural activities (83.8%) and modest family size of 9 persons per households, explains propensity of rural homes to degrade environment.

**Table 1**
*Household Demographic and Social-Economic Characteristics*

| Variables | **Frequency** | **Mean** | **Std Deviation** | **Std Error** |
|---|---|---|---|---|
| Age | 234 (100%) | 54.96 years | 10.44 | 0.68 |
| Gender | | | | |
| **Male** | 99 (42.3%) | - | - | - |
| **Female** | 135 (57.7%) | - | - | - |
| Household size | 234 (100%) | 8.44 persons | 2.2 | 0.14 |
| Education | | | | |
| **No Education** | 9 (3.8%) | - | - | - |
| **Primary level** | 73 (31.2%) | - | - | - |
| **Secondary level** | 127 (54.3%) | - | - | - |
| **Tertiary Level** | 22 (9.4%) | - | - | - |
| **University Level** | 3 (1.3%) | - | - | - |
| Occupation | | | | |
| **Farmer** | 196 (83.8%) | - | - | - |
| **Trader** | 9 (3.8%) | - | - | - |
| **Civil Servant** | 17 (7.8%) | - | - | - |
| **Informal Sector** | 12 (5.1%) | - | - | - |

*n=234*

Again, land partitioning in Figure 2 describes households' characteristics in regards to economic activity where mixed farming was predominant as livelihoods source. Therefore, results from land layout for various farm ventures reveals rural households preference in income diversification especially to crops farming venture than livestock rearing. High proportion of land partitioned for crop farming venture suggests the importance of crop investment as the most relied households' livelihood source.

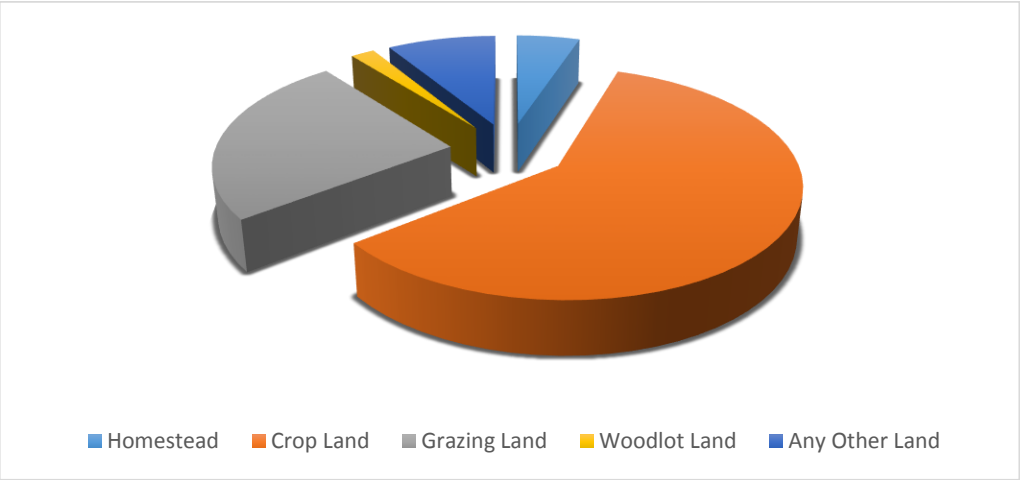


***Figure 1:*** Households Land Use Pattern and Partitioning in the Study Area

**Effect of Foregone Income on Households' Welfare and Conservation**

The mean households' income per year from all sources was 7614.23 USD and the average foregone income for conservation by households was 234.19 USD, implying that households' welfare would be constrained at 3.08% percentage point, while forest cover that could be realised from expressed willingness to forgo land utilities for conservation was 0.86 acres. Therefore, the forest lands at private land as shown in Table 2 would increase from 0.46 acres to 1.32 acres per households, which represent about 87% forest cover improvement.

**Table 2**
*Impact of foregone income on forest cover Improvement*

| Households Income | Foregone income | Welfare effect (-) | Percentage change |
|---|---|---|---|
| 7614.23 USD | 234.19 USD | 7380.04 USD | 3.08% |
| Existing Woodlot on private lands | Allocated land for woodlot | Forest cover Improvement (+) | Percentage Change |
| 0.46 acres | 0.86 acres | 1.32 acres | 86.96% |

Note: all household 234 (100%) expressed to allocate land or increase add some acreage for households with existing woodlot in their land for bequeathed woodlot, while 87 (37.2%) had woodlot in their lands; Currency exchange rate is Kshs 100 = 1USD.

***Determinants of Households Foregone Income for Bequeathed Woodlot***

Results from inferential tests for multi-collinearity among predictor variables using Tolerance Value and Variance Inflation Factor (VIF) threshold in Table 3 revealed no dependency among the predictor variables in OLS model, while analysis of variance (ANOVA) ($F = 3.233$, $p < 0.05$) that determine goodness of fit in regression

models showed to be statistically significance. Adjusted $R^2$ value from the results, showed to explain 36.8% of the variation in the model, indicating the selected variables fit the estimated models well.

The construct of households' size from study results showed to be negatively and statistically significance at (-1.857, $p< 0.1$) with influencing probability of 26.5%, suggesting that increasing numbers in family makes households heads to unlikely forego income for bequeathed woodlot. This influence could manifest from consumptive demands especially from large households size that are highly dependent on farming as their source of livelihood. Study by Baland et al., (2010) concurs with this study findings were large families that exhibits high consumptive demands limits reinvestment due to low income surplus and/or savings, while study by Ayalew and Deininger (2012) viewed large family size to provides labour in agricultural production and conservation venture.

Similarly, existence of woodlot in households' farm was also found to be negatively and significance at (-2.501, $p< 0.05$) with probability to influence at 41.9%, suggesting that households with already established woodlot in their farms were reluctant to cede extra acreage for bequeathed tree planting. These study findings concurs with that of Ndambayaje (2013) who found existence of coppicing tree species to make household to be reluctant in engaging further in tree planting. The variable of land conditions showed to positive and statistical significance at (1.784, $p< 0.1$) with about 60% influencing probabilities for households forego income, revealing the rationale choice by households on resource maximization based on theoretical considerations of Von Thunen theory guided by economic returns on land rent if by chance rural households were faced with two extreme scenarios of land characteristics such as having fertile and infertile land.

Table 3

*Logit Model Results and the Probabilities of Variables Influencing Rural Household's Decision Making to Forego Income for Bequeathed Woodlot*

| **Variables, x.** | **Coefficient** | **Std Error** | **Logit Value (P)** | **t-test** |
|---|---|---|---|---|
| Constant | 2.793 | 6.514 | | |
| Age | 0.195 | 0.471 | 54.8% | 0.415 |
| Years in formal education | - 0.668 | 0.425 | 33.9% | - 1.571 |
| Household population | - 1.018 | 0.548 | 26.5% | - 1.857* |
| Respondents occupation | - 0.053 | 0.284 | 48.7% | - 0.185 |

| | | | | |
|---|---|---|---|---|
| Household land size | 0.517 | 0.374 | 62.6% | 1.382 |
| Household with woodlot | - 0.325 | 0.130 | 41.9% | - 2.501** |
| Land condition | 0.428 | 0.240 | 60.5% | 1.784* |
| Household Income | - 0.161 | 0.329 | 46.0% | - 0.490 |
| Distance to the forest | - 0.314 | 0.232 | 42.2% | - 1.348 |
| Consumed forest goods | 0.766 | 0.445 | 68.3% | 1.720* |
| Woodlot establishing Cost | 0.992 | 0.275 | 72.9% | 3.609*** |
| Household utilities costs | - 0.529 | 0.380 | 37.1% | - 1.392 |
| Stochastic variable | 0.702 | 0.099 | 66.9% | 7.113*** |
| F value | | | | 3.233** |
| Adjusted $R^2$ | 0.368 | | | |

n=234; β = predictor of variable; S.E is the standard error; P(i) = probability of predictors from Logit model converted into percentages; Statistical Significance of variables (p-values) are in hysterics (*** p< 0.001, ** p< 0.05 and * p< 0.1);

Further, the construct of consumptive demands on forest products was positive and statistically significance at (1.720, p< 0.1), implying that households' that were highly dependent on forest products as sources of their livelihood were likely to forgo income for conservation at 68.3% probability prediction. While predictor variable of estimated cost for establishing woodlot such as seedling, transportation and labour cost showed to be positive and statistical significant at (0.992, p< 0.001), with 72.9% probability, suggesting that respondents that expressed high estimates of costs for establishing woodlot had high aspiration for conservation; hence, willing to forgo income for bequeathed woodlot.

However, the random factor in the model which showed to be statistical different at p< 0.001, with positive influencing probability of about 70% for household to forego income for tree planting in woodlot, depicts the existence of some critical variables that remained unobserved or were omitted. These omitted variables form part of the limitation of this study. Although other variables such as age, education level, households head occupation, land size, income, distance to the edge of the forest and households' utilities were non critical in influencing households decision making to forgo income for bequeathed woodlot, their direction of influence and level of probabilities still remain important and therefore, need to be considered while formulating policies and developing conservation programmes.

**Conclusion**

Use of forgone income reveals households' aspiration in regards to resources conservations; hence, it can act as an alternative ecosystem valuation approach. However, households' aspiration through forgone income for conservation was influenced by demographic and socio-economic determinants. The constructs of existence of woodlot in households' farm and family size showed that it impedes rural households to forego income for bequeathed woodlot, while dependency on forest products by rural homes for livelihood and agro-ecological condition of land influenced the desire for rural homes to invest into woodlot in their farms for future generation.

***Policy Recommendations***

Therefore, the identified critical variables that influenced households' decision making to forego income for bequeathed woodlot would trigger the need for policy formulation. Developing Policy that focuses on dissemination of environmental extension services from environmental experts on suitability of specific tree species on land conditions such as wetlands or riparian lands based on statistical significance is needed. Again, introduction of policy incentives on farm input costs and/or energy could lessen household's income constraints, which possibly could allow rural households to have surplus income to invest into conservation venture of bequeathed woodlot or to offsets costs for establishing woodlot. Further, significance of stochastic variables in the regression model, which explain critical variable omitted in the study, form the basis for further investigation.

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