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# Determining farmer's preferences for land use practices under payment for environmental services in Lake Naivasha basin-Kenya

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**ABSTRACT**
This paper evaluates determinants of farmer's preference for sustainable land use practices under Payment for Environmental Services (PES) scheme in three sub-counties of Nakuru County in Kenya. Data were collected from 200 randomly selected farmers. Choice modeling related to preference technique based on random utility theory was applied to analyze data. Results show 93% of farmers were influenced to implement PES and 61.5% preferred practices with particular attributes such as provisions of fodder for livestock, soil retention, soil and water conservation. The PES practice choice was influenced significantly by household socio-economic characteristics including gender, income, soil retention and fertility. This study recommends for increased awareness creation and training on PES concept benefits among farmers and private sector. The awareness will enable farmers make informed farm practice choices. PES farm practices with positive attributes on agro-ecosystems restoration and farmer's socio-economic considerations needs to be promoted as incentives for PES interventions adoption. The study further recommends involvement of more private sector to invest in PES voluntary scheme and the need for stakeholders to integrate PES concept in agriculture extension to ensure more farmers participation for improved farm productivity on scale and to sustain PES practices. This study propose for the government to institutionalize PES as national natural resource policy to enhance sustainable ecosystems management for provision of environmental services and economic development in the long run. This will strengthen PES promotion as conservation and livelihood enhancement tool in other watershed in Kenya.

Key words: Determinants, ecosystem services, Kenya, land use practice, livelihood, PES, preference

**RÉSUMÉ**
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## INTRODUCTION

Agriculture sector contributes over 20 % to the GDP and provides above 70 % of job opportunities in sub-Sahara African countries (UNDESA, 2008; WWC, 2011). Land agro-ecosystems provide a wide range of ecosystem services (DEFRA, 2007) including supporting services notably soil formation and retention, provision of habitat, nutrient cycling, water cycling and provisioning services such as food and water. Land and soil nutrients are key factors of production associated with agricultural practices and land use practices define the soil nutrient cycling value capacity which bears significant influence on agricultural ecosystems. Even though agriculture plays vital global role as the main on-farm occupation (WBCSD and IUCN, 2008), most farming systems face challenges ranging from agro-ecosystems degradation, limited access to farm inputs, partial knowledge and skills to increase productivity through alternative sustainable farm practices for livelihoods enhancement.

However, the increasing global human population currently projected at over 9.1 billion people (FAO, 2009) depend on smallholder farmer's for food supply. Increasing human population is exerting pressure on fixed land resource leading to unsustainable land use practices such as encroachment on conserved areas to expand farmland. Changes in land use practices in rural areas are multifaceted, but largely driven by land users seeking to increase economic returns resulting in human induced ecosystem degradation (Minang *et al.,* 2007). Some of the anthropogenic unsustainable land use practices include clearing and burning of vegetation cover, cultivating on high slopes and riparian areas that expose soil to erosion, nutrient depletion through over cultivation and pollution from overuse of agro-chemicals.

Ecosystem services (ES) are products provided by the natural environment and are categorized on the basis of Millennium Ecosystem Assessment (MEA, 2003) framework as provisioning services, regulating services, cultural services and supporting services. (DEFRA, 2007). Most regulating and supporting ecosystem services lack direct market though are important input services for provisioning services mainly food for household's food security.

Soil and water conservation technologies have been implemented in many watersheds to maintain or rehabilitate degraded agro-ecosystems so as to restore ecosystem services. Alternative interventions have been promoted under Payment for Environmental Services-PES schemes. In addition, PES incentive mechanisms have been implemented to restore watershed ecosystem services through sustainable land use practices aimed at improving farm productivity to balance environmental conservation with socio-economic development. In Kenya, different alternative farm practices have been designed to address conservation and livelihood enhancement. Payment for Environmental Servicesin Lake Naivasha watershed is one of the schemes focused on watershed management for water quality, quantity and improvement of smallholder farmer's livelihoods through rehabilitation of degraded agro-ecosystems as visualized core benefits for

[1] PES is market based scheme generally defined by Wunder (2005) and Engel *et al.* (2008) as mechanisms which fit five sets of conditions; a voluntary transaction where, a well-defined environmental service (or land use likely to secure that service), is being "bought" by at least one buyer, from a environmental *service provider*, if, and only if, the environmental *service provider* secures environmental service provision (conditionality).

buyers and sellers of ES, respectively. The PES scheme is envisaged to have pro-poor potential to reduce farmers' poverty (Bond and Mayers, 2009) by increasing farm productivity. Prioritized PES land use practices for soil and water conservation in Lake Naivasha watershed include; rehabilitation and maintenance of riparian zones through tree planting, grass strips, terracing along steep slopes, fallowing and reduction in agrochemicals use and agro-forestry.

Although different PES interventions are under implementation by selected farmers to restore degraded agro-ecosystems, information on individual farmer's choice and preference determinants for particular PES interventions is still limited.This study was undertaken to fill this gap. Preference is particularly important as key attribute for individual farmer's acceptance of farm practices. This study was based on the premise that farmers will desire to implement farm practice for achievement of short and long term farm benefits including maintenance of agro-ecosystems to enhance productivity as key provisioning ecosystem services. Based on this premise, it was postulated that farmers would prefer practices with attributes that combine achievement of environment conservation and their socio-economic wellbeing under PES scheme. However, farmers tend to select practices based on attributes that meet their expected outcomes and preferences.

The objective of this study was to determine and characterize farmer's preference for PES farm practices and identify factors that influence their preference  based on choice modeling and contingent techniques.This study tested the hypothesis that there are no significant socio-economic attributes which influence farmer's preferences for land use PES conservation practices.

The PES concept has generated increased global interest as alternative incentive tool for conservation and livelihood linkage in agricultural production landscapes. The importance of this study arises from the need to understand if farmer's wisdom of choice for PES practices scheme is influenced by socio-economic household factors.  Informed choice for PES conservation practices has significant implication on reversing agro-ecosystem degradation trend to improve farm productivity and supply of other ecosystem services including clean water flowing downstream to support commercial investment. Landscape rehabilitation restore smallholder farmers' livelihoods including increase in household income and food insecurity.

Famer's preference has been estimated through several approaches and choice modeling related to stated preference (SP) techniques has been widely applied. Stated preference technique requires respondents to choose their preferred conservation technology. The choice model is based on random utility theory (Jordan *et al.,* 2007), developed by Thurston (1927) for discrete choice models consistent with conditional logit models relating to broad choice options, linear and additive indirect utility functions. Choice model is useful for modeling individual's preferences of alternatives. Likewise, a multi-attribute compositional contingent valuation model is useful in assessing preferences for goods and services which lack well-defined market. Because of heterogeneity amongst farmer's tastes and preferences for utility satisfaction, it was essential to model individual farmer's choices for easy estimation of individual farmer's parameters.

**Framing of PES practices in agricultural ecosystems in three sub-counties.** Payment for Environmental Services farm practices in three sub-counties (Nyandarua South, Kinangop and Kipipiri) of Nakuru County in Kenya was initiated based on the need to restore degraded farms in the watershed for provisioning and regulating services. The PES mechanism was initiated by World Wide Fund for Nature and Care-Kenya in 2008 as the intermediary organizations. The project targeted smallholder farmers in Aberdare ranges which are the main head water source for Lake Naivasha. Smallholder farmers upstream were sellers of watershed services while commercial horticultural farmers downstream were the main buyers of watershed services. The project aim is to restore water quality and quantity as service demanded downstream through incentive mechanism to farmers upstream to implement sustainable farming practices. The practices are envisaged to reduce silt load and pollution in water bodies that flow to the Lake Naivasha downstream. The Lake has no surface outlet and depends on recharge from River Malewa flowing from the upper catchment. The PES scheme therefore provides alternative sustainable farm practices that combine conservation of agricultural ecosystems and livelihoods enhancement.

## METHODOLOGY

**Study area.** Lake Naivasha watershed ($0^0$ 08´ to $0^0$ 46´S and $36^0$ 14´ to $36^0$ 43´ E) covers average area of 3,400 $km^2$ (Githaiga, 2012). Lake Naivasha basin has upland forests that form essential watershed catchments and provide water to diverse ecological habitats and also supports livelihoods and economic development. The upland forests are important water towers for Lake Naivasha in Rift Valley and EwasoNgiro, Tana and Athi basins. Main rivers draining into Lake Naivasha are Malewa, Gilgil and Karati (seasonal). The PES scheme is located at the western foothills of the Aberdare ranges, the main catchment area of the Malewa River crucial for both Kenya's horticulture and tourism industry around Lake Naivasha. The sample frame was farming households implementing PES scheme under two Water Resource Users Associations (WRUAs); Upper TurashaKinja located in Nyandarua South, Kinangop sub-counties and Wanjohi WRUA located in Kipipiri sub-county.

**Sampling and sample size determination.** Sample size was empirically determined using the formula adopted from Alpizar *et al.* (2001):

$$n = \frac{Z^2 PqN}{e^2 (N-1) + Z^2 Pq} \quad \text{.................................} \quad 1$$

Where;
$n$ = sample size
N =population size (PES households) = 476
P = population reliability (frequency estimated for a sample of size $n$)
q = 0.5 considered for all developing countries population and p + q= 1 (where q=1- p = 0.5)
e = 0.050 error margin
$Z\alpha/2$ = normal reduced variable at 0.05 level of significance/confidence level and z is 1.96

From formula 1, the sample size n was determined;

$$n = \frac{1.96^2\ (0.5*0.5*476)}{0.05^2\ (476 - 1) + 1.96^2 * 0.5 * 0.5} = \frac{457.15}{2.15} = 213.63$$

Two-stage sampling probability proportional to size was used to stratify two WRUAs as primary sampling units. In the first stage, nine sites (four in Upper TurashaKinja; Mutamaiyu, Kianguyo, Mutarakwa/Kinja, Tulaga and five in Wanjohi WRUAs; Geta, Gitei-Gatondo, Kiamboga, Mikeu, Rayeta) were purposively selected from twelve PES zoned village sites. The second stage involved random selection of household heads from verified source list of 476 farmers in nine sites, giving a total of 213 farmers as sample size (109 from Upper TurashaKinja WRUA and 104 from Wanjohi WRUA).

**Data collection and analysis.** Secondary data were collected by reviewing selected documentedliterature while primary data were collected with the help of semi-structured questionnaire administered to sampled PES implementing farmers. Different sets of non-market attributes for PES farm practices were listed and subjected to individual farmer's preferences. After data collection and triangulation, 13 questionnaires were detected as spoilt therefore discarded and 200 questionnaires were used for further analyses. Coded data were analyzed using qualitative descriptive techniques in STATA version 12.0 and SPSS version 17.0. Logit regression was used to estimate household choices of conservation land use practices and to characterize factors influencing farmers' preference for PES farming practices.

**Empirical Modelling**. Choice experiments have been widely used to measure individual's preferences in different disciplines including economics (Swait and Adamowicz, 2001) and environmental economics (Hanley *et al.,* 1998). Choice experiments are regarded important valuation tool for studies on non-market goods for example the ecological value of ecosystem services which was therefore applicable to determine farmers' preferences for different PES conservation measures (Chapika and Andreas (2009).

Conditional Logit model was used because of its consistency with random utility theory (RUT). Choice modelling was applied to determine farmers' preference and choice of conservation technology practice (s). Choice was assumed to be guided by farmer's expected utility satisfaction derived from attributes that influenced socio-economic and environmental conservation. Random utility model is based on adding stochastic terms to the deterministic utility of each alternative in the choice set, Y for instance. In this study, analysis was based on RUT (McFadden, 1974) which assumed the individual utility function $U_i$ takes the form;

$$U_{i\,(y)} = V_{i\,(y)} + \varepsilon_{yi} \text{ for all } y \in Y \quad 2$$

Where $V_i\ (y)$ is the deterministic utility the *ith* individual associates with a particular choice y and $\varepsilon_{yi}$ is the stochastic term for individual choice ordinarily assumed to be extreme value distributed independently and identically (IID) and the choice set Y of conservation technologies typically assumed to be discrete. If alternative *j* is chosen then $U_j > U_y$ for all $y \neq j$ and if individual maximize $U_i(y)$, this gives rise to choice probability expressed as:

$$P(y) = P\,(V_i + \varepsilon_i) > (V_y + \varepsilon_y) \text{ for all } y \in Y \quad 3$$

Where, Y is a set of possible conservation technology choices. Since PES technologies are not directly marketed and are not consumption products, farmers derive satisfaction from technology attributes. Therefore, the farmer's utility function takes the form:

$$U_{ij} = V\,(a_j, z_j) + \varepsilon_i \quad 4$$

Where selected *ith* respondent utility is related to *jth* PES conservation technology alternative. From Hanemann (2007), consumer utility is also influenced by y's attributes. This implies that utility derived from any of technology alternatives depends on the attributes $a_j$ of technology and farm/farmer's own characteristics $z_i$ for instance (age, education) both denoted by $a_1\ldots\ldots, a_N$ and $z_1\ldots\ldots, z_f$, respectively. The utility function of individual farmer can then be stated as:

$$U_{ij} - v\,(a_j, z_j) + \varepsilon\,(a_j, z_j) \quad 5$$

With probability that an individual chooses the alternative which maximizes the deterministic utility of the other alternatives with higher utility. Based on the conditional logit model (CLM) modified from Cappelen *et al.* (2010), equation 5 can be written as:

$$P\,ij = \frac{e^{\,v\,(a_{ij},\, z_i)}}{\sum_{y \in Y} e^{\,v\,(a_{ij},\, z_i)}} \quad \text{for all } y \in Y \quad 6$$

Where y is one of the probable conservation alternatives in data choice set Y. Therefore,the individual indirect utility function is estimated as:

$$V_{ij} = \beta_0 + \beta_{1a_1} + \beta_{2a_2} + \ldots\beta_{na_n} + \delta_{1z_1} + \ldots\delta_{fz_f} + \varepsilon_i \quad 7$$

Where;

$V_{ij}$ = deterministic utility of ith individual associates with a particular *jth* choice or y PES practice

$\beta_0$ = Constant (intercept)

$\beta_i$ and $\delta_i$ = Vector of coefficient $\beta_1$ to $\beta_n$ and $\delta_1$ to $\delta_f$ of unknown parameters to be estimated (where; is = 0, 1, 2…n; 0, 1, 2,…f, respectively), $\beta_1$ to $\beta_n$ and $\delta_1$ to $\delta_f$ are attached to vectors of technology attributes a and farmers socio-economic interacting characteristics z which could influence utility and

preference
$n$ = number of conservation technologies with specific attributes
$f$ = number of farmers own characteristics
$\varepsilon_i$ = is the stochastic term
Selection of preferred alternative farm practices was important to achieve PES scheme goals of conservation and livelihoods enhancement as the basis for sustainable economic improvement.

## RESULTS AND DISCUSSION

**Household characteristics.** Table 1 shows that 134 males and 66 female farmers were interviewed with variation in household age ranging between 27-98 years, mean of 54 and mode of 40 years. Literacy varied among the respondents and 62.5% had primary education, 18.5 % had achieved high school education, 1.5 % college/University level of education and 17.5 % had not received formal education. The mean average family size was 6 family members.

Table 2 shows land use and main farming goals. Over 88% of the farmers interviewed practiced mixed farming (crops and livestock keeping). Dynamic combination could be an on-farm strategy to spread-out farm risks for both livestock and crop enterprises and therefore improving household resilience from effects of natural calamities like pests and diseases, floods and climate change related effects on farm practices. Combination of food security and income generation was the main farming goal reported by 71.6 % of the respondents. Other farmers indicated farming goals as food security and to earn income (12.5 and 16 %, respectively).

Table 1. Household characteristics

| Variable description | Count | %response | Range | Mean | Mode | Std. Deviation |
|---|---|---|---|---|---|---|
| Sex of household head | | | | | | |
| Male | 134 | 67 | | | | |
| Female | 66 | 33 | | | | |
| Household head age | | | 27-98 | 54.19 | 40 | 15.14 |
| Household head education level | | | | | | |
| None | 35 | 17.5 | | | | |
| Primary | 125 | 62.5 | | | | |
| High school | 37 | 18.5 | | | | |
| College/University | 3 | 1.5 | | | | |
| Household family size | 200 | | 1-17 | 5.76 | 5 | 3.139 |
| Valid N (Listwise) = 200 | | | | | | |

Table 2. Land use and main farming goals

| Variable description | Frequency | % Response |
|---|---|---|
| **Land use systems** | | |
| Farming/crop | 17 | 8.5 |
| Livestock keeping | 6 | 3.0 |
| Farming/crop and Livestock | 177 | 88.5 |
| Total | 200 | 100.0 |
| **Main farming goals** | | |
| Food security | 25 | 12.5 |
| Earn income | 32 | 16.0 |
| Food security and income | 143 | 71.5 |
| Total | 200 | 100.0 |

The mean average land size was 2.47 acres (0.99 ha) per household. Land is the main source of ecosystem services including provisioning services such as food. Overdependence on land for food security compounded by small land sizes leads to over cultivation and subsequent land degradation. Famers would, therefore, prefer PES practices that conserve agro-ecosystems in order to sustain provision of ecosystem services

Table 3 shows challenges farmers faced before PES scheme was initiated. Soil erosion was the main challenge reported by 35 % of farmers. Soil erosion is linked to low farm yields observed by 33.5 % farmers, which is explained by depletion of soil fertility levels leading to low productivity. These findings corroborate similar results in Naivasha PES scheme feasibility studies by Gathenya and WWF-CARE Kenya (2007) which contributed to identification of hydrological and diminishing livelihood problems.

**Preferences for land use PES conservation interventions with attributes to influence on socio-economic and environment conservation.** Table 4 indicates that over 90% of the respondents were influenced to engage in PES practices while 87% preferred particular PES practices implying that households valued PES practices. Given the heterogeneous nature of households, varied preferences is an indicator of individual farmer's derived maximum utility from PES practices in terms of socio-economic and environmental benefits.

Figure 1 shows the attributes of various interventions hypothesized to influence farmer's choice of particular PES practices. Provision

Table 3. Land use challenges

| Land use challenge | Frequency | % Response |
|---|---|---|
| Low yields | 67 | 33.5 |
| Pests and diseases | 21 | 10.5 |
| Soil Erosion | 70 | 35 |
| Decreasing land use size | 7 | 3.5 |
| Pollution of water sources | 4 | 2 |
| Floods | 2 | 1 |
| Lack of financial capital | 8 | 4 |
| Lack of water for irrigation | 1 | 0.5 |
| High prices of farm inputs | 2 | 1 |
| 1 and 7* | 1 | 0.5 |
| Lack of market for farm produce | 3 | 1.5 |
| Human-wildlife conflict | 1 | 0.5 |
| Frost | 6 | 3 |
| None | 1 | 0.5 |
| Poor roads | 2 | 1 |
| Water scarcity | 4 | 2 |
| N=200 | | |

Table 4. Influence to practice PES and PES preference

| Variable description (N=200) | Frequency | | Statistic | |
|---|---|---|---|---|
| | No | Yes | Mean | Range |
| Influenced to practice PES (0=No; 1=Yes) | 14 | 186 | 0.93 | 0-1 |
| Preference for PES practice (0=No; 1=Yes) | 27 | 123 | 0.87 | 0-1 |

of fodder for livestock, soil retention, soil and water conservation were significant attributes that influenced choice as reported by 23 %, 14 % and 9 % of the farmers, correspondingly. Findings relate farmer's need to improve farm productivity as influenced by soil fertility levels and to mitigate livestock feeds scarcity as plausible factors that influence productivity for provision of regulating and provisioning services.

The need to rehabilitate degraded land to retain soil on farms, reduce siltation in water flowing downstream as provisioning service demanded by commercial farmers the buyers of ecosystem services influenced famers to choose particular PES practices. Desire to increase productivity also influenced farmers preferences for interventions expected to expedite soil fertility restoration on degraded farms. Source of food and soil fertility improvement significantly influenced farmers' choices of PES practices. The PES interventions which ensured households food security through restoration of soil fertility were highly preferred. However, there were other farmers' preferred PES interventions with combination of attributes. From Figure 1, combination of fodder for livestock and soil-water conservation were significant attributes indicated by 5.5% of the respondents. Preference for a combination of attributes to guide choice for PES practices explains farmer's expectation to realize multiple benefits from implementation of PES scheme farming practices. Soil retention is essential for soil nutrient cycling and fertility improvement. They are key regulating services for improvement of provisioning services related to food and clean water. Source of food/nutrition provisioning service was an important attribute associated with fruit trees in addition to enhancing regulating services such as climate moderation, soil structure and soil formation services.

**Socio-economic factors determining farmer's preference for land use PES conservation.** Results presented in Table 5 show determinants of farmer's preference for land use linked to PES on-farm practices. Gender was significant (P>z

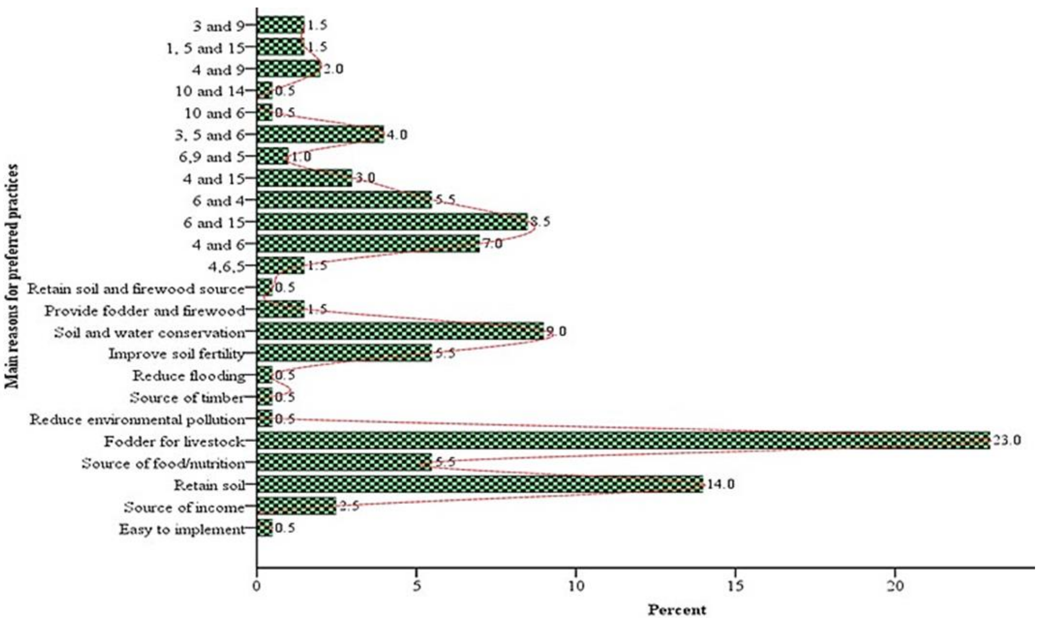


Figure 1. Attributes of PES farm practices.

Key; 1=Easy to implement; 2=Less expensive; 3=Source of income; 4=Retain soil; 5=Source of food/Nutrition; 6= Fodder for livestock; 7=Reduce environmental pollution; 8= Source of timber; 9= Source of firewood; 10=Reduce flooding; 11=Manage frost; 12= Prevent pests and diseases; 13=Wind break; 15=Soil and water conservation; 16=Provide fodder and firewood; 17=Retain soil and firewood source

=0.082) and explains how PES interventions were preferred by men and women. Interventions such as terracing are physically demanding and time consuming, as such they are less attractive for women, while planting of fruit trees, grass strips and practicing agroforestry were considered to be less labour intensive and provided tangible benefits quickly. Selection of PES interventions were also based on level of land degradation and gender (WWF-CARE Kenya, 2007; Nyongesa, 2016).

Age was a significant factor that influenced farmer's choice of on-farm PES practices (P>z =0.054). The mean age was 54.19 years and at this age, farmers would consider selecting less strenuous PES farm practices. In a related study, Kisaka and Ajuruchukwu (2015) found that gender and age have a positive influence on choice for PES practices. Land tenure was significant factor (P>z =0.006) that determined farmers' choice of on-farm PES practices. Secured land ownership influences the type of farm activities and PES practices preferred. Interventions that require long term to establish such as terracing and tree planting would be associated with private land ownership as opposed to practices that required short time to establish for instance grass strips.

The PES mechanism design is market based and requires seller-buyer negotiations to voluntarily accept to sell and buy environmental services respectively. To make such decisions, the farmer must own the land as a requirement. Farmers are land stewards and land ownership as part of property right requires that incentive or payment from buyers of ecosystem directly benefits land owners implementing PES interventions to provide ecosystem services. Land is a key natural asset and an essential factor that influenced respondents' preference for on-farm PES practices. The PES scheme links upstream smallholder farmers and downstream investors through mutual agreement. Famers are paid by investors for farm opportunity cost foregone to implement conservation practices creating market for ecosystem services.

Table 5. Determinants of farmer's preferences for land use

| Variable description | Coef. | Std. Error | z | P>z |
|---|---|---|---|---|
| Preference for PES practice choice | | | | |
| (0=No; 1=Yes) | | | | |
| Food security | 0.527 | 0.621 | 0.850 | 0.396 |
| Household gender | -0.857* | 0.492 | -1.740 | 0.082 |
| Household head age | -0.036** | 0.019 | -1.930 | 0.054 |
| Land tenure | 0.600*** | 0.218 | 2.760 | 0.006 |
| Soil retention | 1.168** | 0.587 | 1.990 | 0.047 |
| Prevent pests and diseases | -1.577** | 0.788 | -2.000 | 0.045 |
| Soil- water conservation | -0.309 | 1.154 | -0.270 | 0.789 |
| PES impact on soil fertility | 4.246*** | 1.913 | 2.220 | 0.026 |
| Poverty influence | -1.210 | 0.900 | -1.340 | 0.179 |
| Income source | 1.714*** | 0.596 | 2.880 | 0.004 |
| Flood reduction | 1.319*** | 0.626 | 2.110 | 0.035 |
| Land use system | -0.125 | 0.451 | -0.280 | 0.782 |
| - | 3.469 | 3.066 | -1.130 | 0.258 |

(***) significance at 1%, (**) significance at 5%, (*) significance at 10%, Logit estimates: Number of observations=200, LR $chi^2$ (12)= 28.6, Prob > $chi^2$=0.0045, Log likelihood = -64.8554, Pseudo $R^2$=0.1807

Soil retention was an important factor (P>z =0.047) preferred to improve soil fertility and increase farm productivity as regulating and provisioning service. Soil retention also reduced silt load in rivers and improved clean water flow downstream as ecosystem service demanded by buyers. Results corroborates a report by Shan *et al.* (2010) that the decision to implement PES practices is influenced by expected farm benefits. Reduction on agro-chemical use (P>z = 0.045) for pest and disease control was significant regulating service that determined farmer'schoice of on-farm PES intervention. Reduction on agro-chemical use was one of the key factors driving initiation of Naivasha PES scheme to reduce pollution of water bodies. High costs of agro-chemicals equally influenced choice of practices that would reduce farmers' use of agro-chemicals.

The envisaged PES impact on soil fertility (P>z = 0.026) is linked to soil retention. Several studies have associated PES' positive impact on soil fertility with high farm yields and food security. Robertson *et al.* (2014) reported that through PES schemes, farms could be readily managed to contribute to clean water, bio-control and other ecosystem benefits including long-term soil fertility, thereby promoting agriculture that is economically and environmentally sustainable. Declining farm productivity over time associated with decreasing soil fertility influenced respondents to choose intervention that would restore soil fertility. Soil fertility is important for enhanced productivity and therefore its significance in influencing selection of PES interventions was expected.

Income source (P>z = 0.004) influenced farmers' preference for PES practices. Farmers would prefer any practice that will increase their incomes. The alternative PES practices with such possibilities influenced preference. However, extension training received before and during PES implementation could have reinforced farmer's preferences for certain types of interventions.

Farmers also chose PES interventions that could control floods and reduce silt load in river ecosystems. Flood control is an important regulating ecosystem service. Flood reduction was significant (P>z = 0.035) and determined farmers preference for PES practice. Farmers chose PES interventions which could mitigate against natural externalities, notably, flood management. This could lead to subsequent reduction of silt load in river ecosystems thus enhancing clean water as an important service demanded by buyers downstream. Boko *et al.* (2007) reported that farmers are often concerned with strengthening their resilience against effects of climate change manifested by wide range of natural occurrences including floods. Therefore, there was need to safeguard against loss of livelihoods from destruction of crops and livestock enterprises, infrastructure and other non-agricultural enterprises. Interventions that enhance regulating services, for instance, run-off, floods and erosion control influenced farmer's preference for particular PES practices.

Figure 2 shows PES upstream farms on high gradient ground land before PES scheme was initiated. Figure 3 illustrates PES farms under PES grass strip and agro-forestry conservation structures while Figure 4 shows horticulture farms around Lake Naivasha. Figure 5 shows PES annual event when farmers received their payment from buyers of ecosystem services.

## CONCLUSIONS AND RECOMMENDATIONS

This study applied choice modeling to examine farmer's stated preference for PES farm practices. The study has shown that the majority of farmers are influenced to make PES practice choices and further reveal that variation in farmers' preference for PES practices is influenced by the socio-economic attributes for specific PES interventions. This study has shown that variables which significantly influenced preference were gender, age, land tenure, soil retention, prevention of pests and diseases, practice impact on soil fertility, income source and flood control. These factors are

Figure 2. Smallholder farms on steep slopes in the upper catchment. Photos: ICRAF, 2007.

Figure 3. Two smallholder farms under PES conservation grass strips and agroforestry interventions along contours in the Upper catchment. Photos: Nyongesa, 2012.

Figure 4. Aerial view of greenhouse horticulture farms (left) and one of the flower farm greenhouses around Lake Naivasha (right), inside greenhouse (Inset). Photos: WWF, 2013


Figure 5. Members of Upper TurashaKinja (left) and Wanjohi WRUAs (right display their dummy cheque during annual payment event by buyers of ecosystem services. Photo: Nyongesa, 2012.

important to consider in PES scheme design to improve adoption of PES practices among farmers to restore degraded farms and increase productivity. Based on findings, this study recommends for increased awareness creation and training on benefits of PES concept among farmers and increase involvement of private sector as buyers of ecosystem services. This will enable farmers make informed choices for PES farm practices with positive attributes on agro-ecosystems restoration and farmer's socio-economic needs as incentives for practice adoption and sustainability. The adopted practices restore farm productivity and improve production of other ecosystem services including water flow to support commercial investment downstream. Promotion of PES schemeis recommended to strengthen the mutual business linkage between smallholder farmers upstream and the private sector downstream as sellers and buyers of ecosystem services, respectively. The payment provides additional income to households and is an incentive to smallholders to sustain the PES interventions for watershed management. The study further recommends for integration of PES concept in agriculture extension sector to ensure more farmers participate to improve their farm productivity, food security, income generation and conserve landscapes on scale. This study propose the need for the government to institutionalize PES as national natural resource policy to enhance sustainable ecosystems management for provision of ecosystem services and sustainable socio-economic development in watersheds.

**STATEMENT OF NO CONFLICT OF INTEREST**

We the authors of this paper hereby declare that there are no competing interests in this publication.

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