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77- Explaining investments in sustainable land management: The role of various income sources in the smallholder farming systems of western Kenya

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Abstract

Smallholder farms in the humid highlands of East Africa are undergoing changes that question the notion of the rural space. Characterized by land degradation, increasing population pressure, intensive farming and continuous cropping in small plots, smallholder farmers have increasingly embraced additional forms of nonfarm income generation activities. The observed changes put to question parameters used in the analysis of smallholder farming systems in the region. In this paper, we endeavour to analyze how these changes in smallholder farming systems influence investments of proven sustainable land management practices. The paper is based on a study of 320 farm households comprising 494 plots in the western Kenya region. For cross-section data, use is made of the OLS and instrumental variable methods to explain investments in sustainable land management. In contrast to a number of recent studies, specification is made of *non-farm income* (NonFarmincome) as income from non-agricultural activities, and *natural resource-based income* (NRMincome) as income from natural resource management activities undertaken away from individual farm holdings. The NRMincome activities have an implication on landscape conservation, as they are mainly undertaken in communal and other public lands. Results show that non-farm income contributes to investments in soil prevention practices, contrary to the results of a number of studies looking broadly at off-farm incomes. The findings have implications for suitable policies for enhancing sustainable land management. This study argues that those policies need to focus on landscape level conservation, enhance non-farm income, and address impacts on communal lands and other common property regimes resulting from smallholder farmers' natural resource management income strategies.

Key words Non-farm income, Natural Resource Management based income, Soil erosion prevention, soil fertility management

1. Introduction

A major threat to food security in the eastern Africa region is land degradation. Although agricultural research and extension have disseminated technologies and offered advisory services on sustainable land management, the impacts have been generally minimal (German 2006, Grepperud 1997, Lyamchai 2007). In smallholder farming landscapes, land degradation is more complex, and is associated with changes in socio-ecological conditions and increased vulnerability of agro-ecosystems to shocks and uncertainties (Mahdi, Shivakoti and Schmidt-Vogt 2009, Maro 1988, Nyssen, Poesen and Deckers 2009). Addressing land degradation in the region requires an examination of smallholder farming systems to better understand factors that explain the low technology adoption rate, as well as seize opportunities for facilitating wide scale investments in sustainable land management (Dercon and Christiaensen 2010, Kamau 2007).

Smallholder farming systems constitute a combination of agricultural production and other income generating activities that contribute towards overall farm output (Barrett *et. al.,* 2001). Traditional and modern systems are blended together for greater production efficiency. However, challenges to smallholder farming systems are numerous. Barret and Swallow (2006) assert that increasing population numbers, diminishing soil productivity resulting from land degradation and poor marketing access limit productive investments. As poverty is endemic in the smallholder farming systems of East Africa, low income levels reduce the capacity of farmers to invest in land quality improvements. Among the difficulties that smallholder farmers face is that of optimization in an environment of competing resource needs (Waithaka, Thornton and Shepherd 2006).

There is increasing constraints to access to land in Kenya and other countries in the region, particularly in the smallholder agricultural areas that were formerly land abundant and where extensive farming methods were applied (Kabubo-Mariara, Mwabu and Kimuyu 2006, Byiringiro and Reardon 1996). These constraints are driven by population pressure, fragmented land holdings and declining soil fertility. Farm level resource allocation is bound to evolve with changing farmer priorities. Complexities in smallholder farming systems are compounded by their dynamic nature. Currently, intensive farming involving continuous cropping in small areas of land, unsustainable utilization of customary resource areas and illegal incursions into public and trust lands are a common phenomenon. This makes sustainable land management not only necessary but also an implementation challenge.

Though often viewed as stable, smallholder farming systems are undergoing rapid change (Giller et al. 2011). Evolving rural diversification strategies contributes to and may result from these changes (Nielsen et al. 2013, Barrett, Bezuneh and Aboud 2001, Ellis 2000). Stemming from insights on the Lewis model of the role of dualism in the process of economic transformation(Lewis 1954), structural change in the smallholder farming systems has amplified the significance of the nonfarm sector (Reardon 1997, Bigsten and Tengstam 2011). This has entailed an expansion of the hired labour market, self-employment and wage employment in the rural areas. The labour differentiation has also been augmented by improved education levels of the populace, and has an upward implication on the marginal productivity of labour. What do these changes portend in light of the reduced land sizes, high population growth and increased significance of the cash economy in the rural areas? Specifically what influence does this scenario have on sustainable land management in the fragile but agriculturally important smallholder farming systems of the East African highlands?

This paper addresses the factors that explain investments in conservation by smallholder farmers from highly erodible area of the East African highlands. It pays specific attention to the role of rural household income sources on investments in sustainable land management. It models investment in specific sustainable land management interventions, and focuses on the role of the various farm household income streams. The article departs from other studies (Lien, Kumbhakar and Hardaker 2010, Lisa Pfeiffer 2009, Matshe and Young 2004, Bhaumik, Dimova and Nugent 2011, Chang and Wen 2011), by specifying the nature and form of nonfarm income and natural resource based income generation strategies. In this article, nonfarm generating strategies are understood to comprise non-agricultural enterprises undertaken either on-farm or away from the farm. Natural resource management income streams refer to natural resource-based enterprises that are undertaken off the farm and mostly in communal lands or even in public and trust lands. These definitions have an implication on landscape level conservation policy formulation. They allow for differences in policy action targeting smallholder farms, communal lands and other common property regimes.

Sustainable land management interventions consist of various practices and technologies, which are adopted either singly or through a combination of land management practices. There is a great variability in the suitability, acceptability and adaptability of these interventions commensurate with the complexity and heterogeneity in the smallholder farming systems. At farm level, sustainable land management interventions consist of soil, water conservation and soil fertility augmentation practices and technologies which are adopted either singly or in combination. The sustainable land management technologies and practices vary in terms of their suitability, acceptability and adaptability. Their adoption is also dependent on the characteristics of the smallholder farming systems. Many empirical studies undertaken on land degradation have either focused on soil erosion or soil fertility. They are, therefore, not able to clearly represent the holistic smallholder farming situation where various combinations of technologies and practices are used (Tagwira 1992, Ayoub 1999, Unai Pascual 2006, Yuelai 1994, Amsalu and de Graaff 2007, Anley, Bogale and Haile-Gabriel 2007, Ajayi et al. 2009).

A large body of literature exists on determinants of agricultural technology adoption (Feder, Just and Zilberman 1985, Asfaw, Mithöfer and Waibel 2010, Asfaw et al. 2012, Zhang et al. 2012, Fischer and Qaim 2012) and on what guides natural resource management (NRM) practices in Sub-Saharan Africa (SSA) (Lee 2000, Barret 2002, Amede et al. 2007, Ahaneku 2010). A number of studies have applied the livelihoods approach to better understand smallholder farming systems (Adato 2002, Ellis 1998, Ellis 2000, Ahmed, Allison and Muir 2008). Others have explored the socio-economic and institutional factors that influence the adoption of some specific sustainable land management technologies and practices (Tiwari et al. 2008, Shiferaw, Okello and Reddy 2009, Sheikh, Rehman and Yates 2003, Pender and Gebremedhin 2008, Amsalu and de Graaff 2007). This has shown different factors influencing adoption such as perception on technology and participation in off-farm work.

A cost-benefit analysis of the nature and severity of land degradation with reference to Central America and Caribbean countries was conducted by Lutz *et.al.,* (1994) . They emphasized the role of soil conservation technologies in enhancing soil fertility in the medium to long term. Literature on land tenure effects (Besley 1995, Brasselle et,al.,2002, Hagos and Holden 2006) indicate a weak or unclear link between conservation investment and tenure security in the form of land titling alone or land insecurity resulting from redistribution. Saint-Macary *et. al.,* (2010) found that issuance of land titles is a necessary, but not sufficient prerequisite to encourage adoption of soil conservation.

Also relevant to understanding smallholder response to the increasing challenges of land degradation, are studies on the nature and form of sustainable land management technologies and practices. Hennessy (1997), states that incentives to invest may be reduced substantially when conservation technologies have stochastic properties. The stochastic properties could include complexity of the technology, labour requirement, production risk effects, local agronomic factors and fixed costs associated with the adoption of the technology. This view is also supported by other more recent studies on sustainable agriculture (Rodriguez et al. 2009, Zhen et al. 2006).

Though farm households raise agricultural output, productivity and earnings in several ways, common constraints in this regard include risk and lack of access to credit, insufficient capital and poorly functioning factor markets (Gbemisola Oseni 2009). Therefore, diversifying income sources into non-farm and off-farm activities may provide the required capital for increasing farm productivity (Reardon, Crawford and Kelly 1994). However, these activities could also compete with farm production. Thus understanding the emerging role of income diversification and its impact on investments in sustainable land management is essential.

There has, however, been far less attention on the possible local level negative impacts of non-farm and off-farm sectors on agriculture. Pfeiffer *et. al.,* (2009) found out that in Mexico, off-farm income had a negative effect on agricultural output and the use of family labour on the farm, but a positive one on the demand for purchased inputs. Lien *et. al.,* 2010 found that among Norwegian farmers, in addition to demographic, time trend, and some regional effects, there was a significant negative effect on farm output attributable to off-farm income.

A consensus is emerging that as the rural economy grows, household participation and intensity of involvement in agricultural activities declines, it is gradually replaced by greater involvement in non-agricultural activities (Winters *et. al*., 2010, Davis *et. al.,* 2010). However, this trend has not been ascertained in the case of stagnating or declining rural economic growth, typical of the eastern Africa highlands. These highlands are characterized by severe land degradation, coupled with high population that has impacted negatively on rural economic growth (Mbaga-Semgalawe and Folmer 2000, Barrett 2002, Clay *et. al.,* 1998).

Proof of increased farm productivity will provide a basis for scaling up of sustainable land management practices in smallholder farming. However, linking income diversification to adoption of sustainable land management requires information at the plot, farm and landscape levels. A reason for the dearth of empirical research on determinants of land improvement investments by African rural households is the difficult data requirement (Clay, Reardon and Kangasniemi 1998, Mazvimavi and Twomlow 2009). Household farm and nonfarm income assets, demographic characteristics and ecological properties of farm holdings are examples of necessary information. There has been very little information on how participation in the non-farm or off-farm sector, affect choice of farming technologies and the mix of farming activity Davis et al. (2009). In our study we particularly address natural resource-based income activities aspects of the off-farm sector as they have direct implication on landscape level conservation. This study contributes to this information gap by examining how participation in the non-farm and natural resource based off-farm sector affects investments in sustainable land management, amongst smallholder farmers of the highlands of Kenya.

In contrast to similar studies, this article treats non-farm and natural resource based income strategies separately. This is with the understanding that the two income generating strategies may have different effects on investments in sustainable land management at the farm and landscape levels. However, it builds on a growing literature based on non-farm and off-farm income generating activities. These include the theoretical work on the models of agrarian economy (Hymer and Resnick 1969) that gave way to many studies on non-farm employment.

2. Economic model specification

We use a farm household model to illustrate the possible effects of increased non-farm and natural resource-based incomes to production and consumption, in households facing a budget constraint and a land quality constraint. The farm household model depicts a production process where at the beginning of the year, a budget is made for production inputs and non-farm inputs including labour and investments in land quality improvement. At the end of the year or farming season, the farmer consumes a part of the harvest and sells the surplus. Proceeds from agricultural production and non-farm activities within this period are used for consumption and other livelihood needs, repayment of existing loans, or ploughed back into farm production or non-farm activities.

We develop an agricultural household model with endogenous market participation (Janvry *et. al.*, 1991, Chatterjee and Corbae 1992), meaning that households with different characteristics (including productivity, preferences, schooling, age, dependency levels, household types, labour, and other inputs of production) will make different decisions on market participation.

In the model, the agricultural household has three ways of getting income: producing agricultural goods (Q_t), at price of goods (p); engaged in Nonfarm (N_t) at the wage rate (ω); directly selling some natural resources acquired off–farm (R_t) at the price of the resource (n). The household incurs the following costs: hiring workers (H) and the wage rate (v) and buying other inputs of production such as fertilizers, pesticides (C_t) at the cost of (f)

Therefore the farm households' objective is to maximize income I_t :

$$\max_{N_t R_t H_t C_t L_t} \int_0^T I_t \, e^{-rt} \delta t$$

where r is the discount rate . The households' income at any time (t) is

$$I_t = pQ_t + \omega N_t + nR_t - vH_t - fC_t \qquad (1)$$

Producing agricultural goods depends on how much labour is employed on the farmland L_t, the quality of farmland S_t, and other inputs of production such as fertilizers. Hence:

$$Q_t = Q(L_{t,} S_t, C_t) \qquad (2)$$

In defining the farm households' objective, we assume the plot size is known, and for simplicity minimize the role of capital (Machinery and tools). n, ω and v are the wage rates for NRM income R_t, non-farm N_t, and hired labour H_t respectively.

We thereafter identify the state variables (representing stock, or a state–such as quality) and an instrumental variable (variable used by farmer to optimize). The stock variable Land qualityS_t declines naturally, but can be improved through some improvement activities. It therefore changes over time as follows:

$$\frac{dS}{dt} = -\alpha S_t + FM_t \tag{4}$$

where F is the improvement, which is a function of the amount of labour input in the improvement (M) α is a natural land quality decline factor.

There are some restrictions to the problem; the amount of labour the household uses (minus hired labour) cannot exceed what is available:

$$L_t + N_t + M_t - H_t < m \tag{5}$$

where m is the amount of family labour available.

Another restriction to the problem; the household must have a basic minimum amount of consumption income.

$$I_t \geq \ I'_t \tag{6}$$

Lastly, we identify the instrument variables, which are: how much labour is used on the farm (L); how much income from extraction of natural resources (R); how much income from Nonfarm (N); hired labour (H); how much inputs we buy (C); and how much labour we invest in SLM (M).

Therefore we set up the current-value Hamiltonian:

$$H = pQ_t + nR_t + \omega N_t - vH_t - fC_t + \lambda[pQ_t + nR_t + \omega N_t - vH_t - fC_t - I'_t] + \mu[L_t + N_t + M_t + R_t - H_t - m] + \theta[-\alpha S_t + FM_t] \tag{7}$$

Optimality conditions are that: $dH/dL = p\ dQ/dL + \lambda p\ dQ/dL - \mu = 0 \Rightarrow p\frac{dQ}{dL}(1+\lambda) = \mu$

From the optimality conditions, the value of production at time t plus the initial minimum liquidity minus the shadow price of labour μ will be equal to zero. This implies that the marginal benefit of farm labour is equal to the shadow price of labour.

$$dH/dN = \omega + \lambda\omega - \mu = 0 \Rightarrow \ \omega(1+\lambda) = \mu;$$

The non-farm wage plus the extra liquidity accruing from initial basic income equals the shadow price of labour(μ).

$$dH/dR = n + \lambda n - \mu = 0 \Rightarrow n(1+\lambda) = \mu;$$

$\frac{dH}{dM} = -\mu + \theta\frac{dF}{dM} = 0 \Rightarrow \frac{dF}{dM} = \frac{\mu}{\theta}$;

$dH/dS = r\theta - dHm/dS = r\theta - p\ dQ/dS - \lambda\ dQ/dS + \theta\alpha$(Where parameter r denotes the discount rate)

We assume that $\theta = 0 \Rightarrow (r+\alpha)\theta = p\frac{dQ}{dS}(1+\lambda) \Rightarrow \theta = \frac{p}{r+\alpha}\frac{dQ}{dS}(1+\lambda)$

Where resource stock does not change $\theta = 0$, we infer Kuhn tucker condition such that there is a corner solution where:

$\lambda(pQ_t + \omega N_t + nR_t - vH_t - fC_t - I'_t)$ =0

$dH/d\lambda = 0$ (Implying that the labour restriction must always hold)

The model and the first-order conditions of the Hamiltonian provide theoretical insight into the possible role of a number of variables in the decisions on sustainable land management. The model represents the dynamic nature of land degradation; we however analyze a snapshot that enables us to employ a cross section study at a specific reference point in time. In the model, to relax the restriction for household income maximization (equation 7), the households may choose to increase nonfarm and NRMincome activities. These could influence investments in agricultural production through probable diversion of family labour into the increased nonfarm activities.

In the context of reducing farm land sizes and the agricultural productivity effects of land degradation, our study tests the following hypothesis: Firstly, non-farm and natural resource-based income strategies elicit negative effects on investment in sustainable land management technologies and practices due to the competition for labour. Secondly, NRMincome will act as a safety valve for smallholder farmers enabling them maintain necessary household liquidity levels; and thirdly the community's cultural attachment to land may sway farmer households from pure profit maximization motive.

3. Methodology

3.1 Survey design

A cross-section household survey involving a stratified random sampling procedure was undertaken in the Vihiga District of Western Kenya. The sampling was used to select smallholder farmers from two representative divisions of the "larger" Vihiga District (Vihiga District has been divided into 3 districts, Hamisi, Emuhaya, and Vihiga districts). The selected divisions, namely Shaviringa and Jepkoyai divisions are selected as typical representative of Vihiga District in terms of landscape level variations, population density, natural resource endowments and the mix of activities undertaken by the smallholder farmers.

The sampling framework was based on village lists of household heads per village in the custody of village leaders. These lists had been updated during the 2009 national level census. From the lists, every 9th household member was selected for the household survey. Total samples of 320 farm households were interviewed and data and soil samples collected from 494 farm plots from the selected households. In Shaviringa division, 160 samples were drawn from 15 villages in a total of 3 sub-locations whereas in Jepkoyai division, 160 samples were drawn from 21 villages of 3 sub-locations.

The structured survey questionnaire was designed to collect social, economic and biophysical characteristics of smallholder holdings, providing both plot level and farm level information. Further, in the months of April, May, June, July and August of the year 2011key informant interviews were carried out with farmer groups, government officials and non-government organizations involved in sustainable land management and poverty alleviation programmes.

3.2 Soil sampling and analysis

In the sampled household farms, soil was sampled at 5 points per plot, and evenly distributed to include the middle of the plot but avoiding the edge extremes. Soil samples were collected using a soil auger of 5.3 cm diameter at 0-20 cm depth and representative per plot composite samples made for 447plots in 320 farms. These were air-dried, weighed and passed through a 2 mm sieve. The 2mm sieved air-dried samples were thoroughly mixed with a spatula to obtain homogeneity. Soil NIR diffuses reflectance spectra were recorded using a Fourier–transform NIR spectrometer. The analysis provided used the set up described by Shepherd and Walsh (2007) and provided concentrations of total nitrogen, phosphorous, and extractable potassium in mg per Kg. These elements were used as indicators for land quality in the regression analysis.

3.3 Appraising sustainable land management measures

A variety of SLM measures can be found at the local level, though in some cases neither land users nor researchers are aware of such practices, sometimes used traditionally or by a few innovative land users (Schwilch, Bachmann and Liniger 2009). In order to reach a common understanding of SLM measures, the study undertook appraisal and identification of conservation measures through a stakeholder workshop approach. This approach involved discussing various SLM measures highlighted in literature, and their local level interpretation. The process involved two workshops, one at the district level in involving consultation with local stakeholders, community leaders and district level leadership. Shortly thereafter, a second workshop was conducted at the grassroots level. The second workshop was mainly with local farmers and village level leaders. The deliberation process provided for a common understanding of the term sustainable land management, and the categorization of specific SLM practices based on their functions (Table 1).

Table 1: SLM categories as applied in the study

Category identified	Name used in study	Specific practices
Soil and water conservation	Terracing	Soil bunds Grass strips Contour ploughing
Soil fertility improvement	Manure application	Manure Composting
	Chemical fertilizer	Inorganic fertilizers
Agroforestry	Agroforestry	Multi-purpose trees Contour hedges and boundaries Improved fallows using fertilizer trees
Disease and pest control		Crop rotation Mulching

4. Empirical analysis

In this section, plot level, farm level and community level data is employed to examine the relationship between investments in specific SLM practices and various income generating strategies. We perform a cross-sectional analysis for 2010, since many smallholder farmers rarely keep records and could, therefore, only get reliable data for the immediate former year of production. A linear model with the dependent variable being the natural log of investments in specific sustainable land management practice is adopted.

Highlighted in Table 2, are the 3 dependent sustainable land management variables under investigation. "erosionprevention" which refers to SLM practices and technologies used in developing terraces are practiced in 369 plots whereas manure application is undertaken in 139 plots and agroforestry practiced in 101 plots. The main explanatory variables are the natural logs of income streams from Nonfarm income, Natural resource management income (NRMincome), livestock production and remittances, and the value of crop production. The role of the income streams in influencing investments in SLM is investigated given a number of defined household and plot level characteristics. The household level characteristics include age of household head, type of household and education measured as years spent in school. The food stock variable gives an indication of how many months in a year; food is available in the household store. The plot variable indicates the division of sections of the farmland in terms diversity in land quality, agronomic practices and location in relation to the homestead.

Table 2 also has plot level characteristics that include dummy variables for number of plots, soil sample result variables that control agricultural land quality. These include concentrations of total nitrogen, phosphorous and extractable potassium, as well as slope, soil depth and farmer perception of land degradation. Based on soil fertility ratings benchmarks (Landon 1991.) The mean total nitrogen content (Table 2) of the plots analyzed is under low category (0.1-0.2), the maximum content reported amongst the plots analyzed is under the medium soil quality category(0.21-0.5). Further, the mean extractable potassium (exk) falls under medium quality (0.26-0.80). Available phosphorus was also under medium quality (7-20). Other explanatory variables include community level characteristics that may be associated with landscape level investments in sustainable land management.

Table 2: Sample statistics of variables used in the econometric models

Variable label	Variable Description	Units	Obs	Mean	Std. De	Min	Max
Farm household income streams							
nonfarm	nonfarm income	Ksh	297	71442.5	142646	0	1095000
nrmincome	income from NRM	Ksh	211	24800	43975	124	500000
plotcro~e	crop income	Ksh	475	35655	142372	72	2025000
total_live~g	livestock income	Ksh	455	44786.5	91782	105	826500
remmita~e	Annual remittance	Ksh	367	17151	25646.7	500	180000
Household level characteristics							
age_of_hou~d	Age of household head	Years	494	56.93	14.09	19	104
distance_f~m	Distance to market	Km	494	3.03	3.84	0.01	28
FHHWD	Female headed household	1/0	494	.2653	.4419	0	1
FHHAH	Female head absent husband	1/0	494	.0386	.1925	0	1
MHHP	Male head polygamous	1/0	494	.0122	.1096	0	1
MHHW	Male head one wife	1/0	494	.6599	.4742	0	1
MHHWD	Male head widower	1/0	494	.0243	.1541	0	1
foodstock	Months with food per year	Number	494	4.001	2.422	0	12
dependency~o	(<15>64)/(>15<64) year olds	ratio	494	.5691	.6992	0	6
lnlvstokcost	Annual livestock costs	Ksh	494	7.633	3.142	0	12.59
education	Years of schooling	Years	494	8.680	3.894	0	14
numberofpl~2	Dummy for 2 plots	1/0	494	.3947	.4893	0	1
numberofpl~3	Dummy for≥ 3 plots	1/0	494	.5749	.4949	0	1
Plot level characteristics							
totalnitro~n	Total extractable nitrogen	g/Kg	447	.1478	.0449	.045	.333
p	phosphates	mg/Kg	447	9.459	10.35	.729	114.32
exk	Extractable potassium	mg/Kg	447	.5303	.2044	.160	1.474
slope2	Medium (>5%<15%)	1/0	494	.5486	.4981	0	1
slope3	Steep (>15%)	1/0	494	.1275	.3339	0	1
soildepth1	Deep (>100cm)	1/0	494	.3076	.4620	0	1
soildepth2	Medium (>30cm<100cm)	1/0	494	.5486	.4981	0	1
landdegrd2	Farmer perception -Medium	1/0	494	.7126	.4530	0	1
landdegrd3	Farmer perception-Poor	1/0	494	.0283	.1661	0	1
plotfertcost	Inorganic fertilizer costs	Ksh	494	2345.186	3901.345	0	34000
ln_Laborcost	Log of labour costs	Ksh	494	12.24	8.816	0	42.5
Erosionprev	Costs of maintaining terraces*	Ksh	369	2296	5849	50	50100
lnmanure	manure costs*	Ksh	139	655.6	868.6	10	4600
Agroforestry	Agroforestry costs*	Ksh	101	1235.2	2501	100	23400
Community level characteristics							
Shaviringa	Division as a location effect	1/0	494	.5000	.5005	0	1
ambiguityi~e	Ambiguity in culture and policy	1/0	494	.2166	.4123	0	1
customaryl~e	Customary law on land	1/0	494	.2004	.4007	0	1

***For prediction purposes, we apply the sample average procedure by Duan (1983), to avoid complication when transforming the dependent variable by taking the natural logarithm**

4.1 Econometric approach

We investigate the effect of various sources of household incomes on investment in sustainable land management, given a set of prevailing socio-economic and biophysical conditions. This is presented by three models agreed upon during our stakeholders meeting. In the analysis ordinary least squares (OLS) are applied as well as instrumental (IV) variables method. We estimate the following models:

$$\begin{aligned}\ln \text{Erosionprevention} &= \alpha_0 + \alpha_1 \ln\_nonfarm + \alpha_2 \ln\_nrmincome + \alpha_3 \ln\_cropvalue \\ &+ \alpha_4 \ln\_livestockincome + \alpha_5 \ln\_Remmittances + \alpha_6 X + \alpha_7 Y + \alpha_8 Z + \varepsilon \qquad (9)\end{aligned}$$

$$\begin{aligned}\ln\_\text{manure} = \beta_0 &+ \beta_1 \ln\_nonfarm + \beta_2 \ln\_nrmincome + \beta_3 \ln\_cropvalue \\ &+ \beta_4 \ln\_livestockincome + \beta_5 \ln\_remmittances + \beta_6 X + \beta_7 Y + \beta_8 Z + \upsilon \qquad (10)\end{aligned}$$

$$\begin{aligned}\ln\_\text{Agroforestry} &= \gamma_0 + \gamma_1 \ln\_nonfarm + \gamma_2 \ln\_nrmincome + \gamma_3 \ln\_cropvalue \\ &+ \gamma_4 \ln\_livestockincome + \gamma_5 \ln\_remmittances + \gamma_6 X + \gamma_7 Y + \gamma_8 Z + \mu \qquad (11)\end{aligned}$$

The coefficients α_1, α_2,$\alpha_3$and α_4 and the corresponding β's, γ's and δ's in equations 9, 10, and 11, provide an estimate of the average effect of participation in respective income generating activities on investment to particular sustainable land management practice. A negative coefficient would imply reduced investments in SLM and the drawing of labour away from land quality maintenance to other household income generating strategies. The land quality characteristic is represented by soil fertility, soil depth and slope variables as well as farmers perception on the extent of plot level land degradation.

A positive coefficient for nonfarm or other income generating activities would indicate a positive impact on the maintenance of land quality through overcoming credit constraints. Although credit access is a key determinant of self-employment, it should be noted that non-farm income sources relax the cash constraints as substitutes for credit requirement (Escobal 2001). X, Y and Z are vectors of explanatory variables at household, plot and community levels. $\varepsilon, \upsilon, and\ \mu$ represent error terms for equations 9, 10 , and 11 respectively.

4.2 Constructing instrumental variable for non-farm income

The OLS specification presents an endogeneity problem, where households participating in non-farm and NRMincome activities could have unobservable characteristics that influence investments in sustainable land management. This could be related to economic motivation, ability, entrepreneurship, which could create an omitted variable bias (Gbemisola Oseni 2009, Maertens 2009). Further, non-farm income streams come from a collection of activities that include self-employment such as having small-scale business, employment on contracts, rent and transfers. This narrows the range of possible instrument variables. We use the 2SLS model to correct for the potential bias that may be the result of endogeneity. The IV approach can be effectively used to reduce bias if it also meets the exogeneity requirement that the instruments must be uncorrelated with the endogenous variable, conditional on the other covariates. It therefore must not be correlated with the error term (Kilic et al. 2009). Instruments validity relies on persuasive argument, economic theory and norms established in prior related empirical studies (Trivedi 2010). It is also necessary that the requirement be relevant. This implies that the instrument must account for a significant variation of the endogenous variable, after controlling for the remaining exogenous regressors.

In our study we use the divisional household income ranking (Godoy et al. 2009) , the diversification index (DI), defined as the sum of the square share of income streams to total household incomes as well as the dummy variable representing requests for fixed seasonal input prices . Kilic *et. al.* (2009) use the share of non-farm employment as an instrument. Household income ranking and DI are statistically relevant as they are correlated with participation in non-farm activities. They are exogenous as they do not affect how much investments are made on SLM by the households. We undertake two tests: one is to test whether the instruments are weak and the second is to test for validity of the instruments by doing an over-identification test (Tables 3, 4).

Table 3: Test for weak instruments based on F test

Dependent variable	Variable	R-sq	Adjusted R-sq	Partial R-sq	F*	Prob>F
ln_ErosionPrev	ln_Nonfarm	0.4399	0.3756	0.1670	25.11	0.0000
	ln_nrmincome	0.5410	0.4883	0.2856	24.40	0.0000
ln_Manure	ln_Nonfarm	0.6560	0.5437	0.2778	12.08	0.0000
	ln_nrmincome	0.7426	0.6585	0.2403	5.58	0.0000
ln_Agroforestry	ln_Nonfarm	0.7684	0.6507	0.3105	9.89	0.0000
	ln_nrmincome	0.6514	0.6514	0.4743	13.71	0.0000

*Based on the F-test of the joint significance of the two instruments excluded from the structural model. This in our study is larger in 4 cases (25.11, 24.4, 12.1, 5.05, 9.89, and 13.7) than the rule of thumb value of 10 to indicate that the instruments are not weak (Stock 2007).

Table 4 : Test for over-identifying restrictions

Dependent variable	**Erosion prevention**		**Agroforestry**		**Manure**	
Test		p-value		p-value		p-value
Sargans Chi(2)	.2464	0.6425	1.199	0.2734	4.574	0.0325
Basmanns Chi (2)	.1952	0.6586	1.193	0.3589	3.684	0.0479

With the 2SLS estimator, we apply Sargans (1958)and Basmanns (1960)test estimations to ascertain the instruments independence from an unobservable error process. A statistically significant test statistic will indicate that the instrument may not be valid. This is not so in our case indicating therefore that the instruments are valid. However for manure as the dependent variable, the instruments are valid only at 1% significant level.

5. Results

Within the context of evolving smallholder farming systems with increasing land pressure, land fragmentation (Figure 1), and high land degradation, the results of the 4 models comparing both OLS and 2SLS regressions are discussed.

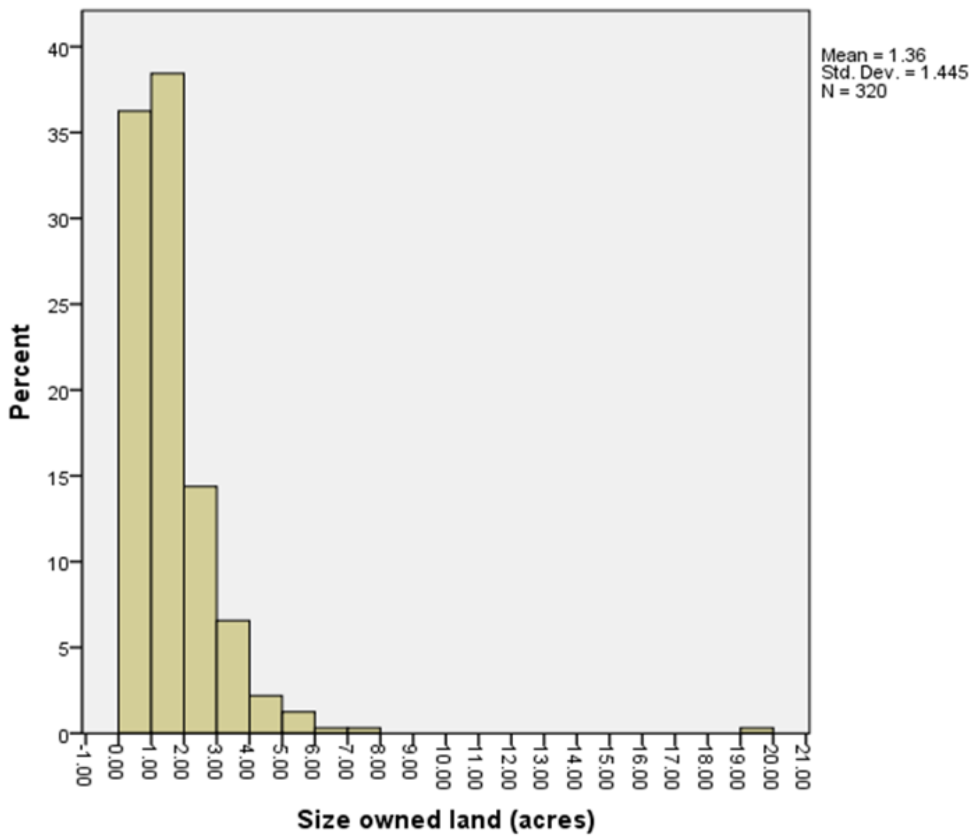


Figure 1: Land size per household (acres)

The small land sizes shown in Figure 1 are further divided into plots. These plots receive varying levels of management attention, based on land quality differences. Tittonell *et. al.,* (2005) showed differences in soil fertility between fields within a single farm. These differences could be as wide as those found between agro-ecological zones. In undulating landscapes the fields that are farther from the homestead are often also located on steeper slopes with thinner soils and more erosion risk (Giller et al. 2011). In smallholder farms throughout Sub-Saharan Africa, it is a common pattern for small fields to receive substantial inputs of fertilizers and manure, but others to receive nutrients infrequently or never (Rowe et al. 2006).

The results (see Table 5) show declining total farm level investments in erosion prevention by farm households that have more than one plot, compared to those owning a single plot irrespective of the land sizes. Non-farm and crop income show a significant (1% level of significance) positive impact on fostering erosion prevention and control. We discuss ln_Nonfarm ln_plotcropValue and ln_remmitance in terms of ln_Erosionprevention, by transforming the dependent variable from natural logarithms in equation 9. We find that nonfarm income is associated with a 37% proportionate raise in expenditure on soil erosion control. In contrast our 2SLS analysis shows that expenditures on soil erosion control are 19% lower with households receiving remittances.

Table 5: Regression results for ln_Erosion prevention and Erosion Prevention

Variables	OLS		2SLS		Tobit	
	Coefficients	**t-values**	**Coefficients**	**z-values**	**Coefficients**	**t-values**
Farm household income streams						
Nonfarm	0.02249***	3.53***	.0376**	2.17	0.00365***	2.67
nrmincome	0.01558**	2.15**	.00510	0.27	-0.00185	-0.43
plotcro~e	0.1336**	2.15**	.1451	2.36	-0.000621	-1.08
lvstokin~e	0.03474	1.08	0.0296	0.91	-0.000521	-0.39
remmita~e	-.00691	-0.93	-.00196**	-0.19	-0.00816	-1.09
Household level characteristics						
age_of_hou~d	-.00408	-0.67	-.000288	-0.04	6.0303	0.51
FHHWD	0.11270	0.56	0.0838	0.42	-311.76	-0.84
FHHAH	0.20634	0.63	0.7420	0.21	-887.46	-1.57
MHHP	-0.74396***	-2.74	-1.1918***	-2.87	863.51	1.16
MHHWD	-1.1172**	-1.79	-0.7094	-1.59	331.59	0.39
Education	0.02106	0.95	0.1717	0.77	55.41	1.23
Foodstock	-.10514**	-2.43	-0.1003**	-2.39	-141.78**	-2.45
dependency~o	-.3543***	-2.79	-0.3036**	-2.25	-871.82***	-3.80
lnlvstokcost	.00224	0.07	-0.007125	-0.22	-0.00494*	-1.73
plots2	-0.6152	-1.12	-0.6733	-1.27	1332.15*	2.19
plots3	-1.0984**	-1.94	-1.309**	-2.19	-242.67	-0.37
Plot level characteristics						
totalnitro~n	3.2125	1.03	2.134	0.62	-10507.94	-1.49
p	0.00532	0.52	0.00614	0.62	-27.070	-1.31
exk	-0.72334	-0.92	-0.7811	-1.01	2666.09	1.54
slope2	0.4753***	2.68	0.4649***	2. 65	481.581	1.43
slope3	0.19501	0.76	0.1751	0.68	-373.39	-0.76
soildepth1	0.0443	0.16	-0.0279	-0.10	508.41	1.21
soildepth2	0.1530	0.58	0.0804	0.29	206.42	0.53
Community level characteristics						
ambiguityi~e	0.2804	1.39	0.3064	1.62	1139.36***	2.87
customaryl~e	-0.3998**	-2.19	-0.3641**	-1.97	20.049	0.05
shaviringa	-0.6404***	-2.73	0.2435**	-2.55	-406.12	1.75
R-squared 0.204	**N=296**		**N=296**		**N=447**	

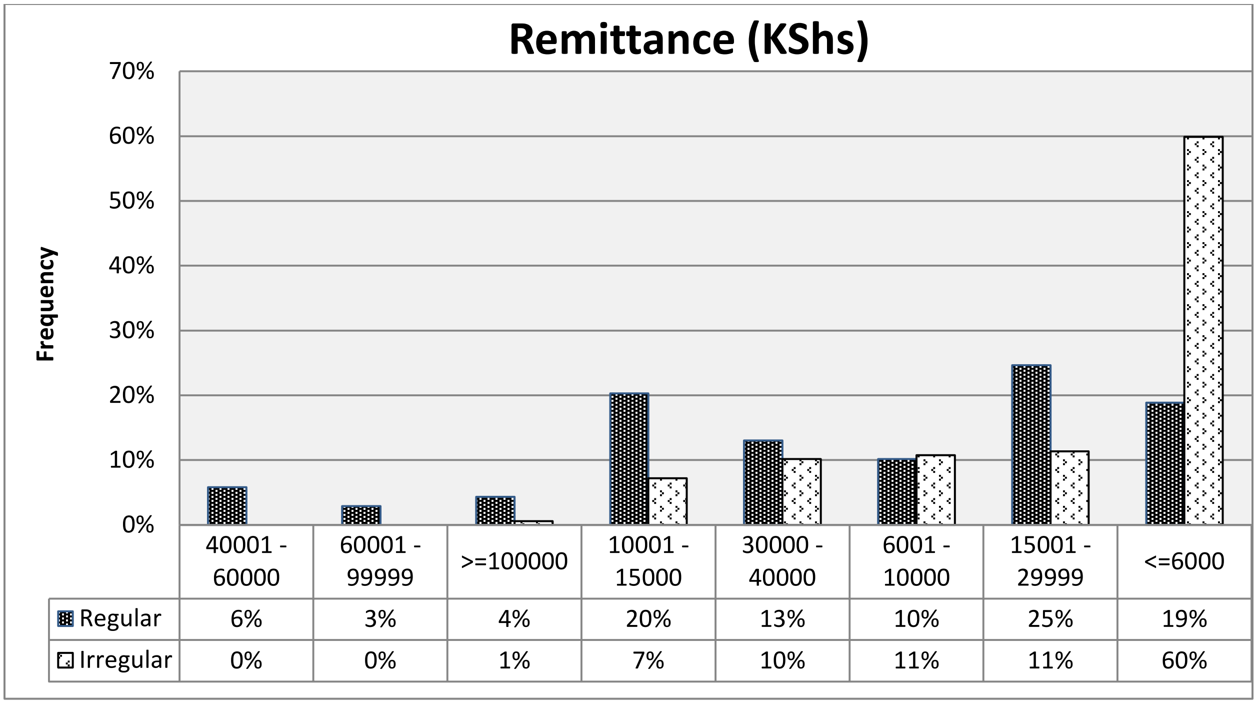
The quantity of food stored in the farm (food stock) has a negative impact at 5% level of significance on erosion prevention. This indicates that those households producing higher food quantities have less inclination to invest in soil erosion prevention. It could also be an indication of good quality land resource base, which may not require high rehabilitation costs. A higher dependency ratio implies less investment in soil erosion prevention. The negative coefficient for dependency ratio at 1% level of significance in both OLS and Tobit analysis and in conformity with (Hagos and Holden 2006) .

At the plot level of analysis, medium slopes (>5 %< 15% steepness) are associated with a 46% increase in expenditure on soil erosion prevention. The positive coefficient for medium slopes at 1% level of significance is in conformity with a number of studies in the literature (Menale Kassie 2008, Anley et al. 2007). However, Jansen *et. al.,* (2006) found that the slope of a plot seemed to have little effect on farmers decision to invest in erosion prevention.

In comparison to households with single plots, fragmented plots especially those with more than 3 separate plots showed reduced expenditure on soil erosion prevention at 5% significant level. The more the number of plots, the higher the transaction costs, leading to reduced investments per plot (Clay et al. 1998, Hagos and Holden 2006).

Investment in land quality improvement is also linked to community level institutional factors. Rural economies in developing countries are less competitive due to pervasive impediments and weak enabling environment. The divergence between private and social paths of soil use may be attributed to imperfect information (Shiferaw and Holden 1998). Farmers lack economic incentives to invest their time and money if they cannot capture the full benefits of their investments (Shiferaw *et. al.* 2009b). A solution suggested by farmers towards reducing factors that hinder investments in sustainable land management is on adjusting customary laws on land inheritance to conform to free market situation prevalent in the urban areas. In agreement to this suggestions our study show that households that highlighted customary law on land inheritance as a problem had a 36% lower investment in soil erosion prevention than those of other households after controlling for other characteristics.

Zaal and Oostendorp (2002) assert that regular remittances or windfall profits from high-cash crop prices may be important in addressing capital scarcity; our analysis shows no positive effect of remittances on investments in SLM. On further enquiry, interviewed farmers asserted that received remittances were irregular and hence not available for investment. Figure 3 illustrates the annual share value of remittances received by farmers. It also shows percentage responses on whether the remitted amounts were regular. For the majority (79%) who received remittances, the amounts were very small less than Ksh. 6000 (about 72 US$). Further, 60% of this category received their amounts irregularly and could therefore factor remittances in the production process.

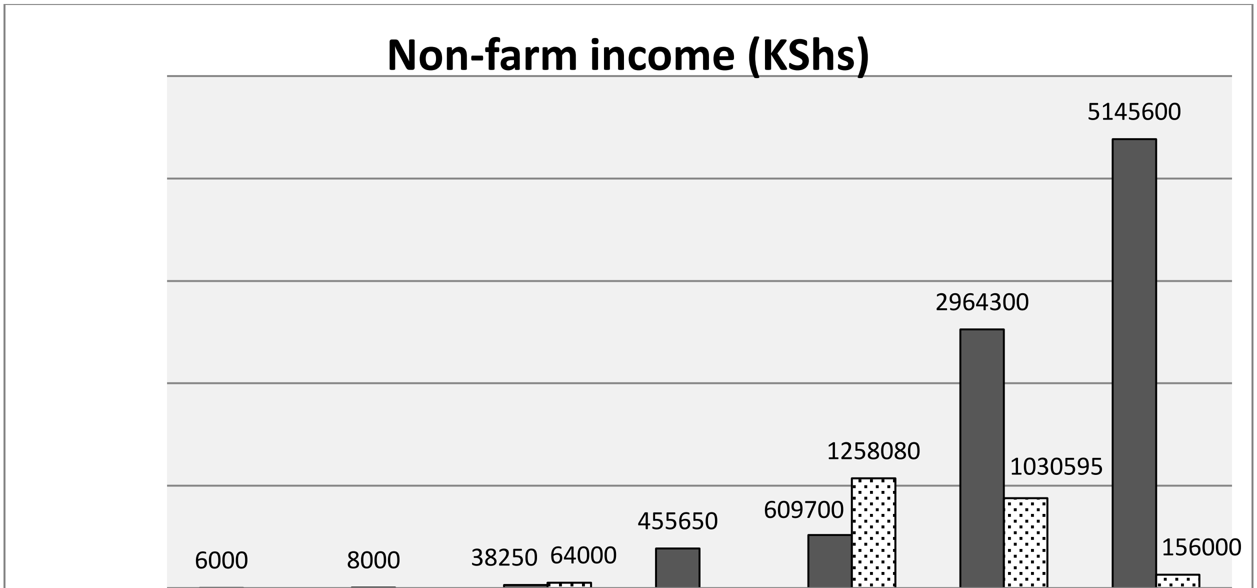


	40001 - 60000	60001 - 99999	>=100000	10001 - 15000	30000 - 40000	6001 - 10000	15001 - 29999	<=6000
Regular	6%	3%	4%	20%	13%	10%	25%	19%
Irregular	0%	0%	1%	7%	10%	11%	11%	60%

Figure 2: Annual share value of remittances

When defined broadly, off-farm income has been found to exert a negative influence on soil and water conservation investments (Amsalu and de Graaff 2007, Tenge et. al., 2004, Gebremedhin and Swinton 2003, Pender and Kerr 1998, Mbaga-Semgalawe and Folmer 2000). However, in our study, we specifically address non-farm income streams and find that they are positive and significant; hence suggesting that increased non-farm income provides the necessary capital for investments in soil erosion prevention.

Figure 3, illustrates the annual share of nonfarm income streams. It also provides an indication of how dependable the nonfarm activities are in regularly paying dividends. The graph shows that formal employment and business activities provide the highest share of nonfarm income, while wage labour is the most irregular. Amongst the nonfarm income activities undertaken by farmers in the study area also include rents from provision housing, land leasing, pension and a low minority who receive direct government assistance under a pilot project targeting the aged.



	Government Assistance	Pension	Land Leasing	House rent	Wage Labour	Bussiness	Employment
Regular	0.1%	0.1%	0.3%	3.9%	5.2%	25.3%	43.8%
Irregular	0.0%	0.0%	0.5%	0.0%	10.7%	8.8%	1.3%

Figure 3: Annual share of nonfarm income activities

In the regression results for manure (Table 6), livestock cost is associated with an 8.9 % increase in investment in manure, at 10 % level of significance. This implies that the manure generated from the livestock enterprise is invested into land quality improvement. This notwithstanding, the feed constraints associated with small land sizes are forcing the farmers to herd livestock away from their farms and hence missing out on the manure droppings. The analysis undertaken did not indicate any positive effect of all the household income streams on investments in manure. Farmers who cited as a major problem ambiguities arising from mismatch between cultural rules and government policies were less likely to invest in manure by 56% compared to those who did not. This may be the farmers who were not keen worried of the unplanned use of common property for production purposes.

Manure and compost require much labour to carry and spread on the field (Waithaka *et. al.* 2007). Deterioration of Soil Organic Matter (SOM) varies by agro-ecology but it is more intense in East Africa (Ayuk 2001). SOM is critical for maintaining soil fertility and has been found to be fundamental biophysical root cause for the decline in food production in Africa (Sanchez 2001). Animal manure is a key source resource for nutrition management and farmers create zones of soil fertility by preferential allocation of this resource especially when it is in short supply. This includes sourcing for manure in community lands and other common property areas.

Table 6: Regression for Ln_manure and Manure

Variables	OLS		2SLS		Tobit	
	Coefficients	t-values	Coefficients	z-values	Coefficients	t-values
Farm household income streams						
ln_Nonfarm	-0.001021	-0.21	0.03110	0.86	-0.00190**	-2.20
ln_nrmincome	-0.00761	-0.85	-0.02779	-0.53	0.00136	0.84
ln_plotcro~e	-0.0239	-0.25	0.001253	0.01	0.00056	-0.61
lnlvstokin~e	-0.06949	-1.57	-0.102457	-1.50	0.001296	1.02
ln_remmita~e	-0.00522	-0.42	0.00433	0.27	0.000967	-0.31
Household level characteristics						
age_of_hou~d	0.00408	0.45	0.01109	0.84	7.4479	1.27
FHHWD	-1.2747	-1.08	-0.14430	-0.47	29.494	0.17
FHHAH	-1.275***	-2.91	-0.79024	-1.01	-508.783	-1.25
MHHP	-0.4393	-0.72	-0.6763	-1.08	851.16*	1.80
MHHWD	-1.0598**	-2.08	-0.7084	-0.81	-501.59	-1.05
Education	0.0169	0.49	0.00929	0.27	30.256	1.38
Foodstock	-0.06766*	-1.69	-0.04804	-1.16	-36.834	-1.16
dependency~o	0.0472	0.26	0.0699	0.37	-90.24	-0.69
lnlvstokcost	0.0836*	1.90	0.08997*	1.77	0.00536*	1.84
plots2	-1.387*	-2.36	-1.651**	-2.54	-589.27	-1.02
plots3	-1.1703**	-1.78	-1.5172**	-2.40	-538.72	-0.94
Plot level characteristics						
totalnitro~n	0.527	0.11	-0.10569	-0.02	1849.67	0.64
p	0.00397	0.38	.00472	0.46	14.478	1.60
exk	-0.4838	-0.47	-1.0834	-0.77	-592.711	-0.89
slope2	0.2625	1.20	0.4132	1.41	-215.497	-1.21
slope3	-0.3532	-1.18	-0.2538	-0.67	-309.533	-1.21
soildepth1	0.2445	0.73	0.0343	0.08	62.098	0.26
soildepth2	-0.0687	-0.27	-0.1514	-0.55	368.123*	1.65
Community level characteristics						
ambiguityi~e	-0.5641*	-2.64	-0.7597*	-2.04	52.287	0.31
customaryl~e	0.1878	0.67	0.2710	0.62	166.249	0.92
shaviringa	-0.1964	-0.51	-0.2548	-0.56	-146.066	-0.71
R-squared 0.2917			N=125		N=447	

Studies across Sub-Saharan Africa show that differences in farmer-induced soil heterogeneity are largely due to the differential availability of nutrient resources, in particular manure, between farm types (Tittonell et. al. 2010). It is also noteworthy that majority of the less endowed households but rely on manure and less fertilizer. This is based on the assumption that such households would be more concerned with meeting food security needs before pursuing income related objectives (Omamo et. al., 2002, Salasya 2005, Abdulai and Crole Rees 2001, Abdulai et. al., 2010).

The results in Table 7 present ln_Agroforestry as the dependent variable, and explain investments in agroforestry amongst smallholder farmers in terms of available household income streams. From these results, households engaged in NRMincome activities invest 9% more in agroforestry at 1 % level of significance. In contrast, those involved in nonfarm activities invest 10% less in agroforestry at 10 % level of significance. Further, recipients of remittances are associated with 4% reduction in investments in agroforestry thus indicating that investment in agroforestry was an available option for households under capital constraints. Results also show that smallholder farmer involvement in natural resource-based income increases the probability of investment in agroforestry, probably to bridge the gap between natural resources available on farm and that which is sourced off-farm.

Departing from criteria used by a number of studies, we redefine off-farm to specifically refer to natural resource-based income sources from off the farm (Huffman 1980, Lien et al. 2010, Huang, Wu and Rozelle 2009). Under liquidity constraints, NRM income is sourced in common property areas as well as in public land. It is found to be the more widely available income generating strategies. Though beneficial to individual households, this option is extractive and a negative influence on conservation at landscape level. Figure 4, illustrates the share of NRMincome activities undertaken off the farms, in the study area. Firewood, timber, fodder and sand harvesting respectively, have the highest value share of income. Other NRM income activities include charcoal making, collective tree nurseries, fishing and forest honey. Among the entire NRMincome activities only tree nurseries may not be considered negatively, but they constitute a minimal share of the activities.

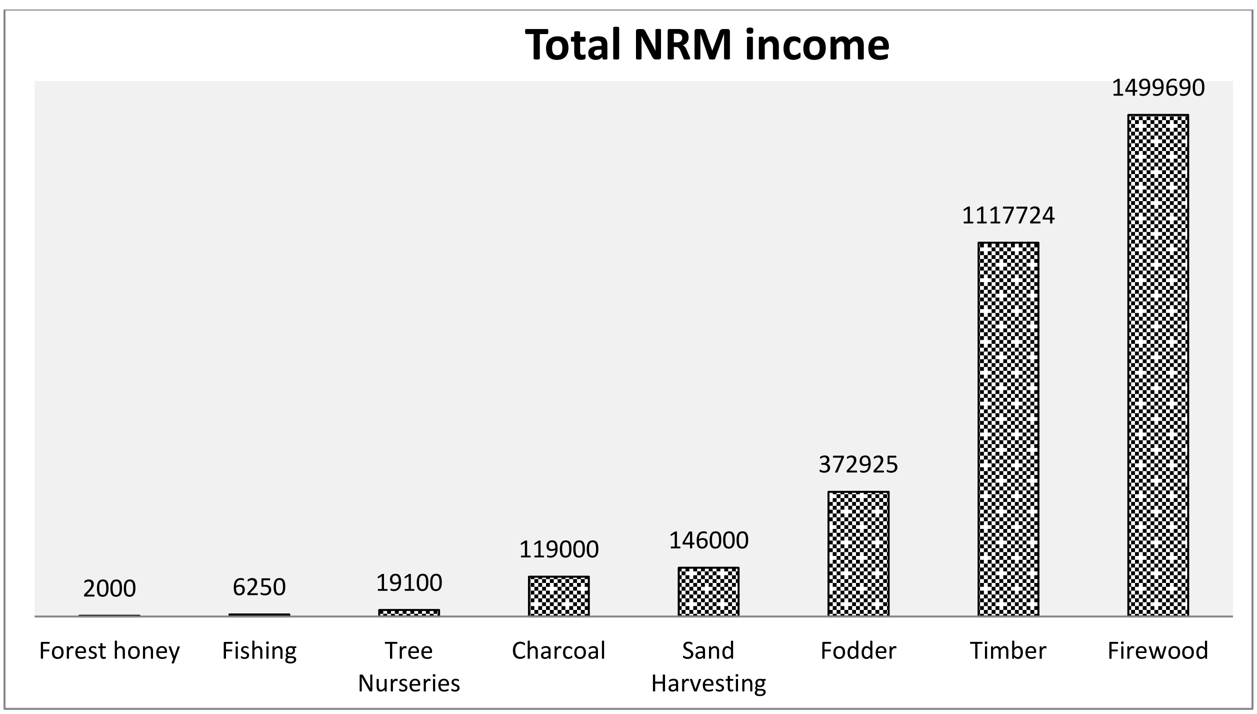


Figure 4: Annual share of NRMincome activities

Further, polygamous households had a positive effect on investments in agroforestry at 1% level of significance. This can be attributed to the availability of family labour, as well as the increased household energy requirements(Shackleton, Gambiza and Jones 2007). The significant positive effect also shows that family labour is important in developing countries where the moral hazard associated with hired labour is common (Asfaw *et. al.* 2012) hence make hiring labour costly for households with a small family labour force.

Reducing land sizes does not diminish household requirements for timber and other tree products. The households investing in agroforestry are able to accrue for themselves a number of benefits. Agroforestry systems can play an important role in the management of soil organic matter (Ayuk 2001). This is exemplified by the following options: mucuna, tephrosia, sesbania and caliandra (Adesina and Coulibaly 1998). Agroforestry also provides hedgerows a stream of benefits for the household engaged in livestock production including fodder, green manure. However, trees on farm are usually located in the poorer land quality plots. This aspect is illustrated by the 24% increased investments in agroforestry by smallholder who own more than 3 plots compared to those with single plots; this is at 10% level of significance.

Table 7: Regression results for ln_Agroforestry

Variables	OLS		2SLS		Tobit	
	Coefficients	**t-values**	**Coefficients**	**z-values**	**Coefficients**	**t-values**
Farm household income streams						
ln_Nonfarm	-0.0146	-0.76	-0.1431*	-2.33**	-0.0055	-1.32
ln_nrmincome	0.0306**	3.04	0.0978***	2.85***	0.0093**	2.60
ln_plotcro~e	0.1117	0.89	0.03187	0.20	.00208	1.57
lnlvstokin~e	-0.000586	-0.01	.06054	1.03	-0.00292	-0.94
ln_remmita~e	-0.0158	-1.07	-.0874*	-2.36**	-0.000207	-0.02
Household level characteristics						
age_of_hou~d	.01222	1.22	-0.002674	-0.18	-13.403	-1.01
FHHWD	0.1099	0.21	-0.2107	-0.35	-88.078	-0.15
FHHAH	-1.4077**	-2.16	-1.274*	-1.69*	-3185.7*	-1.89
MHHP	3.641***	3.11	4.596***	3.46	1038	0.55
MHHWD	-0.1438	-0.24	-0.7961	-0.86	1159.59	1.23
Education	-0.02002	-0.37	-0.0194	-0.31	-91.24	-1.38
Foodstock	-0.0516	-0.79	.02588	0.27	-28.99	-0.34
dependency~	0.148	0.63	-0.21904	-0.73	360.94	1.28
lnlvstokcost	0.0167	0.32	.0585	0.90	-0.0139*	-1.68
plots2	0.1787	0.24	.21885	0.33	-579.4	-0.52
plots3	0.33118	0.42	1.516*	1.65	-601.45	-0.51
Plot level characteristics						
totalnitro~n	4.89	0.75	5.169	0.78	13559.6	1.24
p	-0.01469	-0.54	-0.01731	-0.65	6.418	0.24
exk	-0.07091	-0.04	0.787	0.45	-3806.3	-1.42
slope2	-0.1306	-0.43	-0.4887	-1.27	726.1	1.26
slope3	0.11505	0.33	0.0538	0.12	808.54	1.15
soildepth1	0.4844	1.19	0.0121	0.03	739.43	1.11
soildepth2	0.4036	1.04	0.0235	0.05	754.74	1.01
Community level characteristics						
ambiguityi~e	-0.1518	-0.37	-0.531	-0.93	-298.1	-0.52
customaryl~e	-0.639	-1.56	0.357	0.55	-1471.6**	-1.98
shaviringa	-0.7716	-1.45	-0.917	-1.58	-2303.7**	-2.03
R-squared 0.359			**N=91**		N=447	

6. Conclusions

Although much has been learned from diverse experiences in sustainable resource management, there is still inadequate understanding of the market, policy and institutional failures that shape and structure smallholder farmer incentives and investments decisions. Though there are various types of sustainable land management practices and technologies that are adopted in various parts of the region, enabling a wide scale landscape level conservation process has remained elusive. The paper has explored how participation in nonfarm and natural resource based sectors affects investments in sustainable land management. We specifically examine whether nonfarm and natural resource-based incomes elicit negative effectives on investments in SLM; do NRMincome activities provide a safety valve for cash strapped smallholder farmers enabling them attain necessary household liquidity and if communities cultural attachment to land influence farm level investments.

Amongst the 3 main sustainable land management practices in the study, erosion prevention was positively influenced by nonfarm activities; agroforestry was also positively influenced by NRMincome activities while manure application had no significant effect on investments in SLM. These results were counter-intuitive as they rejected our expectation of competition for labour between farming activities and nonfarm. Evidently nonfarm and NRMincome activities improved household level liquidity, providing necessary investment capital. The nature of NRMincome activities which is mostly undertaken in common property areas provide insight on its effect on investments in agroforestry. There is however need to carry out further studies on NRMincome activities and more specifically on it's relationship with household energy requirements. Investing in agroforestry is a labour intensive practice. Male headed polygamous families had a positive impact on investments in agroforestry. Probable explanation would be availability of family labour. Against common expectations, remittances were found to have negative impact on investments in erosion prevention as well as agroforestry. On further enquiry, the study found that remittances were irregular and mainly used to address emergency priority issues such us settling medical bills or buying food. Evidently, households finance levels are becoming crucial in decision making. This lends credence to our surmising that NRMincome could be acting as a safety valve.

Most smallholder farmers valued crop production primarily for food security and not for income generation. Unstable market prices accentuated constraints in marketing basic food products such as maize and beans. As land is fragments, plot sizes reduce, impacting negatively on the scale of crop production. This notwithstanding, all the farmers interviewed engaged in crop production and demonstrated a strong attachment to their land and on smallholder farming in particular. Farm level financial liquidity was addressed in different ways. A majority of smallholder farmers without non-farm income sources engaged in natural resource management income generation for their immediate financial need. Increased NRM activities had the prospect of degrading public and community landscapes as very few of these activities were environment friendly.

This paper provides the context for addressing the challenges faced by diverse stakeholders and smallholder farmers in surmounting land degradation problems through sustainable management of agro-ecosystems. The three sustainable land management practices addressed in this study showed varied factors affecting their adoption and investment therein. Primarily, policy support for SLM need to address specific measures separately as these measures demonstrate varying response amongst smallholder farmers. Based on these results, we propose that sustainable land management programmes be focused on the broad landscape level to capture and understand interactions between plots, farm levels and common property areas. There is also need for more analysis on the socio-economic importance of the natural resource based income strategies, poverty status and associated ecological costs borne out of decisions made by farmers facing increasing challenges wrought from increasing population and reducing farm sizes. Further, policy support needs to be directed towards emerging opportunities such as support to rural non-farm activities would positively affect sustainable land management efforts.

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