An Evaluation of the Effects of Land Tenure on Land Use in Kenya: Evidence from Bondo, Busia and Siaya Districts

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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

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Abstract

Land is an important asset for economic, social and cultural development in Kenya. Agriculture is a key sector in the Kenyan economy, which requires optimal and sustainable use of agricultural land available. Insecure land ownership is one of the challenges that hinder optimal and sustainable land use in the country, while secure rights have resulted to instances of productive land being left idle and land hoarding. This study applies the Generalized Estimating Equation model on Yala Wetland data obtained from the Kenya Institute for Public Policy Research and Analysis 2005 field survey to investigate how land tenure affects land use and land improvements in Kenya. The results indicate that private title holders had an increased probability of investing on land improvements compared to those on communal land, while livestock keeping, food and cash crop farming had an increased probability of investing on land improvement compared to those whose land was idle. Land tenure was not significant in those farms that no farming activity was taking place, but the type of soil was significant with those farms with rocky unsuitable soils having higher probability of not being farmed compared to the other types of soils. Land tenure did not affect food crop farming. It affected farming involving cash crops, whether planted alone or in combination with food crops. Land reforms, especially titling in agricultural areas, need to be fast tracked as this would encourage investments on land improvements and the growing of perennial crops, thereby reducing land degradation. For the dry areas and those regions with unsuitable soils for farming, the government needs to encourage farmers to undertake other forms of farming that do not depend on soil type such as fish farming and bee keeping. Introduction of land tax for those productive farms left unattended is an option the government can explore that would reduce instances of idle land and land hoarding.

Table of Contents

1. Introduction

Land is an important asset for economic, social and cultural development in Kenya. Since pre-colonial to post independence periods, whether politically or socially, land has been at the epicentre of major developments in the country. It was the main motivation for the struggle for independence with aggrieved communities rising up against the white settlers, who had illegally annexed land from them. In post independence period, land has been one of the major causes of conflict among different communities. Historical land allocation disputes, the squatter problem and economic disparities among different communities have been sited as the underlying causes of these disputes (Government of Kenya, 2008).

Land forms the basis on which agricultural investment is anchored. The two are inseparable. Agriculture is a key sector in the Kenyan economy and forms the main economic activity of the rural populace. The sector contributes about 24 per cent of the GDP, 75 per cent of industrial raw materials and 60 per cent of export earnings. The sector is also credited as one of the major employer accounting for 18 per cent of total formal employment in the country (Government of Kenya, 2007 and 2008).

Kenya has an approximate area of 582,646km^2, 97.8 per cent of which constitute land and 2.2 per cent water surface. Out of the total land mass, only 20 per cent can be classified as medium to high potential agricultural land and the rest (80%) is mainly arid or semi-arid land (ASAL). About 75 per cent of the country's population lives and depends on the 20 per cent of the medium to high potential agricultural land (Government of Kenya, 2009).

1.1 Historical Background

Land tenure in Kenya is complex. Harbeson (1971) gives a historic perspective of land reform in Kenya. Following the colonization of the country by Britain, white farmers forcefully displaced indigenous Africans from the more productive areas and settled there, giving rise to the so called "white highlands". The Europeans put in place a colonial land policy that gave exclusive rights to non-African communities on the farm land they occupied and their businesses. This led to the destruction of traditional land tenure patterns and increased pressure

on land occupied by Africans which was largely unproductive. The outbreak of the Mau Mau war in 1953 was mainly due to these land grievances.

While the Mau Mau insurgence was being put down, the colonial government began a massive land consolidation and title registration in African reserves, especially in Kikuyu land. This was later followed by the opening up of the "white highlands" to capable African farmers, who had some money to purchase and develop sub-divisions of European farms with financial aid from the World Bank and the British government. Prior to independence in 1962, the British Government announced that it would finance by grant and loan the transfer of million acres of European farm land to thousands of landless Africans. This resettlement programme continued way past independence due to pressure of the surging number of landless and unemployed Africans.

1.2 Land Tenure

Land tenure refers to the terms and conditions under which rights to land and land-based resources are acquired, retained, used, disposed off or transmitted (Government of Kenya, 2009). Land tenure in Sub-Saharan Africa is a more elusive concept than the simple holding of title. Traditional tenure systems still impinge on the freedom with which farmers can alienate land (Place and Hazell, 1993). A good example is on family land where, though it may be titled, cannot, in most cases, be sold to a third party and is usually passed on from one family member to another.

The National Land Policy (Government of Kenya, 2009) seeks to designate all land in Kenya as public, community and private. Public land is defined as all land owned by the Government and dedicated to a specified public use or made available for private uses at the discretion of the Government. Community land refers to land lawfully held, managed and used by a specific community. Families and individuals are allocated rights to use the land in perpetuity, subject to effective utilization.

Private land constitutes land held by an individual or other entity under freehold or leasehold tenure. Under freehold, an individual is conferred unlimited rights of use and disposition. These unlimited rights have allowed individuals to buy land, sub-divide into small sometimes uneconomical portions and later sell. This reduces the

agricultural productivity of land. The Government intends to put in place measures to determine appropriate land sizes according to use and productivity of land.

Leasehold tenure involves the derivation of rights from a superior title for a period of time in exchange for specific conditions including but not limited to, the payment of rent. Time is of essence in leaseholds and the Government seeks to ensure that all future leases will be 99 years or less and subject to revocation, if they do not conform to approved development conditions.

Land use in Kenya depends on the setting: whether rural or urban. In urban settings, there is intensive land use due to high population densities. Zoning laws are enforced to encourage development along pre-determined areas whether for commercial, industrial, residential or recreational areas. In rural areas, land is mainly used for agricultural and livestock keeping (Waiganjo and Ngugi, 2001). Forest and wildlife conservations fall under public land, with the exception of few privately owned wildlife sanctuaries.

This paper focuses on the effect of land tenure on use of land to support agriculture and livestock keeping using data from five sub-locations in Bondo, Busia and Siaya districts. The region receives between 800mm and 2,000mm of rainfall annually. Areas along the shores of Lake Victoria are drier, but it gets progressively wetter towards the hinterland as the altitude rises. Due to its close proximity to the lake, the region experiences high humidity with evaporation rates ranging between 1,800mm and 2,000mm annually. Agriculture, fishing and livestock keeping are the main economic activities of the region. Maize, sorghum, sweet potatoes, cassava and beans are the main food crops produced in the region, while sugarcane, cotton, tobacco and coffee are the main cash crops grown. Livestock keeping mainly entails local breeds, while fishing activities are carried out in Lake Victoria (Government of Kenya, undated 1, 2, 3).

1.3 Problem Statement

Vision 2030 recognizes agriculture as one of the six priority sectors that would raise GDP growth rate to 10 per cent in a number of years. As was seen in early 2000, any incentive in the agricultural sector more or less stimulates economic growth. This is due to the country's largely agricultural dependent economy, which contributes 24 per cent to

GDP and 65 per cent of total exports. Agricultural investment is done on land. For these reasons, land remains one of the most valuable and sought after asset for Kenyan people.

Kenya is recognized as one of the few Sub-Saharan African countries that, over the years, has undertaken extensive land registration and titling programme (Migot-Adholla *et al.*, 1991; Place and Hazell, 1993). Despite having achieved this fete, insecure land ownership is sited as one of the challenge that hinders optimal and sustainable land use in the country (Government of Kenya, 2008; 2009). Tenure insecurity is represented by the probability of being evicted from ones land (Hayes, Roth and Zepeda, 1997).

People with private titles may feel more secure compared to those on communal land or those who have rented land for short periods of time. In Kenya, private title holders are allowed unlimited use or underutilization of their land. The absolute ownership and discretion on use has resulted in many instances of absentee landlords, where productive land is left to lie idle for periods of time. Land hoarding where people buy land speculating a raise in price with the aim of resale, presents another dimension to this problem. Most of these people who do not put their land on productive use are the middle class and elite of the society who have alternative sources of income (Waiganjo and Ngugi, 2001; Kenya Land Alliance, 2002).

Farmers are usually faced with the choice of growing food crops and cash crops or livestock keeping. Depending on farm and household sizes, farmers can also practise a combination of different land uses. Major food crops used globally to feed people and livestock are annual crops that mature in one year, are harvested and replanted the following year. These crops, however, are known to strip land off organic nutrients over time. Perennial crops, on the other hand, live longer than one year despite being harvested annually. They store more carbon, maintain better soil and water quality, and manage nutrients more conservatively than annual plants (ScienceDaily, 2009; Cox *et al.*, 2006). Most cash crops are perennial crops. Tenure insecurity and a desire for faster economic return may induce farmers to invest in annual crops and pasture rather than in perennial crops (Futemma and Brondizio, 2003).

Despite the importance of the relationship between land tenure and land use, most research work on land tenure in Kenya has concentrated on the interrelationships between land tenure and agriculture

productivity (Migot-Adholla *et al.*, 1991; Place and Hazell, 1993; Place and Migot-Adholla, 1998). This paper seeks to bridge the gap by empirically testing the effects of land tenure on land use using data at the plot level from Bondo, Busia and Siaya districts in Kenya.

1.4 Study Objective

The overall objective of this study is to assess if land tenure has a significant effect on land use. Specifically, the study seeks to:

- Examine if land tenure is related with the type of activity practised on land, for example livestock farming, food crop farming, cash crop farming or food and cash crop farming.
- Examine if land tenure affects land improvements.

1.5 Justification of the Study

Kenya has undertaken extensive land registration and titling programme since pre-independence. It is recognized as one of the few Sub-Saharan African countries with such extensive registration (Migot-Adholla *et al.*, 1991; Place and Hazell, 1993).

Vision 2030 recognizes land as an essential factor of production. Insecure land ownership is envisaged as a hindrance to sustainable and optimal land use in the country (Government of Kenya, 2007). Kenya Land Alliance (2002) lists the impacts of unsustainable land use practises in Kenya. Degradation of the environment leads to lower fertility and productivity of natural resources (such as soils) resulting in food insecurity and increased poverty. In order to achieve self-sufficiency, farmers who own small parcels of land overstretch their land leading to encroachment of idle land, especially in search of pasture. This leads to land-use conflicts. About 75 per cent of the country's population lives and depends on the 20 per cent of medium to high potential agricultural land, thus the need for good/sustainable land use (Government of Kenya, 2009). It is therefore important to empirically test if land tenure affects land use in rural Kenya, and thus inform the government's plan of undertaking extensive land titling and putting in place measures to control land use in the country.

2. Literature Review

2.1 Theoretical Framework

Convectional economic theory holds that secure property rights in land, especially individual property rights, are a pre-requisite for land development and economic growth (Miceli, Sirmons and Kieyah, 2001). The gains from property rights are traditionally seen as arising from three things: firstly, secure property rights create conditions that encourage investment by making long term planning possible as well as ensuring that rewards from the investment will be appropriated by the investor. Secondly, property rights make possible the functioning of credit markets and the use of land as collateral. Credit does not only leverage the use of land as an asset but provides resources for increased investment as well. Finally, secure property rights make commerce between farm owner and other people easier, expanding opportunities and thereby increasing gains from trade (Mooya and Cloete, 2008).

Besley (1995) presents a simple theory on how land rights could enhance investment incentives. In communal tenure systems, a customary authority, such as a tribal chief, grants claims and regulates transfers of land. Individualistic rights, mostly in form of private title, grants ability to transfer the land without needing a community sanction to the title holder. Consider an individual deciding at time *t* how much capital, denoted by k_t, to invest on a given field. The returns function for time *t+1* is $V(k_t, R_{t+1})$ and depends on property rights at *t+1* denoted by R_{t+1}. It is assumed that $V(.,.)$ is increasing in both arguments and concave in k_t. The cost of the investment is denoted by $c(k_t, R_{t+1})$, which is assumed to be increasing in k_t and non-increasing in $c(k_t, R_{t+1})$.

The optimal investment choice thus satisfies:

$$\max\{W(k_t, R_{t+1})\} \equiv V(k_t, R_{t+1}) - c(k_t, R_{t+1}) \tag{2.1}$$

It then follows that:

$$\frac{\partial k_t}{\partial R_{t+1}} = -\frac{W_{12}(k_t, R_{t+1})}{W_{11}(k_t, R_{t+1})} \tag{2.2}$$

Since $W_{11} < 0$ is at a maximum, it implies that investment increases as rights are improved if $W_{12} > 0$. Thus, farmers with secure property rights are more inclined to invest on their land, unlike those with insecure property rights.

According to Sinclair (1967), theories on land use and location can be traced back to Von Thunen's theory. The theorem examined the laws which governed the pattern of agricultural land use in the early 19th century. The theorem recognized that land use pattern depended upon competition between various types of agricultural use of a particular piece of land. The controlling factor in this competition was economic rent, defined as return from investment in the land. Transport costs were the primary factors determining economic rent and since the costs increased with distance, economic rent from any one land use can be expressed as a function of distance from the market. The theorem states that the form of land use providing the greatest economic rent would make the highest bid for the land and displace all others. Thus, the most productive land use will compete for the closest land to the market, and activities not productive enough will be located further away. The theorem has a set of assumptions: the land surrounding the market is flat and its fertility uniform, and there is one isolated market and farmers in the region utilized a single form of transportation to carry their products to the market. While the theorem may have its shortfalls, the issues of market access, distance and type and nature of road networks remain pertinent in Kenya. This study incorporates market distance as one of the independent variables.

2.2 Empirical Studies on Land Tenure

There are a number of research studies that have been undertaken on land tenure effects on agricultural productivity and investment in Kenya and other Sub-Saharan African countries. Migot-Adholla *et al.* (1991) used cross-sectional data from Ghana, Kenya and Rwanda in 1987-88 to investigate if indigenous land rights systems are a constraint on agricultural productivity. The data on land improvements and land productivity provided little support for the view that limitations under indigenous law on the right to transfer land are a constraint on productivity. Place and Hazell (1993) re-examined the Migot-Adholla *et al.* (1991) data set carrying out further analysis. The authors found out that land rights are not a significant factor in determining investments in land improvements, use of inputs, access to credit or the productivity of land.

Place and Migot-Adholla (1998) used data collected in four regions in Kenya to investigate the effects of land registration and title on security of tenure, use of formal credit, crop yields and land concentration. The

data came from Madzu and Lumakanda areas in Kakamega District and Kianjogu and Mweiga areas in Nyeri District. The areas of Madzu and Kianjogu represent traditional African farming areas (former African Reserves) with very high population densities, while Lumakanda and Mweiga are former exclusive white farming areas. This enabled the authors to contrast the impacts of registration under the two different conditions. The authors found no evidence to suggest land titling is related to farm productivity but that titles are acquired for enhancing security of rights rather than for increasing agricultural production.

Hayes *et al*. (1997) investigated the determinants of investment, input use and productivity under customary tenure in peri-urban areas of the Gambia. Using Generalized Probit Analysis, the authors found tenure security enhances long term investments which in turn enhance yields. Similarly, Alston, Lidecap and Schneider (1996) found that having a title led to more land-specific investment in the Brazilian frontier.

2.3 Land Use

Kenya Land Alliance (2002) gives a holistic overview of land use in Kenya. Land is currently the most important resource from which the country generates goods and services. The national economy is primarily agro-based. The major land-cover types in Kenya are forests, savannahs, grasslands, wetlands, fresh and saline water bodies and deserts. These are used for agriculture, pastoralism, water catchments, nature reserves, urban and rural settlements, industry, mining, transport and communication, tourism, recreation, fishing, cultural sites, forestry and energy.

About 2.4 per cent of total land cover is under indigenous and exotic forests. About 12 per cent of the land has high rainfall supporting cash crops, horticulture and floriculture, food crops and dairy farming. The semi-arid area covering about 32 per cent of total land has average rainfall and supports mixed crop and livestock rearing. Irrigated flower farming has in recent past emerged as a major type of land use. Over 50 per cent of the total land cover is arid, with extremely low and erratic rainfall. This expansive land is used for extensive livestock production under nomadic systems. Specific areas in the country with unique terrain have been set aside for forests, wildlife sanctuaries, water catchments, marine life and cultural sites. These are major tourist attraction sites.

Smucker (2002) examined the changes in land tenure and the impacts of those changes on land use and land management in Tharaka district. The author observed the changes in land use before land adjudication. He noted that in Tharaka, where commonage grazing has been a major component of livelihood strategies, land reform has brought about the demarcation of common grazing lands for private and government development and contributed to the decline in secondary resource access. As such, a general transition away from livestock keeping and towards more intensive crop production has characterized the majority of households throughout the district. The continued decline of secondary resource rights, combined with population growth, has led to high rates of adoption of a suite of conservation measures.

Much of the research on land tenure in Kenya and Sub-Sahara Africa in general has focused on the relationship between land tenure and investment in agricultural productivity, while the effect of land tenure on land use has received little interest. Smucker (2002) studied the change in land tenure regimes (specifically from customary to private tenure) and the impact this change has on land use and management. The empirical research involving land tenure and investment in Kenya has not so far indicated a significant relationship between the two, contrary to convectional economic theory. This study seeks to investigate the effect of different land tenure regimes on the type of land use being practised and land improvements using plot level data from three districts.

3. Methodology

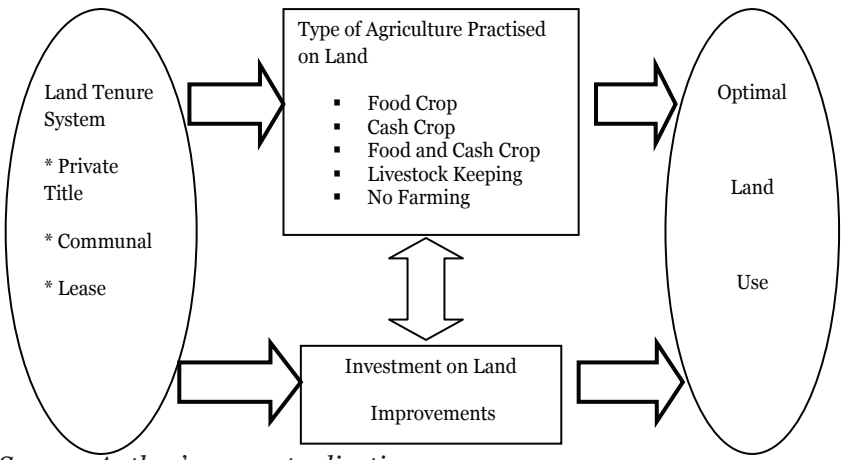
3.1 Conceptual Framework

The National Land Policy (Government of Kenya, 2009) states that the use of land in urban and rural areas as well as in the land/water interfaces has been an area of major concern to all Kenyans. Problems of unsustainable production, inadequate land use planning, poor environmental management and inappropriate ecosystem protection are common.

The conceptual framework on the effect of land tenure institutions on agriculture land use is shown in Figure 3.1. The conceptual framework closely follows that of Place and Hazell (1993).

Land tenure is one of the key factors that define patterns and change in land use. Tenure risks resulting to a greater need for faster economic return may induce farmers to invest in annual crops and pasture rather than in perennial crops (Futemma and Brondizio, 2003). Major crops used globally to feed people and livestock are based on an annual system, in which crops germinate and are harvested in one year, and replanted the following year. These systems are notorious for stripping organic nutrients from soil over time. Perennial systems, on the other hand, contain plants that live longer than one year, despite being harvested annually. Perennial crops produce more and require less input than annual crop lands (ScienceDaily, 2009; Cox *et al.*, 2006).

Figure 3.1: Conceptual framework of land use in relation to tenure security



Source: Author's conceptualization

Absolute ownership and discretion on use has resulted in many instances of absentee landlords (Waiganjo and Ngugi, 2001). This results to idle land that is underutilized.

While tenure insecurity is represented by the probability of being evicted from ones land, the farmer chooses between investment in capital equipment which is not lost in the event of an eviction, land improvements which are completely lost in the event of an eviction, and non-agricultural activities and assets which are unaffected by eviction (Hayes, Roth and Zepada, 1997). It then follows that farmers who feel more secure on their land (those with private titles or with long term leases), may have a higher probability of recouping the benefits from land improvements and will thus be more inclined to make medium or long term land improvements (Place and Hazell, 1993). A good investment on land improvements depicts good land use that translates into better productivity of the land.

The decision to invest on land improvements also depends on the type of farming to be undertaken on the farm. For example, terraces will be constructed by farmers with the intent to grow crops and not by livestock farmers. Absentee landlords, who own idle land that has no farming taking place, will most likely not invest on land improvements as they are not expecting to recoup their investment. While land improvements are meant to improve the quality of the land, some farmers may chose not to invest on them due to other constraints such as finances and lack of knowledge.

The two hypotheses of interest to be tested in this paper are:

i) Land tenure systems do not affect the type of land use

ii) Land tenure institutions do not affect land improvements

3.2 Model for Land Use

In this study, the dependent variables of interest are: type of land use (livestock keeping, cash crop farming, food crop farming, land with no farming or a combination of food crop and cash crop farming) and land improvements (if any land improvement was undertaken or not). The main independent variable of interest is land tenure (private title, communal and lease). Other independent variables include: plot location, characteristics of the plot owner (age, gender, education, occupation, etc), characteristics of the plots of land owned and farmed

by the households (size in acreage and type of soil of each plot in a household).

Our unit of analysis is at the plot level, with households and owner characteristics same for those with multiple plots. We thus use a model that gives consistent estimates of the regression parameters and take into account the correlation structure among different plots owned by one household.

The relationship between the independent variable land tenure, and the dependent variables type of agriculture practiced on the land and land improvements was investigated using generalized estimating equations (GEEs) (Liang and Zeger, 1986; Zeger and Liang, 1986). GEEs are an extension to generalized linear models that allow for clustering of responses. In this study, plots of land are clustered within households. In other words, different plots owned by one household are clustered together. Let y_{ij} be the binary outcome value for the i^{th} plot ($i=1,...,K$) in the j^{th} household ($j=1,...,n$) and x_{ij} be the covariate value for the i^{th} plot ($i=1,...,K$) in the j^{th} household ($j=1,...,n$). GEE models the marginal distribution of y_{ij}. We assume that the marginal density of y_{ij} is

$$f(y_{ij}) = \exp\left[\left\{y_{ij}\theta_{ij} - a(\theta_{ij}) + b(y_{ij})\right\}\phi\right] \tag{3.1}$$

where $\theta_{ij} = h(\eta_{ij})$, $\eta_{ij} = x_{ij}\beta$, x_{ij} is the covariate value for i^{th} plot ($i=1,...,K$) in j^{th} household ($j=1,...,n$) and $h(.)$ is a binomial canonical link function.

Let $R(\alpha)$ be a nxn symmetrical matrix which fulfills the requirement of being a correlation matrix, and let α be an $sx1$ vector which fully characterizes $R(\alpha)$. Liang and Zeger (1986) refer to $R(\alpha)$ as a 'working' correlation matrix.

$$V_i = A_i^{\frac{1}{2}} R(\alpha) A_i^{\frac{1}{2}} / \phi \tag{3.2}$$

where $A_i = diag\left\{a''(\theta_{ij})\right\}$ is an nxn diagonal matrix for i^{th} plot. V_i will be equal to $cov(Y_i)$, if $R(\alpha)$ is indeed the true correlation matrix for the Y_i's.

The generalized estimating equations are defined by

$$\sum_{i=1}^{K} D_i^{T} V_i^{-1} S_i = 0, \tag{3.3}$$

where $D_i = \left(d\left\{a_i'(\theta)\right\}/d\beta\right) = A_i \Delta_i X_i$, $\Delta_i = diag(d\theta_{ij}/d\eta_{ij})$ is an nxn matrix and $S_i = Y_i - a_i'(\theta)$ is of order $nx1$ for the i^{th} plot.

For each land use type and land improvement, the GEE regression model was selected following Villar *et al.* (2007) method as follows: first, for each potential confounding land owner, plot characteristic variable was assessed independently and those significant at 10 per cent retained. Secondly, all variables retained were included in a single model as predictors. The variables that are not significant at the 5 per cent significant level were discarded by fitting successive models, deleting variables one by one. The effect on the type of agriculture practiced and land improvements outcomes of each type of land tenure (Communal and lease) as compared with private title were expressed as odds ratio and 95 per cent Confidence Intervals (CI).

Odds ratio

Odds ratio are sometimes a better scale than probability to represent chance. They have a mathematical advantage in that, unlike probability, they are unbounded above (Faraway, 2006). Suppose we have two covariates x_1 and x_2, the usual GEE modelling for binary outcomes has the following setting:

$$\log it(\mu_{ij}) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} \tag{3.4}$$

where $\mu_{ij} = E(y_{ij}) = a'(\theta_{ij}),\ \log it(p) = \log(p/(1-p)) = \log(odds)$

Estimation of β is obtained by solving the generalized estimating equations given by 3.3 (Barnhart and Williamson, 1998). Now β_1 can be interpreted as follows: a unit increase in x_1 with x_2 increases the log-odds of success by β_1 or increases the odds of success by a factor of β_1 (Faraway, 2006).

The odds ratio allowed for comparison of the effects of land tenure regimes on different land uses.

Confidence intervals

Suppose a statistic *t* is computed from a random sample for an unknown parameter θ in the population from which the sample has been drawn. Suppose c_1 and c_2 are constants such that

$$P[c_1 < \theta < c_2, \textit{for given value of } t] = 1 - \alpha \tag{3.5}$$

where α is the level of significance. The interval c_1, c_2 within which the unknown value of the parameter θ is expected to lie is known as confidence interval (CI). The limits c_1 and c_2 so determined are known as confidence limits. If *t* is the statistics used to estimate the parameter θ, then

$$(1-\alpha)\%\ confidence\lim its\ for\ \theta = t \pm S.E.(t) \times t_{\alpha} \quad (3.6)$$

where t_{α} is the significant or critical value of t at α level of significance, *S.E.(t)* is the Standard Error of the sampling distribution of the statistics (Gupta, 2009). In this paper, α=0.05 which gives 95 per cent confidence limits, the statistics are the coefficient estimates and their robust standard errors. The confidence intervals are computed on the log-odds scale and then the endpoints transformed as follows (Faraway, 2006):

$$\exp onetial(t \pm S.E.(t) \times t_{\alpha}) \quad (3.7)$$

3.3 Data

To investigate the effects of land tenure on land use, we use data from a 2005 field survey undertaken by the Kenya Institute for Public Policy Research and Analysis (KIPPRA) on rural households that are involved in papyrus related activities in the Yala wetland along the shores of Lake Victoria in Kenya. Papyrus mostly grows along the shores of lakes Victoria, Kanyaboli, Namboyo and Sare. It is not grown by people on their farms. Individuals of the households selected had to travel from their farms to areas along the shores of the lakes in order to harvest papyrus. Thus, though the data was collected from papyrus harvesters, the likelihood of homogeneity on the type of agriculture practised and land tenure is minimal, if any. Further, the households were randomly selected in a span of eight villages in three different districts, reducing bias (Ikiara, Mwakubo and Nyang'oro, 2009).

A total of 318 households were randomly selected and interviewed in the Yala swamp that spans three districts: Bondo, Busia and Siaya. A myriad of information was collected from each household but for purposes of this study, we restrict ourselves on the location characteristics, characteristics of the household head and characteristics of the plots of land owned and farmed by the households. Table 3.1 lists the variables of interest in this study.

A binary variable for secondary occupation was created from the variables main occupation and secondary occupations. It was coded as a YES, if either the main occupation or the secondary occupation of the household head had a different occupation other than farming. The number of people in a household, including the household head, was counted and another variable, household size, created.

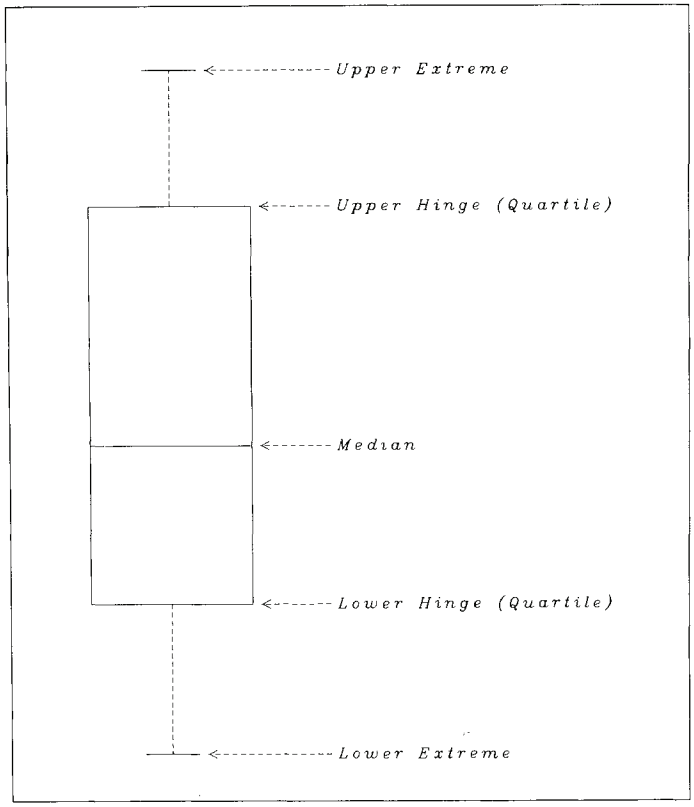
Table 3.1: List of variables used in the study

Variable	Type	Factor levels
Household head/Land owner characteristics		
Gender of land owner	Factor	Male, female
Age	Integer	
Place of birth	Factor	Same location, same location but different village, other regions.
Years lived in the village	Integer	
Marital status	Factor	Single, married monogamous, married polygamous, widow
Religion of land owner	Factor	Catholic, protestants, other religions
Education level	Factor	No education, primary, secondary, diploma and degree
Secondary occupation	Factor	No other occupation, has another occupation other than farming
Household size	Integer	
Land characteristics		
Division	Factor	Boro, Bundalangi, Uranga, Usigu
Plot area (acres)	Integer	
Tenure	Factor	Private title, lease, communal (main independent variable)
Land use	Factor	No farming, livestock keeping, cash crop, food crop, food and cash crop (dependent variable)
Soil type	Factor	Rocky, red, black, mixed soils
Slope	Factor	Flat, slight slope, moderate flat, steep slope
Land improvement	Factor	No land improvement, land improvement (dependent variable)
Market distance (KMs)	Integer	

Source: 2005 KIPPRA field survey

The data is presented in percentages, box plots and trellis graphs generated using R (2009), a language and environment for statistical computing. A box plot is a graphical plot that shows the overall shape of a set of data by a box with whiskers. The central box shows 50 per cent of the data that is between the lower and upper quartiles. The box is usually oriented so that the whiskers are vertical and extend from the ends of the box to the minimum and maximum of the data. The median is represented by a horizontal line across the box. Very extreme points (outliers) are plotted separately as points, circles or asterisks (Dewey, 1992; Venables and Ripley, 2002). Figure 3.2 shows the general structure of a box plot.

Figure 3.2: Configuration of a box plot

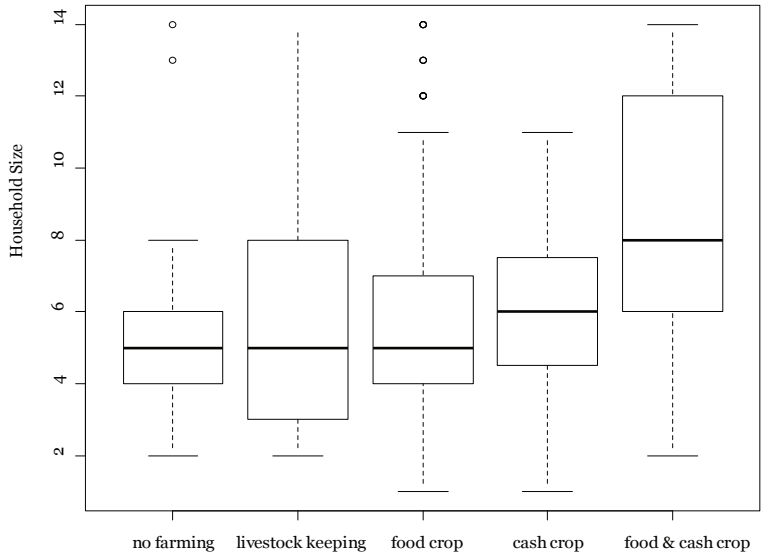


Source: McGill et al., 1978

The bottom 25 per cent of the data sample is represented by the space between the lower whisker and the box, the middle 50 per cent within the box, and the remaining 25 per cent is contained between the box and the upper whisker. The location of the box within the whiskers can provide insights on the normality of the sample's distribution. If the box is shifted significantly to the lower end, it is positively skewed; if the box is shifted significantly to the high end, the sample is negatively skewed.

Side-by-side box plots are a good way of displaying the relationship between qualitative and quantitative variables (Faraway, 2006). These are usually good for comparing different scenarios, for example the effect of a drug treatment on a number of epileptic seizures compared to placebo treatment. Figure 3.3 is a good example where box plots of different land uses are plotted on the same scale against household size to allow comparison.

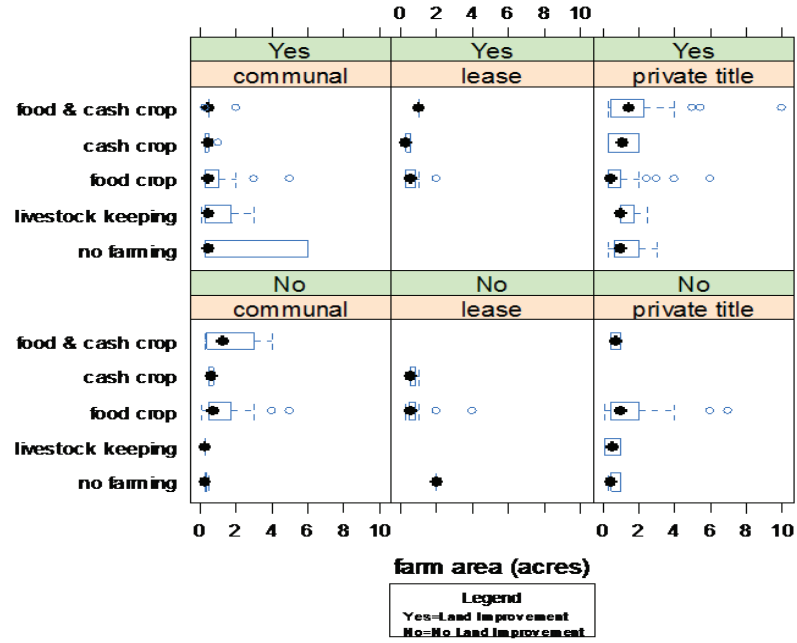
Figure 3.3: Box plots of different land uses against household size



Source: Author's compilation using the 2005 KIPPRA field survey data and generated using R (2009) software

Trellis display is a framework for the visualization of multivariable datasets. Its most prominent aspect is an overall visual design, reminiscent of a garden trelliswork, in which panels are laid out into rows, columns and pages. On each panel of the trellis, a subset of the data is graphed by a display method such as a scatterplot, curve plot, box plot, 3-D wireframe, normal quantile plot or dot plot. Each panel shows the relationship of certain variables conditional on the values of other variables. Trellis display is a powerful visualization technique that uncovers the structure of the data even when the structure is quite complicated. It helps in understanding interactions in studies of how a response depends on explanatory variables (Becker, Cleveland and Shyu, 1996). In this study, the trellis display uses box plots to plot subsets of the data of different land uses against farm areas conditioned on the different land tenure systems (private title, leases and communal) and land improvement (Figure 3.4).

Figure 3.4: Trellis graph of box plots of different land uses against farm area in acres conditioned on land tenure and land improvement



Source: Author's compilation using the 2005 KIPPRA field survey data and generated using R (2009) software

4. Results and Discussion

4.1 Descriptive Statistics

A total of 318 households were randomly selected and interviewed in Bondo, Busia and Siaya districts. Out of these sampled households, 23 did not own and farm any land and are thus excluded from the analysis. Most of the households had more than one plot on which they practised a variety of land uses. In total, there were 495 plots. Boro division had 88 plots, Budalangi division 33 plots, Uranga division 242 plots, and Usigu 132 plots. Usigu division had the largest number of plots with titles (100 plots), followed by Uranga with 95 plots, Boro 47 plots and Budalangi with 6 plots, the least. For communal tenure, Uranga had 102 plots, Boro 34 plots, Usigu 29 plots and lastly, Budalangi with 21 plots. Uranga had the largest number of leases (40 plots), Boro 7 plots, Budalangi 6 plots, and Usigu 3 plots.

About 57 per cent of all plots had land improvement compared to 43 per cent that did not have any land improvements. Land under private title had the biggest proportion (31%) of land with improvements, followed by communal land at 20 per cent and leased land with the lowest proportion (6%).

For those plots that did not have any land improvements, private titled land constituted 20 per cent, communal plots 18 per cent, and leased land 5 per cent. We note in any land tenure category, the difference in proportion between those plots that had land improvements and those that did not, was actually not big with the exception of land under private title where more plots had land improvements (31%) compared to those with no land improvements (20%).

The area surveyed recorded different land uses: 51 plots were under food and cash crop farming, 19 plots under cash crop farming, 17 plots for livestock keeping, while 385 plots were under food crop farming. There were 21 plots that did not have any farming taking place at the time of the study. For those plots under food crop farming, 48 per cent were held under private titles, 40 per cent under communal tenure, while 12 per cent were on lease. For the land under both food and cash crop farming, 74 per cent were in private titles and 24 per cent under communal system. Livestock keeping was practised in 71 per cent of land with private titles, and 29 per cent on communal land. None of the land under lease was used for livestock keeping. For cash crop farming,

it was worth noting that 53 per cent of the land used was leased, 37 per cent communal, while only 11 per cent was under private title. For the farms with no farming activity at the time of the study, majority had private titles (52%), followed by communal land (43%) and leased land (5%).

Figure 3.3 shows box plots of different land uses plotted against household size. Looking at the position of the box plot of households growing both food and cash crops in comparison to the other land uses, we note that these households were the biggest in size compared to those practising other land uses. This box is shifted to the higher side of the whiskers indicating that these households were negatively skewed, thus in this land use, majority of the households had many people residing in them with a median household size of eight people. For those households involved in livestock keeping and those growing food crops, the boxes are shifted to the lower end depicting a positively skewed distribution, indicating that the majority of households practising these types of land uses had few people (Figure 3.3).

Figure 3.4 shows trellis display of box plots of different land uses against farm areas conditioned on land tenure and land improvement. The top panel shows the land uses where the farms had land improvements, while the lower box plots show different land uses where the farms did not have any land improvement. This graph helps in comparison between farm area under different land uses in the three land tenure systems against those with land improvements and those without. For example, you can compare the different land uses under communal tenure but with land improvements (first top panel) and those without land improvement for the same communal tenure (first lower panel).

From the graph, all the box plots with the exception of few outliers plotted as small circles, are located at the lower side of the graphs indicating that majority of the farmers in the Yala region own small parcels of land. Comparing the size of the box plots of farm areas under private titles, we note that more land area had land improvements compared to that without. However, for the land area under food crop farming, as much land under different land tenure systems was with improvement as that land that did not have any land improvement. The same is observed for cash crop farming but under communal and lease systems. For those farms that no farming was taking place at the time of the study, more land area had land improvements despite no

farming taking place compared to those farms that did not have any land improvement (Figure 3.3). Under livestock keeping, more land area with private titles and communal system had land improvements compared to the farms without land improvements under the same tenure systems.

The level of missing values among the land owner and plot characteristics variables of interest was less than or equal to 1.2 per cent, except household market distance which had 3.2 per cent missing values. Thus, none of the variables of interest had more than 5 per cent missing values.

4.2 Results

4.2.1 Land improvement

Land improvements simply refer to investments by farmers/land owners on land to make it more usable/habitable. Examples include terracing, planting trees, soil bunds, drainage and irrigation systems among others. In the survey area, out of the 495 plots surveyed, 57 per cent of them had land improvements, while the rest (43%) did not have.

Generalized Estimating Equations (GEE) (Liang and Zeger, 1986; Zeger and Liang, 1986) were used to explore the relationship between land improvements and tenure security (communal, lease and private title) using plot level data. The relationship is indicated by odds ratio with 95 per cent confidence intervals (CI) and the results are in Table 4.1.

The effect of different land tenure systems on land improvement is statistically significant at 5 per cent (Table 4.1). The odds ratio for a plot having land improvements was increased 1.72 times (95% C.I: 1.03-2.90) for those plots held under private titles compared to those under communal regime. However, for leased land, the odds ratio for a plot having land improvements was reduced by 0.70 times (95% C.I: 0.30-1.62) compared to those held in communal system.

The type of land use being practised on land affects the possibility of investing on land improvements or not. The odds ratio of investing on land improvements were increased by 13.95 times for those farmers practising food and cash crop farming compared to those plots that did not have any farming taking place. For livestock farmers, the odds were increased by 10.72 times of investing in land improvements compared

to those farms that did not have any farming taking place. Cash crop farming had an increased odds ratio of 5.40 times of undertaking land improvements in comparison to those where no farming was taking place. Food crop farming had the least increase in odds ratio for land improvements (1.96; 95% C.I: 0.75-5.07).

The divisional variable was significant indicating that the location of the farm had an influence on the decision to invest on land improvements or not. For instance, farms in Uranga had an increase in odds ratio by 15.90 times (95% C.I: 7.39-34.23) of undertaking land improvements compared to those farms in Boro division. Actually, looking at the data, 73 per cent of farms in Uranga had land improvements, while only 20 per cent of farms in Boro had land improvements.

Table 4.1: Relationship between land tenure and land improvements

		Estimate	Robust S.E.	P value	Odds ratio (95% C.I)
Land tenure	Lease	-0.3575	0.4295	0.41	0.70 (0.30-1.62)
	Private title	0.5464	0.2648	0.04	1.72 (1.03-2.90)
Division	Budalangi	0.9881	0.5524	0.07	2.69 (0.91-7.93)
	Uranga	2.7665	0.3911	<0.01	15.90 (7.39-34.23)
	Usigu	1.2634	0.3678	<0.01	3.54 (1.72-7.27)
Land use	Livestock keeping	2.3721	0.8797	0.01	10.72 (1.91-60.12)
	Food crop	0.6712	0.4862	0.17	1.96 (0.75-5.07)
	Cash crop	1.6856	0.7725	0.03	5.40 (1.19-24.52)
	Food & cash crop farming	2.6357	0.7489	<0.01	13.95 (3.21-60.56)
Marital status	Married monogamous	2.0457	0.9419	0.03	7.73 (1.22-49.00)
	Married polygamous	2.5240	1.0182	0.01	12.48 (1.70-91.81)
	Widow	1.8098	0.9586	0.06	6.11 (0.93-39.99)
Place of birth	Same location different village	-1.1764	0.6113	0.05	0.31 (0.09-1.02)
	Same district different locations	0.0706	0.3124	0.82	1.07 (0.58-1.98)
	Other regions	-0.3336	0.4455	0.45	0.72 (0.30-1.72)

Source: GEE regression results from the 2005 KIPPRA field survey data and generated using R (2009) software

The marital status of the land owner had an impact on land improvements. It was interesting to note that for those who were married in a polygamous setting, their odds ratio of investing on land improvements was increased by 12.48 times compared to single land owners.

4.2.2 Land use

There are five types of land use that were identified in this study namely: food crop farming, cash crop farming, food and cash crop farming, livestock keeping and those farms that no farming activity was taking place at the time of the survey. For each of the land use, a binary variable was created with a success being the practising of a particular land use on the plot. Generalized Estimating Equations (GEE) (Liang and Zeger, 1986; Zeger and Liang, 1986) were used to explore the relationship between land tenure, each of these land uses and the results presented by odds ratio with 95 per cent confidence intervals (Tables 4.2 and 4.3).

For those farms that did not have any farming taking place at the time of the survey, land tenure is not statistically significant (Table 4.2). The location of the plot is affected if farming takes place or not. The odds ratio of not farming increased by 25.85 times for Uranga division compared to Boro division (Table 4.2). Looking at the data, it shows that 62 per cent of those farms that did not have any activity taking place were in Uranga division.

The type of soil affected the lack of farming on a plot. For red, black and mixed soils, the odds ratio of not farming were reduced by 0.29 (95% C.I: 0.05-1.61), 0.15 (95% C.I: 0.03-0.91) and 0.06 (0.01-0.40) times to those farms that were rocky. In other words, those plots whose soils were rocky had higher odds ratio of having no farming activity compared to those plots with other types of soils. The slope of the plots was significant for those farms without farming activity. Plots whose slope was steep increased the odds ratio of having no farming activity by 1.35 times (95% C.I: 0.11-16.01) of those farms with flat slope.

Land tenure is not statistically significant for food crop farming (Table 4.2). In other words, it does not matter if land is leased, communal or held under private title; people will plant food crops in any of these tenure systems. The place of birth of the land owner affected food crop farming with those born in the same location but different villages, increasing the odds ratio of farming food crops by

Table 4.2: Relationship between land tenure, food crop farming and those farms that did not have any farming activity taking place

		Estimate	Robust S.E.	P value	Odds ratio (95% C.I)
No farming					
Land tenure	Lease	-1.2210	1.0089	0.22	0.29 (0.04-2.13)
	Private title	-0.6459	0.5173	0.21	0.52 (0.19-1.44)
Division	Budalangi	1.4958	1.1583	0.20	4.46 (0.46-43.21)
	Uranga	3.2524	1.2929	0.01	25.85 (2.05-325.90)
	Usigu	0.7426	0.9652	0.44	2.10 (0.32-13.93)
Religion	Protestant	-1.6737	0.7294	0.02	0.19 (0.04-0.78)
	Others	-0.8691	0.6812	0.20	0.42 (0.11-1.59)
Soil	Red	-1.2423	0.8758	0.16	0.29 (0.05-1.61)
	Black	-1.8663	0.9071	0.04	0.15 (0.03-0.91)
	Mixed	-2.8451	0.9815	0.004	0.06 (0.01-0.40)
Slope	Slight slope	-1.9681	1.0611	0.06	0.14 (0.02-1.12)
	Moderate flat	-1.3428	0.9202	0.14	0.26 (0.04-1.58)
	Steep slope	0.3022	1.2607	0.81	1.35 (0.11-16.01)
Food crop farming					
Land tenure	Lease	-0.2517	0.4408	0.57	0.78 (0.32-1.84)
	Private title	-0.3361	0.2936	0.25	0.71 (0.40-1.27)
Place of birth	Same location Different village	1.1131	0.6620	0.09	3.04 (0.83-11.14)
	Same district different location	-0.2740	0.3395	0.42	0.76 (0.39-1.48)
	Other regions	-0.4403	0.4798	0.36	0.64 (0.25-1.65)
Household size		-0.1993	0.0450	<0.01	0.82 (0.75-0.89)
Soil	Red	0.8242	0.6364	0.19	2.28 (0.66-7.94)
	Black	-0.1015	0.6324	0.87	0.90 (0.26-3.12)
	Mixed	1.3216	0.6343	0.04	3.75 (1.08-12.00)

Note: Land tenure is not significant for both food crop farming and those farms without any farming activity
Source: GEE regression results from the 2005 KIPPRA field survey data and generated using R (2009) software

Table 4.3: Relationship between land tenure, cash crop farming and farming of both food and cash crop

		Estimate	Robust S.E	P value	Odds ratio (95% C.I)
Cash crop farming*					
Land tenure	Lease	1.7585	0.5345	<0.01	5.80 (2.04-16.54)
	Private title	-1.4227	0.8073	0.08	0.24 (0.05-1.17)
Years lived in the village		0.0422	0.0133	<0.01	1.04 (1.02-1.07)
Plot area (acres)		-0.9682	0.5559	0.08	0.38 (0.13-1.13)
Food and cash crop farming					
Land tenure	Lease	-1.5125	0.9907	0.13	0.22 (0.03-1.54)
	Private title	0.7166	0.3425	0.04	2.05 (1.05-4.01)
Gender of land owner (Male)		0.4613	0.3949	0.24	1.59 (0.73-3.44)
Religion	Protestant	0.4537	0.4866	0.35	1.57 (0.61-4.08)
	Others	1.3175	0.4987	0.01	3.73 (1.40-9.92)
Household size		0.2613	0.0588	<0.01	1.30 (1.16-1.46)
Plot area (acres)		0.2267	0.1124	0.04	1.25 (1.01-1.56)

* Cash crops basically refer to those crops grown for sale. In this paper, cash crop refers to perennial crops.

Source: GEE regression results from the 2005 KIPPRA field survey data generated using R (2009) software

3.04 times (95% C.I: 0.83-11.14) of those who were born in the same location and village.

Household size is statistically significant for food crop farming (Table 4.2), reducing the odds ratio by 0.82 times (95% C.I: 0.75-0.89). In other words, households involved in food crop farming were smaller in size with a median size of five people per household (Figure 3.2). The type of soil affects food crop farming. Red soil increased the odds ratio of food crop farming by 2.28 times (95% C.I: 0.66-7.94) compared to rocky soil, while mixed soil increased the odds ratio by 3.75 times (95% C.I: 1.08-12.00) for food crop farming (Table 4.2).

Land tenure was statistically significant for cash crop farming (Table 4.3). Leased farms increased the odds ratio of cash crop farming by 5.80 times compared to communal land. However, private titling reduced the odds ratio by 0.24 times (95% C.I: 0.05-1.17) of communal farms. The years the farm owner had lived in the village increased the odds ratio for cash crop farming by 1.04 times (95% C.I: 1.02-1.07). Those

who had lived in a village for longer grew cash crops. Plot area was slightly not significant for cash crop farming (Table 4.3).

Land tenure was statistically significant for land use involving farming of both food and cash crop (Table 4. 3). Land under private title increased the odds ratio of food and cash crop farming by 2.05 times (95% C.I: 1.05-4.01) compared to communal land, while leased land reduced the odds ratio by 0.22 times (95% C.I: 0.03-1.54) of communal land.

Household size affects food and cash crop farming (p value =<0.01; Table 4.3) increasing the odds ratio of this type of land use by 1.30 times (95% C.I: 1.16-1.46). Thus, this type of farming was characterized by large households with a median of eight people in a household (Figure 3.2). The size of the farms was statistically significant for this type of farming, increasing the odds ratio of growing both food and cash crops by 1.25 times (95% C.I: 1.01-1.56). Thus, food and cash crop farming was practised on large farms. The models for livestock keeping collapsed due to insufficient data.

5. Conclusion and Policy Recommendations

The analysis of the Yala wetland data indicated that land tenure affects investment on land improvements. Private title had an increased effect of undertaking land improvements compared to communal held farms. Land improvements are worthy investments that lead to better utilization of land, consequently increasing agricultural productivity, while reducing soil erosion and degradation and thus enhancing food security. Investment on land improvements should therefore be encouraged. Investment on land improvements require capital, and farmers need to feel secure on their land and a sense of guarantee of recouping their investments. The Ministry of Land needs to speed up land reforms, giving priority to agricultural areas that will enhance food security in the country which is in line with Vision 2030.

The type of land use practised on the farms affected the decision to invest on land improvements. The four types of land use identified in this study namely livestock keeping; food crop farming; cash crop farming and the growing of both food and cash crops increased the probability of investing on land improvements as compared to those farms that did not have any farming activity taking place. Vision 2030 indicates that there is a total of 457,000 hectares of land with potential for crop farming, but is currently idle in the study area and a total of one million hectares that could be available for crops in the whole country (Government of Kenya, 2008). Our analysis has shown that those who undertake farming activities are more likely to invest on land improvements unlike their counterparts who leave their land idle. The findings thus support the government's plan on land taxation that is meant to discourage land hoarding for speculative purposes and under utilization of land as stipulated in the National Land Policy (Government of Kenya, 2009). One of the envisaged problems of land taxation is ensuring tax is billed to the right person. It is therefore imperative for the government to start by computerizing land records throughout the country and mapping land parcels and their use using Geographical Information Systems (GIS). The computation of the tax and its political implications are areas that need careful consideration.

Our analysis did not indicate a significant effect of land tenure on those farms that did not have any farming activity at the time of the study. However, the type of soils on a particular farm affected the possibility of there being some farming activity or not. Our results show that those farms with rocky soils had higher odds ratio of not

having any farming activity compared to the other type of soils. Having unsuitable soils on ones farm should not be a hindrance to undertaking profit generating farming activities that may not necessary depend on the type of soil, for example bee keeping and fish farming among others. The government should encourage farmers with such types of farms to undertake this kind of farming, thus raising the economic standards of the farmers and encouraging optimal land use.

Land tenure did not have any significant effect on food crop farming. Farmers would grow food crops on any piece of land available irrespective of communal ownership, leased for duration of time or held under private title. People will cultivate land for food crop growing even along road reserves, if only to cater for their household consumption. This scene is replicated in most regions of Kenya. It is no surprise that this type of farming was characterized by small households in the study area. While people may grow food crops on any piece of land irrespective of the land tenure regime being good for the country's food security impetus, this may have a significant impact on land degradation. Food crops are known to strip land of organic nutrients over time (Cox *et al.*, 2006). Our results showed that among the four different land uses identified in this study, food crop farming had the least increase of odds ratio of investing in land improvements (1.96; 95% C.I 0.75-5.07). It is therefore imperative for the government to hasten land reforms that will encourage farmers to invest in land improvements and adopt better farming methods to reduce land degradation.

For cash crop farming, whether grown alone or together with food crops, land tenure was statistically significant. Unlike annual crops, perennial crops store more carbon, maintain better soil and water quality, and manage nutrients more conservatively than annual crops (Cox *et al.*, 2006). Cash crops are mostly perennial crops. Futemma and Brondizio (2003) indicated that tenure insecurity and a desire for faster economic return may induce farmers to invest in annual crops and pasture rather than in perennial crops. There is need to encourage more cash crop farming by putting in place more secure tenure systems and educating farmers on the advantages of cash crop farming.

5.1 Areas for Further Research

Approximate market distance from the households was incorporated in our analysis. This variable was not significant. Geographical

Information System (GIS)–derived measures of location and space have increasingly been used in models of land use and ecology (Staal *et al.*, 2002). Location, with all its dimensions of market access, demographics and agro-climate, would help in a better understanding of land use in Kenya. Staal *et al.* (2002), while comparing GIS-derived variables and survey estimated variables of location showed that GIS-derived variables yield more practical interpretations and were used to make spatial predictions. GIS technology can be explored to investigate different land uses in Kenya.

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