CHAPTER IV

POVERTY, PROPERTY RIGHTS AND LAND MANAGEMENT IN UGANDA

4.1. Introduction

Like in many other developing countries, poverty is one of the major challenges facing policy makers in Uganda. Though poverty was reduced during the 1990's, more recent estimates indicate a national increase in poverty by four percentage points (Appleton and Sewanyana, 2003). About half of the rural households are classified as poor and poverty is more acute for those practising crop farming than among those engaged in non-crop agriculture like livestock and fishing (GOU, 2004b). The fact that, agriculture remains the key economic activity in Uganda (contributing 40% of the GDP, 85% of export earnings and 80% of employment) and the main source of livelihood for the vast majority of the population, especially in the large subsistence segment, indicates the importance of this sector's performance for food security and poverty reduction (GOU, 2004b and NEMA, 2002).

Recent studies show that the major cause of low incomes in the rural areas of Uganda has been stagnating agricultural production (Deininger and Okidi, 2001). One major constraint to improved agricultural productivity in Uganda, as in much of the sub-Saharan African (SSA) countries is land degradation. Exacerbated by poverty, fast growing population, and inadequate tenure security, land degradation poses a threat to national and household food security and the overall welfare of the rural population in Uganda (Nkonya *et al*., 2004).

Poverty acts as a constraining factor on households' ability to invest in mitigating land degradation. Poor households are unable to compete for resources, including high quality and productive land and are hence confined to marginal land that cannot sustain their practices which perpetuate land degradation and further poverty (Kabubo-Mariara, 2003). The poor and food insecure households may contribute to land degradation because they are unable to keep fallow, make investments in land improvements or use costly external inputs (Reardon *et al*., 2001). Majority of the smallholder farmers in Uganda cannot afford these necessary inputs. Due to credit constraints, inadequate tenure security, as well as weak institutions, poverty can also cause farmers to take a short-term perspective, which limits the incentives for long-term investments in soil conservation (Holden *et al*., 1998; Shiferaw and Holden, 1999; Pender *et al*., 1996).

Surprisingly, despite the level and extent of land degradation and government's effort to promote the use of soil conserving techniques, the rate of adoption of this technology is still very low in Uganda. Technology adoption is still below 30 percent (Nkonya et al., 2004). Thus land degradation and therefore poverty are bound to continue worsening unless immediate intervention policies are put in place. Designing appropriate intervention programs requires proper understanding of the factors that determine the adoption of environmental conservation practices. It is of particular interest to understand the role of poverty in land degradation. Given that government resources to eradicate poverty are limited, targeting specific aspects of poverty that critically limit farmers ability to invest in soil conservation and enhance agricultural productivity would help more rational and effective allocation of such limited resources.

More so, designing appropriate interventions may also require understanding the social institutional frameworks under which such policies to curb land degradation operate. The social institutional structure may facilitate knowledge transfer, greater cooperation, coordination and monitoring of effective public service delivery and ameliorate resource constraints such as credit, markets, and farm equipments all important for adoption and diffusion of agricultural technologies.

In Uganda, studies investigating how social structures that vary from one village to another may affect diffusion and adoption of soil fertility management (SFM) and conservation technologies are non-existent despite existent of a wide heterogeneity of tribal affiliations, formal and informal social organisations in the country. This is also despite the fact that empirical literature suggests social capital affects adoption and diffusion of land management technologies (Isham, 2000; Reid and Salmen, 2000; Nyangena, 2005; Rogers, 1995). Rogers (1995) argues that the heart of technology diffusion consists of interpersonal network exchanges between individuals who have already adopted an innovation and those influenced to do so. Barbier (2000) also argues that the successes of Machakos[3] in Kenya may not be replicated elsewhere because communities in that area didn't appear to have rigid social structures, which inhibit individuals or sub-groups from collaborating

Earlier attempts to investigate the impact of poverty on adoption of soil conservation practices in Uganda are limited. The only available studies (Pender et al., 2004; Nkonya et al., 2005) though good foundation for further analyses, provide inconclusive results. These studies use a series of indicators such as education, income, natural and physical capital to measure poverty and come up with inconsistent results. By using binomial decision models, the mentioned studies treat adoption choices as being independent of each other and exclude useful economic information contained in the interdependence and simultaneity of adoption decisions (Dorfman, 1996; Wu and Babcock, 1998; Bekele and Drake, 2003).

Applying a multinomial logit model (MNL) to a data set purposefully collected by the World Bank and the International Food Policy Research Institute (IFPRI)[4], this study intends to answer the following questions:

i. What factors determine adoption of SFM and conservation practices by smallholder farmers in Uganda?
ii. How important is the role of land tenure and property rights for SFM and conservation practices?
iii. How does social capital affect SFM and conservation practices?

[3] See also English et al., 1994, Tiffen et al., 1994, on the success story of Machakos district in Kenya.
[4] Am grateful to Kirk Hamilton (World Bank) and Ephraim Nkonya (IFPRI) for facilitating access to this data set.

iv. How important is household poverty in explaining adoption of SFM and conservation, and which particular SFM and conservation technologies are most affected by the level of poverty?

The rest of the chapter is organised as follows; a short survey of relevant theoretical and empirical literature is presented in section two. Section three presents the analytical model used to estimate the determinants of SFM conservation practices in Uganda. Section four discuses the choice of variables as well as the empirical implementation of the model. MNL results are discussed in section five while section six provides the conclusions and policy implications.

4.2. The linkages between poverty, tenure security, social capital and land degradation

4.2.1 Poverty and land degradation

Many theoretical studies have conceptualised the link between rural poverty and the environment as a "downward spiral", where poverty coupled with population growth lead to environmental degradation and thus further enhancing poverty (Scherr, 2000; Mink, 1993, Dasgupta, 1995; Dasgupta and Maler, 1994; and Ekbom and Bojo, 1999). Many of these studies argue that poor farmers are limited to labour intensive production strategies, as they are unable to use external inputs such as fertilisers to support sustainable intensification and are therefore destined to contribute to natural resource degradation (Mink, 1993 and Ekbom and Bojo, 1999).

On the other hand, Reardon and Vosti, (1995) argue that poverty should not be treated as a single concept but should be disaggregated to identify the particular elements that are responsible for the linkage between poverty and environmental degradation. For instance, a household may be poor in spite of the fact it is endowed with some natural resource assets but lacks other complementary assets like human capital or farm physical and financial assets.

Researchers have tried to study factors that reduce poverty and at the same time enhance investment in land management (Barrett *et al*., 2005). These efforts led to an important approach to identifying factors, which will simultaneously improve conservation and poverty outcomes (Vosti and Reardon, 1997; Duraippah, 1998 and Barrett *et al*., 2005).

4.2.2 Land tenure security and investment in SFM and conservation

The literature also tends to suggest that incomplete property rights reinforce the vicious poverty-environment circle (Duraippah, 1998; Ekbom and Bojo 1999 and Scherr, 1999). This line of argument proposes that insecure tenure rights on land and the imperfect functioning of land markets tend to reduce incentives for smaller rural farmers to invest in long-term conservation measures such as planting trees, and soil conservation structures. This line of argument also suggests that, investment in soil conservation measures can only be undertaken when sufficient returns are expected or guaranteed. This is possible, when tenure security is well defined.

Tenure security in this study is defined as the perceived probability or likelihood of loosing ownership of or a part or the whole of ones land without his or her consent (Holden and Yohannes, 2001; Sjaastad and Bromley, 1997). Through investment in conservation, farmers are expected to improve their productivity, leading to increased agricultural output and increased income and therefore their wealth (Holden and Yohannes, 2001). As Dieninger and Feder (1998) put it, by providing incentives for exerting non-observable extra efforts and for use of purchased inputs, tenure security may also have an impact on productivity and farm output even in the short-run.

Several studies have investigated the impact of land rights on investment in conservation activities in developing countries. Surprisingly, despite the well thought theoretical links, results from studies that link tenure security and investment in conservation activities are contradictory and inconclusive. For instance, some studies show that tenure security is not important in conservation (Migot-Adholla et al., 1991; Place and Hazel, 1993; Brasselle et al., 2002), while others argue that land rights are important for investment in conservation activities (Shiferaw and Holden, 1999b; Deininger and Minten, 1999; Place and Otsuka, 2000; Place and Swallow, 2000; Gabremedhin and Swinton, 2003; Kabubo-Mariara, 2003). These differences are either brought about by differences in measurement of tenure security, or empirical conceptualization of the relationship between investments and tenure rights (Otsuka, 2000; Kabubo-Mariara, 2003).

4.2.3 Social capital and investment in SFM and conservation

Empirical studies show that greater social capital through information sharing, and collective action results in improved adoption and diffusion of technology (Isham, 2000; Reid and Salmen, 2000; Nyangena, 2005). Reid and Salmen (2000) found that social capital (measured in form of trust) is a key determinant of the success of agricultural extension in Mali. By classifying trust into three categories (i.e. trust among farmers, between farmers and extension workers, and extension workers and national institutions), Reid and Salmen (2000) could disaggregate the most important aspects of trust. They however found that all aspects of trust were important in explaining the level and extent of technology adoption. It was also established that social cohesion seen as attendance of social meetings, meetings at churches, cooperation in public goods provision, creates ground for external inputs such as agricultural extension to take root. Women organizations were also found to be consistent diffusers of information and technology (Reid and Salmen, 2000).

In support of the Reid and Salmen (2000) findings, Isham (2000) considered two dimensions of local civil society, the ethnic homogeneity of local group membership, and member participation in decision-making, and their impact on fertilizer adoption in rural Tanzania. He showed that in rural Tanzania, tribal-based social affiliations act as a form of social capital in the adoption decision. A household in a community within which there is greater ethnic homogeneity and greater member participation in decision-making is more likely to adopt. A study by Fafchamps and Minten (1999) showed that better connected agricultural traders have better information on prices and on credibility of clients, and they enjoy higher sales and profit margins. The authors also showed that the traders in Madagascar rank relationships higher than input prices, output prices and access to credit in terms of their importance to business success.

4.2.4 Other factors that influence investment in SFM and conservation

Ability or capacity of farmers to mobilise resources such as needed labour, capital and other factors for conservation purposes is also important in saving land resources from degradation. Many studies have found a strong association between household assets and environmental problems (Shepard and Soule, 1998; Reardon and Vosti, 1995 and Swinton and Quiroz, 2003).

The characteristics of the natural resource base are also important in explaining the pathway from poverty to environmental degradation. Agricultural landscape for different agro-ecological zones is typically quite distinct, and offers quite different risks of resource degradation, and opportunities and constraints for intensification, diversification and land improvement (Scherr, 2000). In Ethiopia, Bekele and Drake (2003) found that slope of the plot has positive correlation with all types of conservation structures. Pender and Kerr (1998) and Lapar et al. (1999) reported similar results for India and Philippines respectively.

Lack of farmer awareness has been found to be an important constraint to positive adaptation to environmental changes and also a constraint to making appropriate investments on land for conservation (Scherr, 2000). This is a problem where degradation effects are not easily observable by the farmers without the necessary technology, for example to establish soil acidification, micronutrient depletion among others. It could also be a problem where the resource degradation problem is not of a local concern but a negative externality to outsiders e.g. down stream sedimentation.

Following this review of theoretical and empirical literature on the relationship between poverty, land tenure, social capital and land degradation/ management, the study proceeds discussing appropriate analytical approaches used to model the described linkages.

4.3. The analytical framework for modelling farmers decisions to adopt SFM and conservation practices

Many previous studies have modelled the decision to adopt conservation technology as a binary choice process, i.e. whether a farmer adopts a recommended technology or not (Anim, 1997; Kabubo-Mariara, 2003; 2005; Place and Hazel, 1993; Nkonya et al., 2005, Pender et al., 2004; Place and Otsuka, 2002). Using such bivariate models excludes useful economic information contained in the interdependent and simultaneous adoption decisions (Dorfman, 1996; Wu and Babcock, 1998; Bekele and Drake, 2003). It is therefore important to treat adoption of soil conservation measures and adoption of soil nutrient enhancing technologies as multiple-choice decisions simultaneously made.

Alternative approaches that would capture the multivariate nature of farmer's choices or decisions include multinomial probit (MNP) and multinomial logit (MNL) models. These models are important for analysis of land management decisions because land management decisions are usually made jointly. Second, they can be used to evaluate the alternative combinations of management practices, as well as individual practices (Wu and Babcock, 1998). MNP models are however, not commonly used. One of the main obstacles to implementing the MNP model is the difficulty with computing the multivariate normal probabilities for any dimensionality higher than two (Green, 2000).

In the present study, farmers' adoption of land management practices (fallowing, organic and inorganic fertiliser use, terracing and combinations of these practices), are modelled using a MNL model. Multinomial models are widely used in other branches of economics but not commonly applied to adoption literature. Bekele and Drake (2003) applied the model to examine choice of soil and water conservation practices in Ethiopia and Caswell and Ziberman (1985) applied the model to examine choice of irrigation technologies in California. In the MNL models, each category is compared to the reference category, and in our study, all other technology choices will be compared to the non-adopters category.

Adoption of soil conservation and nutrient enhancing technologies by households can be evaluated on the basis of alternative decision choices, which can easily be linked to utility. According to Greene (2000), the unordered choice model could be motivated by a random utility framework, where the i^{th} household faced with *j* technology choices, the utility of technology choice *j* is given by,

$$U_{ij} = \beta'_j X_{ij} + \varepsilon_{ij} \tag{4.1}$$

Where U_{ij} is the utility of household *i* derived from technology choice *j*, X_{ij} is a vector of factors that explain the decision made, and β'_j is a set of parameters that reflect the impact of changes in X_{ij} on U_{ij}. The disturbance terms ε_{ij} are assumed to be independently and identically distributed. If farmers choose technology *j,* then U_{ij} is the maximum among all possible utilities. This means that:-

$$U_{ij} > U_{ik}, \forall k \neq j \tag{4.2}$$

Where U_{ik} is the utility to the i^{th} farmer of technology k. Equation (4.2) means that when each technology is thought of as a possible adoption decision, farmers will be expected to choose the technology that maximises their utility given available alternatives (Dorfman, 1996; Zapeda, 1990). The choice of *j* depends on X_{ij}, which includes aspects specific to the household and plot among other factors. Following Green (2000), If Y_i is a random variable that indicates the choice made, then the multinomial logit form of the multiple choice problem is given by:

$$\Pr ob(Y_i = j) = \frac{e^{\beta_j' X_{ij}}}{\sum_{j=1}^{j} e^{\beta_j' X_{ij}}}$$, *j* = 0, 1, 2….j (4.3)

Estimating equation (4.3) provides a set of probabilities for *j*+1 technology choices for a decision maker with characteristics X_{ij}. The equation can be normalized by assuming that $\beta_0 = 0$, in which case the probabilities can be estimated as:

$$\Pr ob(Y_i = j) = \frac{e^{\beta_j' X_{ij}}}{1 + \sum_{K=1}^{j} e^{\beta_j' Z_{ij}}}$$ and: (4.4)

$$Pr\, ob(Y_i = 0) = \frac{1}{1 + \sum_{j=1}^{j} e^{\beta_j' X_{ij}}}$$ (4.5)

Normalizing on any other probabilities yields the following log-odds ratio

$$\ln\left[\frac{p_{ij}}{p_{ik}}\right] = x_i'(\beta_j - \beta_k)$$ (4.6)

In this case, the dependent variable is the log of one alternative relative to the base/reference alternative.

The coefficients in a multinomial logit model are difficult to interpret, so the marginal effects of the explanatory variables on the choice of alternative management strategies are usually derived as (Green, 2000):

$$m_j = \frac{\partial P_j}{\partial x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j\left[\beta_j - \overline{\beta}\right]$$ (4.7)

The sign of these marginal effects may not be the same as the sign of respective coefficients as they depend on the sign and magnitude of all other coefficients. The marginal probabilities measure the expected change in the probability of a particular choice being selected with respect to a unit change in an independent variable (Long, 1997; Green, 2000). Also important to note is that in a multinomial logit model, the marginal probabilities resulting from a unit change in an independent variable must sum to zero, since the expected increases in marginal probabilities for certain options induces a decrease for the other options within a set.

4.4. Empirical Methods

4.4.1 Choice of explanatory variables and model implementation

The study area and the characteristics of the different districts covered by this study are discussed in chapter three. In this section, variables chosen for inclusion in the MNL model as well as the empirical implementation of the model are discussed.

4.4.1.1 Controlling for the effect of poverty

This study used the level of per-capita household expenditure to construct appropriate measures of poverty. This is one of the most widely used approaches to measure poverty (Geda et al., 2001; Mukherjee and Benson, 2003). To compute this variable the study uses data from the 2002 - Uganda National Household Survey (UNHS). Household expenditure in the UNHS is made up of four components: (i) total food consumption expenditure whether purchased or from home production, (ii) total non-food expenditure on durable (iii) total non-food expenditure on non-durable goods, and (iv) non-consumption expenditure such as taxes. The Per-capita household expenditure is expressed in real terms normalised using 1989 as the base year.

Using the generated per-capita household expenditure a poverty dummy variable (poor=1, non-poor=0) was generated. Farming households were thus classified into two categories (poor/non-poor) using the standard national poverty lines [calculated based on the people's food calories requirements adjusted by a mark-up for non-food requirements (Appleton, 2003)]. In Uganda, different poverty lines are used for different regions to take into account differences in staple foods consumed, tastes and consumption preferences, as well as price differences (Appleton, 2003).

The literature postulates that poverty and adoption of various land management technologies are reciprocally interrelated. On one hand, poverty determines the level of adoption of particular technologies. At the same time however, level of adoption may have implications on land productivity and therefore on poverty. Introducing poverty on the right hand side therefore introduces an endogeneity problem in the model. This occurs when the regressors are correlated with the error term.

There is need for an approach that corrects for the possible endogeneity problem, because ignoring it can lead to biased coefficient estimates and inference. Treatment of endogeneity in non-linear models cannot be pursued using the Instrumental variables approach, as commonly used in linear models. The literature however suggests a two-stage probit least-squares (2SPLS). Two-stage probit and Logit models have been widely used to correct for endogeneity in the literature (Lee et al., 1980; Hassan, 1996). A description of this approach and how it was used in this study is presented in section 4.4.2.

4.4.1.2 Controlling for social capital impacts

In this study, one critical component of social capital, namely, participation in agrarian associations such as production, supra community and social groups is used. Membership in agrarian associations has been widely used in the literature to measure social capital (Narayan and Pritchett, 1999; Alesina and La Ferrara, 2000; Grootaert, 1999; Grootaert et al., 1999; Putnam, 1993b) Putnam (1993b) argues that participation in social groups may lead to the transmission of knowledge and may increase aggregate human capital and the development of trust which improves the functioning of markets.

Following Hadad and Malucio (2000; 2003) the proxy measure of membership to a group is redefined to distinguish among the different types of groups to enable the study of how group membership affects adoption of SFM and conservation technology. Since different social organisations play different roles in the lives of rural communities, it is important to establish which particular institutions may be more related to adoption of agricultural technologies and which particular technology. To achieve this objective, a dummy variable (membership to production institutions) is used in the adoption model. Chapter three of this study provides a clear exposition of the different categorisation of these associations as well as their functions and services.

4.4.1.3 Controlling for the impacts of land tenure

It is hypothesized that insecure land tenure provides a disincentive for farmers to invest in land improvements and conservation and therefore low agricultural productivity. In this study, land tenure is measured by the right to bequeath land to next generations is used as the control for the effect of land tenure. Bequeath is an indicator of long-term tenure security.

4.4.1.4 Other Explanatory variables

Choice among the different technologies modelled in this chapter depends on household, institutional as well as plot level characteristics. Examination of the literature focused on adoption of soil conservation and fertility enhancing technologies in Africa suggests that choices among the different technologies depend on household attributes (level of poverty and asset endowments, access to information, household size, age and education of household head), institutional factors (land tenure, social capital) and plot level characteristics (state of soil nutrients, slope, farm size) (Kabubo-Mariara, 2004; 2005; Shiferaw and Holden, 1998; Nkonya et al., 2005; Pender et al., 2004). The set of regressors that were chosen, their definition, measurement, as well as the expected direction of influence on adoption are given in Table 4.1.

Table 4.1: Definition of variables used in the empirical analysis

Variable	Definition	Values/measure	Expected sign
Sex	Sex of household head	1=Male and 0=Female	+/-
Bequeath	Right to bequeath land to next generations	1=yes and 0=no	+
Dist Res	Distance from plot to residence	Kilometres	-
Dist MKT	Distance from plot to nearest mkt	Kilometres	-
Nutrient prob.	Perceived nutrient deterioration of plot	1 if observed deterioration and 0 if not	+
Non-farm inc.	Non-farm income	Uganda shillings	+
Agric extension	Access to agricultural extension information	Dummy (1=if household had access to an extension agent in 2002, 0=if not)	+
Age of hh head	Age of household head	Number of years	+/-
Educ of hh head	Education for household head	Number of years in school	+
Hh size	Size of household	Number of household members	+
Livestock	Livestock Ownership in Tropical Livestock Units (TLU)	Average TLU for common livestock in Uganda is cow = 0.9, Oxen = 1.5, sheep or goat = 0.2, calf = 0.25	+
Number of parc	Number of parcels a household owns	Number	+
Agro-climate	Agro-ecological zones based on rainfall patterns	Agro-ecological zones, (Dummy variable, Bi-modal rainfall =1 and Uni-modal rainfall=0)	+/-
Memb. to pdn org	Membership in production associations	1=yes and 0=no	+

4.4.2 Econometric specification of the MNL model for land management decisions

A Multinomial model for land management practices was estimated using data collected from all the eight districts discussed in chapter three. The choice set (response variable) for the MNL model included six land management technologies: (i) fallowing, (ii) organic fertiliser (iii) inorganic fertiliser, (iv) terracing, (v) combination of the different soil fertility management (SFM) and terracing and (vi) continuous cropping without any land management (no adoption). Several combinations of the different types of soil fertility management were not included in the analysis because of the small number of plots where such combinations were used. For instance, less than 2 percent of all the plots covered used combinations between fallowing and organic fertilizer, fallowing and inorganic, organic and inorganic, and the inorganic and terracing.

The terracing option included represents the use of stones, bench, fanya juu, and fanya chini types of terraces. Organic fertilizer reflects use of mulching, animal manure, household refuse, biomass transfer and cover crop. Inorganic fertiliser use covered the N fertiliser (urea, ammonium nitrate), P fertiliser (SSP, DAP and TSP) and Composite fertilisers (NPK). These technologies are chosen because they are commonly used in Uganda as land management practices or are being promoted for use through the country’s extension system as seen in Chapter three.

Before empirical estimation of the MNL model, the independent variables were scrutinised for possible correlations since multi-colinearity is a common problem with such data sets. A number of variables including distance to nearest all weather road and distance to nearest seasonal road both strongly correlated with distance to markets, main source of income correlated with non-farm income, ethnic dominance and origin of institution (whether local or foreign) correlated with membership were therefore not included in the model.

As noted earlier, a two-stage econometric process was used to correct for endogeneity caused by the endogenous regressors being correlated with the error term. In the first stage, the poverty model was estimated using the probit[5] maximum likelihood procedure. In the second stage, fitted values of the endogenous variable (poverty) are computed using the first stage parameter estimates and used as regressors (instruments) in the MNL adoption model to estimate the determinants of technology adoption. Poverty is expected to reduce the probability of adopting all the different SFM and conservation technologies.

Another challenge was the problem of heteroscedasticity, common in cross section data analysis. In this study, White's heteroscedasticity consistent covariance matrix (HCCM) was used to correct for heteroscedasticity of an unknown form (White, 1980). By including the option "robust" on the MNL model, the study specifies the Huber-White sandwich estimator to correct for heteroscedasticity. Long and Ervin (2000) argue that the HCCM provides a consistent estimator of the covariance matrix of the slope coefficients in presence of heteroscedasticity and can be used to avoid its adverse effects on hypothesis testing even when nothing is known about the form of heteroscedasticity.

MNL models are very commonly used for estimation of polychotomous choice models because of its relative ease of estimates and interpretation. However, the MNL imposes a rather restrictive assumption of "Irrelevance of independent alternatives (IIA)" assumption. IIA assumption implies that the ratio of the utility levels between two choices say organic fertiliser and Inorganic fertiliser remains the same irrespective of the number of choices available. The Hausman test (Hausman and McFadden, 1984) was used to check whether the IIA assumption is violated. The test results show that we cannot reject the null hypothesis of

[5] Logit estimation is also appropriate for analysing binary response data. There is therefore no apriori reason to prefer probit over logit estimation (Green, 2000;Gujarati, 1995)

independence, suggesting use of MNL is appropriate. STATA software (STATAcorp, 2005) was used to implement the econometric analyses.

4.5. Results of the multinomial analyses of determinants of adoption of land improvement and conservation practices

This section presents results of the econometric analyses of the linkage between poverty, property rights social capital and land management practices of farmers in Uganda. Table 4.2, shows the estimated marginal effects and P-levels derived from the MNL model for adoption of land management technologies while appendix 5 provides the estimated MNL coefficients.

Most of the explanatory variables are statistically significant at 10% or less and have the expected signs except for a few surprise outcomes discussed below. Generally the results show that poverty hinders adoption of SFM and conservation technologies. Poverty is negatively related with adoption of organic ($P<0.01$), inorganic ($P<0.01$) fertilizer use, terracing and a combination of terracing and other soil fertility management practices. In fact the magnitudes of the estimated marginal effects of poverty indicate that poverty has a very strong influence on the adoption of these practices compared to other factors. Poverty is also found to positively influence the probability of non-adoption of any technology.

The negative association between poverty and technology adoption suggests that poverty is a key constraint to adoption of land management technologies, which supports earlier findings in related studies (Kabubo-Mariara, 2004; Shiferaw and Holden, 1999b; 2001; Li et al., 1998). However, it could also be a reflection of poor targeting technologies. For instance NAADS has been blamed for targeting the rich and neglecting the poor. From a policy perspective, this finding suggests that government efforts to reduce poverty would improve adoption of conservation and soil fertility management practices. More importantly, technology targeted to the poor through the agricultural extension programs in the country could be important to improve technology adoption.

The results also suggest a positive relationship between adoption of fallowing (P<0.05) and poverty. This may be considered a rather surprising result, because it suggests that the poor with lower asset levels may adopt fallowing more than the rich, who are expected to have more land. However, two reasons may explain this finding. First, descriptive statistics in chapter three showed that there is no significant difference in farm size among the different income quintiles. In fact the chapter shows further that the poor districts such as Lira and Soroti have on average larger farm size than better-off districts. This finding is attributed to the nature of land tenure and distribution of the population in the country. The descriptive statistics also show that the poor districts of the north have low population density, suggesting more land is available for these poor households.
In addition, the land tenure in these districts such as Soroti and Lira is largely customary for communal use. As highlighted earlier, under this tenure regime, in Uganda, land is divided among clans which in turn divide it among the households irrespective of the level of income. Second, the poor usually have limited choices given the cost implications of the alternative choices available.

In this model we also use the right to bequeath land to future generation to capture the land tenure impact. The right to bequeath is seen as an indicator of long-term tenure security and as a result encourages the farmer to have longer planning horizons. As expected, we find long-term tenure security to positively influence adoption of fallowing (P<0.05), organic fertilizer application (P<0.01), terracing and a combination of terracing and other SFM and generally reduces the probability of non-adoption (P<0.01). Our regression results support those in earlier related studies (Shiferaw and Holden, 1999b; Place and Otsuka, 2002; Place and Otsuka, 2000; Place and Swallow, 2000; Gebremedhin and Swinton, 2003; Kabubo-Mariara, 2004), which find tenure rights to be important for investment in conservation activities. The policy implication of this finding is that policies that facilitate and encourage tenure security such as easing the land registration and titling processes in order to ensure long-term tenure security can significantly increase the probability of adoption and provides incentives for investment in conservation activities.

A surprise result however is the negative relationship between land tenure and adoption of inorganic fertilizer. Suggesting that farmers prefer to use inorganic fertilizer on less secure land to maximize short-term benefits and reserve other inputs for owned plots, with long-term security. This is in support of earlier findings by Gavian and Ehui (1999) in Ethiopia, who found that small holder farmers tend to use inorganic fertilizer on less secure lands.

Membership in production associations were found to be positively related to the likelihood of adopting fallowing ($P<0.1$), terracing ($P<0.1$), inorganic fertilizer and generally reducing the probability of non adoption of all technologies ($P<0.05$). These outcomes are expected because of information dissemination among group members, trust and cooperative action among the members that production related institutions promote. These findings suggest that investment and promotion of social capital institutions such as production associations is of importance to adoption of SFM and conservation technologies. Two policy implications of these outcomes are clear. First, development projects should not be designed to deal with all communities uniformly, but be adapted to different levels of existing social institutions and norms. A study by Purcell and Anderson (1997) concluded that designers of extension programs need to place emphasis on pre-project analysis and project preparation in order to asses and identify farmer circumstances, including formal and informal institutional constraints.

Second, extension workers need to understand the social and institutional fabric in their areas of work. They should promote and exploit the existing social infrastructure for dissemination of information about new technologies, and encourage cooperative action in areas of resource pooling such as labour sharing, savings among others. For example, the extension system in Uganda for information sharing has been mainly based on the training and visits by extension agents on scheduled meetings. It is therefore argued that such visits and training should be organized with already well-established local organizations because of the already established trust inherent in these institutions but also this arrangement would reduce project costs of mobilization. As discussed in chapter 2, the new NAADS program has tried to use a similar approach but has had serious implementation problems.

One surprising result however was the negative relationship between membership in production associations and the adoption of organic fertilizer use. Production institutions comprise of savings and credit associations, rotating credit schemes, farmers groups and women groups. Of these categories, membership to the first two constitutes 60 percent of the total membership. This could therefore suggest availability of credit that is used to purchase SFM alternatives instead of labour intensive organic fertilizer. Secondly in the districts of Arua and Kapchorwa where inorganic fertilizer is mostly used, the production associations such as farmers groups are directly involved in procurement and distribution of inorganic fertilizer to the members, and therefore promoting use of purchased inputs and hence the less need for using organic sources.

Farmers' access to information though positively related with most of the practices, the results from the MNL model show that agricultural extension doesn't significantly affect adoption of most of the technologies except use of inorganic fertilizer ($P<0.05$). Prior adoption studies in Uganda (Nkonya et al., 2005; Pender et al., 2004) have come up with similar findings. Two reasons may explain this outcome. First, the extension system in Uganda has been packaged to promote use of inorganic fertilizer in an effort to intensify agricultural production. Secondly, the weak relationship between extension and adoption decisions might be attributed to the inadequate and some times complete absence of extension services. Only 28 percent of the sampled households had

had a single visit by an extension agent for a period of one year. The policy implication of this outcome is that there is need to revitalize the extension services and open it to support use of other traditional SFM and conservation technologies that are more readily available to the farmers.

Households that are endowed with family labour are expected to use labour intensive management practices. This explains the positive and significant relationship between household size and adoption of organic fertilizer ($P<0.01$) and terracing, which are labour intensive. The negative relationship of household size with fallowing ($P<0.1$) could be attributed to the fact that larger households tend to hold smaller farms and hence can not afford to fallow but use other alternative SFM practices. Farmers' age was significantly and positively related to adoption of fallowing ($P<0.05$), but negatively related to adoption of inorganic fertilizer use ($P<0.01$). One possible reason that could explain this outcome is that older farmers are more risk averse and therefore resistant to change to newer technologies since they are more used to traditional management systems.

In fact non-farm income was found to be positively related to adoption of fallowing ($P<0.01$) but negatively related to adoption of inorganic fertilizer ($P<0.05$), terracing ($P<0.01$) a combination of terracing and other SFM ($P<0.05$) and organic fertilizer. This is another surprising result since non-farm income is expected to bring the much-needed cash for the purchase of external inputs. Earlier analyses (Nkonya et al., 2005) have come up with similar results. A number of reasons could explain this outcome. First, agriculture is generally not profitable in Uganda (Nkonya, 2002) and this discourages investments in SFM and conservation. Secondly, non-farm activities are generally more profitable and are in many cases full time activities and sometimes located away from the farm and taking away the much needed labour in the agricultural sector. The non-farm activities eventually become the key source of family livelihood. As Haggblade et al. (1989) argue initially farmers integrate non-farm activities with farming activities on a seasonal or part time basis. With time, returns from non-farm activities are invested in farming activities but eventually because of increases in demand for non-farm goods, those involved in non-farm activities break away from farming to become involved in non-farm activities on a full time basis.

Agro-climatic zones stand out as an important factor that could explain differential use of SFM and conservation technologies in the study areas. For instance, the likelihood of using fallowing and inorganic fertilizer in the bi-modal agro-climatic zones is 27.63 and 9.69 percent, respectively, lower than in Unimodal agro-climatic zones. As noted in chapter three, most districts in the Unimodal zones are sparsely populated and therefore fallowing is more possible than in the densely populated districts in the bi-modal zones. The likelihood of using inorganic fertilizer is also higher in the Unimodal agro-climatic zones because of organized input supply for maize/barley and tobacco farmers in Kapchorwa and Arua districts, respectively, and relatively better extension services in Soroti district. However, the likelihood of using organic fertilizer and terracing is higher in the densely populated bi-modal agro-climatic zones, because of availability of family labour and ability to pay for hired labour, since these are labour intensive technologies.

Results show that the number of parcels a household owns is significantly and positively related to fallowing ($P<0.01$), inorganic fertilizer ($P<0.01$), terracing ($P<0.01$) and a combination of SFM and terracing ($P<0.01$). In general, having more parcels reduces the probability of non-adoption ($P<0.01$). Having more plots is an indicator of a larger farm size allowing the farmer to practice terracing, and fallowing quite easily. One biggest challenge in the densely populated highland districts is that terraces are occupying large productive space hence leading to their destruction. The results however also show a negative relationship between number of plots and organic fertilizer use. This is again as expected because use of bulky manure on many plots involves high costs of transporting and distribution, hence reducing the likelihood of adopting the technology.

The results show that farmers tend to adopt organic fertilizer ($P<0.01$) on plots closer to their homesteads while adopting fallowing ($P<0.01$), inorganic fertilizer ($P<0.01$), terracing ($P<0.05$) and a combination of terracing and other SFM practices ($P<0.01$) in far off plots. Overall, longer distances from homesteads to plots increase the probability of non-adoption ($P<0.01$). The reason for this outcome is that organic fertilizer use is a labour intensive activity. The greater the distance therefore the greater the labour needs and other associated transaction costs for transporting and distributing the bulky manure. Farmers therefore choose to use less costly technologies such as fallowing and inorganic fertilizer in far off plots and more labour intensive organic fertilizer in plots close to their homesteads.

As expected, distance to markets was found to reduce the probability of adopting inorganic fertilizer ($P<0.01$) but increases the probability of using fallow ($P<0.01$) and a combination of terracing and other SFM technologies ($P<0.01$). Far off markets imply high costs of transactions for both inputs and output goods. The high costs coupled with the level of poverty, therefore reduces the probability of using marketed inputs like inorganic fertilizer while increasing use of traditional technologies such as fallowing. From the policy perspective, these findings suggest that road infrastructure development would reduce non-adoption of marketed inputs.

Table 4.2: Marginal effect for the MNL for adoption of Land Management technologies

Variable	Fallow		Organic Fert		Inorganic Fert		Terracing		Terracing+SFM		Non-adopters	
	ME	P-Level	ME	P-Level	ME	P-Level	ME	P-Level	ME	P-Level	ME	P-Level
Sex	0.0916***	0.0000	0.0114	0.3560	-0.0166*	0.0530	0.0232***	0.0010	0.0051	0.5930	-0.1146***	0.0000
Bequeath	0.0447**	0.0470	0.0417***	0.0010	-0.0111*	0.0590	0.0038	0.5090	0.0010	0.9310	-0.0800***	0.0030
Dist Res	0.0110***	0.0040	-0.0407***	0.0000	0.0015***	0.0000	0.0011**	0.0280	0.0027***	0.0040	0.0244***	0.0020
Dist MKT	0.0094***	0.0070	0.0002	0.9350	-0.0044***	0.0000	0.0002	0.7840	0.0038***	0.0000	-0.0092**	0.0200
Nutrient prob.	0.0304	0.1060	0.0095	0.3430	-0.0046	0.2260	-0.0034	0.5270	-0.0110	0.2380	-0.0210	0.3350
Non-farm inc.	0.0588***	0.0000	-0.0088	0.1400	-0.0058**	0.0240	-0.0423***	0.0000	-0.0347**	0.0220	0.0329*	0.0660
Agric extension	0.0061	0.7840	0.0105	0.3800	0.0157**	0.0150	0.0110	0.1240	-0.0160	0.1510	-0.0274	0.2920
Age of hh head	0.0020**	0.0140	-0.0008*	0.0760	-0.0006***	0.0080	-0.0003	0.2010	0.0004	0.4740	-0.0008	0.4170
Educ of hh head	0.0004	0.9080	0.0007	0.6700	-0.0006	0.2800	-0.0014	0.1250	0.0013	0.4750	-0.0004	0.9190
Hh size	-0.0116***	0.0090	0.0072***	0.0040	0.0052***	0.0000	0.0010	0.4260	-0.0013	0.6560	-0.0006	0.9190
Poverty	0.2375***	0.0060	-0.1525***	0.0010	-0.0815***	0.0000	-0.0025	0.9030	-0.0657	0.1470	0.0646	0.5280
Livestock	-0.0007	0.7560	-0.0008	0.4910	-0.0002	0.7160	0.0007**	0.0460	-0.0007	0.3780	0.0017	0.4600
Number of parc.	0.0207***	0.0000	-0.0072***	0.0010	0.0018***	0.0010	0.0034***	0.0000	0.0064***	0.0000	-0.0251***	0.0000
Agro-climate	-0.2763***	0.0000	0.0446***	0.0010	-0.0969***	0.0000	0.0245***	0.0000	-0.0078	0.6620	0.3118***	0.0000
Memb to pdn org	0.0432*	0.0560	-0.0050	0.6550	0.0089	0.1030	0.0117*	0.0860	-0.0069	0.4820	-0.0519**	0.0450

SFM = Soil Fertility Management; Non-adopters are used as the base category. *, **, and *** represent the level of significance at 10, 5 and 1 percent respectively

Ownership of livestock assets has limited impact on most land management technologies. Ownership of livestock is only positively and significantly related to adoption of terracing ($P<0.01$). This could be explained by the fact that livestock is considered a measure of wealth that increases the availability of capital and makes investment in conservation feasible. Surprisingly we do not find a positive and significant impact of livestock ownership and adoption of organic fertilizer. Possible explanations for the non-significance of the livestock ownership variable on adoption of organic fertilizer is that the measure of tropical livestock unit used in the study captures all types of animals including goats, sheep, calf, cows, ox etc. In areas where households keep cattle, which generate significant amount of animal manure, are not seriously involved in crop agriculture except for small subsistence gardens. Some are nomads and livestock is their major source of livelihood. In other areas where sheep and goats and other small animals may be kept, as much as they may be involved in crop agriculture, the animals generate limited manure.

4.6 Conclusions and policy implications

This chapter was concerned with the determinants of adoption of land management technologies, in particular, the impact of poverty, social capital and land tenure on adoption of SFM and conservation activities. In order to capture the interdependence and joint nature of adoption decisions, a multinomial logit analyses was performed generating findings that suggest the following,

i) Poverty increases the probability of non-adoption in general and particularly reduces the probability of adopting organic and inorganic fertilizers and terracing, mainly because the poor have limited access to cash and markets and lower land and livestock assets. This finding suggests that government programs to reduce poverty would go a long way in promoting the use of SFM and conservation practices. In the following chapter, the study explores more the determinants of poverty and more importantly the role of social capital in explaining poverty in Uganda.

ii) Land tenure security is positively correlated with adoption of fallowing and organic fertilizer use only but generally reducing the probability of non-adoption of land management technologies. However it was found not to significantly influence adoption of soil inorganic fertilizer use and terracing. These results also suggest that programs that enhance tenure security such as land registration would encourage adoption of most land management practices.

iii) We also find that participation in social institutions generally tends to increase the probability of adopting most land management practices. This finding is also very important especially in Uganda where social capital issues are not well researched and incorporated in government policy papers. Investment in social capital is therefore of paramount importance for adoption of land management technologies. The policy implication of these results is that extension workers should understand the social and institutional fabric in the places of work. Extension agents themselves need to be trained to enhance local context so that the villagers become more receptive to new agricultural techniques and methods. For policy purposes therefore, development projects should not be designed so that they deal with all communities uniformly, but be adapted to different levels of existing social institutions and norms. The role of social capital on household welfare will therefore be the major concern for chapter five of this thesis.