Research Application Summary

Determinants of land management practices in the agricultural highlands of Uganda: A case of Kabale highlands in Western Uganda

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Abstract

The study investigated land management decisions in the agricultural highland area of Kabale district in South Western Uganda. Data were analysed using multivariate regression techniques.Results showed that demographic characteristics such as farmer's age, household size and education level; and plot level characteristics such as slope gradient and crop types were significantly associated with the choice of land management practices. The study recommends the strengthening of training and extension education programmes to support the adoption of land management practices in the agricultural highlands. Extension training and services linked to crop types (annuals and perennials) need to be strengthened. Training and extension services should focus on the best practices to use based on the slope gradients of plots.

Key words: Agricultural highlands, Kabale, land management, multivariate probit

Résumé

L'étude examine les décisions de gestion des terres dans la région montagneuse agricole du district de Kabale au Sud-ouest de l'Ouganda. Les données ont été analysées à l'aide des techniques de régression multivariée. Les résultats ont montré que les caractéristiques démographiques telles que l'âge des agriculteurs, la taille du ménage et le niveau d'éducation ainsi que les caractéristiques de niveau de la parcelle telles que le gradient de la pente et les types de cultures ont été associées de façon significative avec le choix des pratiques de gestion des terres. L'étude recommande de renforcer les programmes de formation et d'éducation à la vulgarisation pour soutenir l'adoption des pratiques de gestion des terres dans les régions montagneuses agricoles. La formation à la vulgarisation et les services liés aux types de cultures (annuelles et vivaces) doivent être renforcés. La formation et les services de vulgarisation

devraient se concentrer sur les meilleures pratiques à utiliser en fonction des gradients de pente des parcelles.

Mots clés: Régions montagneuses agricoles, Kabale, gestion des terres, probit multivarié

Background

Sustainable natural resource utilisation is key for Uganda's sustained poverty eradication by ensuring wise use by the present generation without compromising the availability for use by future generations. The poor depend on the environment especially natural resources including land for the satisfaction of their basic needs. As land deteriorates in quality, the poor become poorer. Poor agricultural yields resulting from degraded soils lead households to obtain alternative sources of livelihood such as deforestation or encroaching on ecologically fragile areas, for example wetlands and steep hillsides to make up for the short fall.

According to the Ministry of Water, Lands and Environment, MWLE (2003), Uganda's natural resources have come under increasing degradation or depletion especially in the high fragile areas. The two most fragile ecosystems in the country are the highlands and the wetlands. The worst affected are the Southwestern highlands which includes the districts of Kabale and Kisoro. These districts are reportedly 85 - 90% affected by soil erosion (National Environment Management Authority, NEMA, 2001). Other badly affected (75% - 80%) areas include Mbale and Kotido in the Mt. Elgon ranges in eastern Uganda, and the cattle grazing district of Rakai, southern Uganda. Many authors have expressed concern over the increasing land degradation in the highlands of East Africa (e.g. Getahun, 1991; Farley, 1995; Hilhorst and Muchena, 2000). Specifically, in the Kabale highlands, out of a total land area of 165,300 hectares, 90% is estimated to be affected by soil erosion (NEMA, 2001). Erosion is mainly attributed to the steep slopes, population pressure, deforestation, poor farming methods and vulnerable soils. Although farmers are aware that the negative consequences are a result of their land management practices, they have not taken any initiative to adopt better practices that could reverse land degradation. This study aimed to contribute to knowledge on factors that influence farm level decisions on land management practices in the highlands with specific reference to Kabale district. Specifically, the study determined the factors that influenced farmer's choices of land management practices. It was hypothesised that plot characteristics and

farmers' education level were the major determinants of choice of land management practices.

Land use and management in the Kabale highland region. A study by Bolwig (2002) on land use change in Kabale district revealed that the total size of farmland (fallow and cultivated) only increased significantly in one area, while the expansion of farmland in the upland areas had already stopped by the 1950s, due to the lack of available land. There was conversion of papyrus swamps into fields and pastures, which was more pronounced in the areas where all upland areas had already been converted into farmland in the 1950s. In the areas where grassland, bush land and woodlands were covering important areas in the 1950s, these land use classes were converted into small-scale farmland and planted woodlots. Their findings suggested that farmers tend to expand production first into upland areas and thereafter into the wetlands, possibly because of the significant work involved in draining swamps.

Studies of the evolution of land use, the agricultural system and soil degradation were previously conducted in Kabale using remote sensing, household and field surveys, transect (Olson, 1996; Breyer *et al.*, 1997) and participatory approaches (Mbabazi *et al.*, 2003). The studies found that since the 1950's, almost all land that had been under pasture or wetlands had been converted to cultivation, and most fields were being managed with only short fallows.

Bamwerinde *et al.* (2006) in a study on idle land in the densely populated Kigezi highlands of South-western Uganda found that plot abandonment and long fallow was a common problem in the area. Grisley and Mwesigwa (1995) investigated socio-economic factors influencing seasonal fallowing in Kigezi highlands and revealed that only 26% of farmers reported cropland under fallow.

Farmers' choice of land management practices. Farmers have been exposed to various land management practices such as contour ploughing, terracing, agroforestry, among others. These practices have been tested on farm and approved efficient. However, not all farmers are able to apply them despite the recognition that their land is increasingly degraded. Several studies have attempted to determine the reasons why technologies may or may not be taken up.

Some of the explanations are farmer-specific in terms of household level characteristics (Nkonya 2002; Doss 2006), while others are related to land tenure and other economic factors (Anley *et al*., 2007; Salasya *et al.*, 2007). For instance, Nkonya (2002) found that access to credit increased the probability to adopt agroforestry technologies. It has also been found that support programmes for initial investment (Bekele and Drake, 2003) and the slope of the land (Amsalu and De Graaf, 2007) were positively related to adoption of land conservation measures.

Another factor is farmers' perception about the levels of deterioration of arable land. Farmers who perceive their land as fast deteriorating and producing less than desired, tend to adopt good land management practices. For instance, Yila and Thapa (2008) found that accelerated erosion had a positive influence on adoption of land management technologies in Nigeria. On the other hand, farmers who perceive their soils to be fertile tend to have low adoption of conservation practices as observed by Amsalu and De Graaf (2007). Land ownership (Gebremedhin and Swinton, 2003), extension services (Anley *et al*., 2007) and membership to farmer groups (Tenge *et al*., 2004) are some of other influencing factors.

Study Description

The study was conducted in Kabale district in South-western Uganda. Kabale was purposively selected because it is the worst affected area in Uganda in terms of land degradation resulting from high population pressure and use of environmentally unsustainable land management practices. The district is a highland area with steep slopes, intensely cropped hillsides and high population densities. It has a total land area of 1,827 km^2 and a total population of 461,785 people (250 people per km^2). The soils are generally volcanic and fertile, although some parts have less fertile Ferrosols and Andosols (Djimbe and Hoekstra, 1987). About 93% of the population live in the rural areas outside Kabale Municipality and depend on land for their livelihood. However, erosion and consequent soil degradation have been a major problem for many decades (Carswell, 2002).

Data and sources. Data were collected from both primary and secondary sources. Primary data sources involved a survey using face-to-face interviews with household heads or their spouses using a structured questionnaire. The data collected included information on socio-demographic and economic characteristics of farmers, plot level characteristics, and various

land management practices used by farmers (collectively or singly). Secondary data sources included journal articles, research reports and other publications, including internet sources of information.

Three sub-counties were purposively selected from the district, one representing areas of relatively high economic activity, the second one represented the relatively more rural areas. At the sub-county level, two villages were randomly selected from a list of villages in the sub-county provided by the sub-county chiefs. From each sub-county, a village was randomly selected from which respondents were stratified based on plot location (hillside or valley). From each stratum, 25 farm households were randomly selected giving a total sample size of 150 households.

Data analysis. Different methods were used in data analysis including descriptive statistics and econometric approaches. Descriptive statistics were used to characterise selected farmers and the different land management practices the farmers used. An econometric model of the choice of land management practices was estimated. The dependent variable had five response levels representing the major land management practices reported by farmers. These were terraces, crop rotation, use of organic fertiliser, trenches and agro-forestry. The covariates included socio- demographic and socio-economic characteristics such as age of the household head, household size, and education level of household head. Plot characteristics included plot distance from homestead, plot location, slope gradient, tenure status and main crop types. The multivariate probit is a generalisation of the probit model used to estimate several correlated outcomes jointly and is generally specified as:

$$Y_i^* = \beta X_i + \varepsilon_i \quad \text{..... (1)}$$

Where Y_i^* are the underlying latent variables that index the land management options on a given plot, X_i is a (kx1) vector of explanatory variables, β is a (kx1) vector of the parameters estimated, and ε_i is the stochastic error term. The dependent variable is not mutually exclusive, that is, a farmer can choose to use one or more land management practices simultaneously

on the same plot. Thus the decision to choose a set of land management practices is jointly determined.

The multivariate probit estimates maximum likelihood coefficients of *M* equations using the Geweke-Hajivassiliou-Keane smooth recursive simulator (Greene, 2000).

The study used the farmer's plot as the unit of analysis. A multivariate probit model was specified as shown in equation 2. The dependent variables consist of the five main land management practices that were reported by over 5% of the farmers in the study in order to estimate key determinants of decision to use these practices.

$$y=\beta+\beta_1 x_1+\beta_2 x_2+ \ldots + \beta_{10} x_{10} + e \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where
y =Land management practice (terraces, organic fertilisers, trenches, crop rotation, agroforestry)
x_1 = Age of household head (years)
x_2 = Household size
x_3 = Education of the farmer (years in school)
x_4 = Tenure of plot (1=freehold and 0=otherwise)
x_5 = Variable for plot location (1 = hillside and 0 = valley)
x_6 = Variable for plot slope (1 = steep and 0 = gentle)
x_7 = Type of crops grown on plot (1=annuals, 0=perennials)
x_8 = Distance of plot from homestead (kilometres)
e = random error term
β_1 - β_{16} = coefficients to be estimated.

Results and Discussion

Characterisation of farmers in the Kabale highland region. Characterisation of farmers was done using descriptive statistics of key factors that may influence use of land management practices. Results in Table 1 reveal that the mean age of the farmers was about 45 years which is consistent with

Table 1. Demographic characteristics.

Characteristic (n=150)	Minimum	Maximum	Mean	Standard Deviation
Age of farmer (years)	21	85	44.8	14.5
Education level of farmer (years)	0	20	6.7	4.8
Household size	1	12	5.4	2.2
Number of plots (ha)	0.4	2.0	0.8	0.3
Mean plot size (ha)	0.1	4.1	0.9	0.7
Distance of plot from homestead (Km)	0	30	1.9	3.1

the national average of 44 years in Pender *et al*. (2004a). Mean level of education was only about 7 years indicating that the majority of the farmers had attained primary level education. The average household size was about 6 people per household, ranging from 1 to 12 people, and consistent with national estimates (Uganda Bureau of Statistics, 2007). The average number of plots owned by the household head was 2, with a mean household farm size of about 0.81 ha.

Results in Table 2 indicate that the majority of the primary plots were located more on the hills (63.3%) - either on the hillsides or hilltops. In addition, the majority of the plots reported were located on steep slopes (70%).

Table 2. Primary plot characteristics.

Characteristic	Percentage of farmers
Location	
Hill	63.3
Valley	36.7
Tenure type	
Mailo	1.3
Freehold	95.3
Customary	3.3
Soil fertility	
Good	90
Poor	10
Slope	
Steep	70
Gentle	30
Crops grown on plot	
Annuals	57.3
Perennials	42.7

Majority of the farmers reported that their primary plots were held under freehold tenure. This is true as freehold is the most dominant form of tenure in the Western region of Uganda with about 8.6% of parcels under freehold (Alobo *et al.*, 2011). Pender *et al.* (2004a) found that type of tenure influenced crop choice among farmers. Cereals, legumes and root crops (in pure stands) were planted less on *mailo* land than on customary land while cereals/legumes mixed cropping was more common on *mailo* land. Cereals and root crops in pure stands were also

less common on freehold or leasehold tenure than on customary, and cereals/legumes were more common.

Majority (90%) of the farmers in the study reported that the fertility of their primary plots was fairly good. This suggests that the farmers in the study generally perceived that their farms were fertile which has wider implications on the adoption of land management practices. It indicates low awareness among farmers on soil fertility management considering the low productivity trends reported by national statistics. Despite farmers perceiving their farms as fertile, several studies indicate that declining soil fertility is one of the major causes of declining agricultural productivity in Uganda (MAAIF, 2000; Pender *et al.* 2001), and that the poor soil fertility is inherent in much of Sub Saharan Africa (FAO 1995; Voortman *et al.,* 2000).

Majority (57.3%) of farmers reported growing mostly annual crops on their primary plots. This result is consistent with results of Mbabazi *et al.* (2003) in a study on participatory land degradation in Kabale district. They found that arable farming was practiced on the lowlands, on the slopes and on the hill tops with main crops grown being annuals (sorghum, Irish potatoes, sweet potatoes, maize, beans, peas, finger millet and vegetables).

Results show that use of land management practices among farmers was varied but very low (less than 35%). The major land management practices which were reported to be under use on the primary plot by more than 5% were terracing followed by organic fertiliser, trenches, crop rotation, agroforestry and contours. The others such as grassbunds, intercropping, trashlines, short fallow, mulch, monocropping and minimum tillage were the least used (less than 5% users). The results suggest that in general the use of important land management practices among farmers is declining. Some of the characteristic land management practices that other studies found to be common in the 1990s (Olson, 1996; Breyer *et al.,* 1997) such as crop rotation, trash lines, and use of mulch were being used by less than 10% of our sample of farmers.

Between 5-15% of the farmers reported using organic fertiliser, trenches, crop rotation, agroforestry and contours for land management. These results corroborate other findings; Sserunkuuma (2005) found that the most common land management practices in Uganda included addition of organic fertilisers (animal manure, crop residues and household refuse),

mulching and crop rotation. The minimal use of contours (by 6.7% of the farmers) points to what was noted by the Uganda Human Development Report (2007) that in early 1930s, all the Kabale farmers were required to practice contour farming a fact that helped reduce soil erosion on the steep slopes. Currently, most contours are very old and eroded because they were not well maintained and are no longer effective.

The least used land management practices (reported by less than 5%) were grassbunds, intercropping, trashlines, short fallow, mulch, monocropping and minimum tillage. The use of long fallow was not reported on any of the primary plots, but a small number of farmers (2.7%) reported using short fallow periods of a few months. Mbabazi *et al.* (2003) also found that in Kabale district, land under fallow was limited due to its scarcity fuelled by population pressure and the need for families to grow more food.

Determinants of choice of land management practices. Results for the multivariate probit model in Table 3 indicate that the probability of choosing terracing as a land management practice was significantly and positively influenced by age (at 5%), education level (at 1%) and type of crops on the plot (at 1%). All other variables except distance of plot from home were positively associated with terraces, indicating that plots that were further from home were less likely to be terraced. The education level of the household head is considered to be complementary to accessing extension services. Education improves one's ability to understand and assimilate information about new agricultural technologies. Older and more educated farmers are therefore more likely to use terraces, probably because they are less likely to change their production practices compared to the younger ones, because of more knowledge on the importance of such practices obtained from experience and education.

The results contradict those of Nkonya (2002) who found that education of the household head reduced the probability to adopt soil and water conservation technologies, including the use of bench terraces. However, Sserunkuuma (2005) found that participation in agricultural training and short-term extension programmes was associated with higher use of land management practices. Also, Nkonya *et al.* (2008) found some evidence that primary, secondary and post-secondary education was associated increased use of land management practices in

Table 3. Multivariate probit estimation of choice of land management practices.

Variables	Terracing	Organic fertiliser	Trenches	Crop-rotation	Agro-forestry
Age of household head (years)	0.018**	-0.009	-0.007	0.007	0.011
	-0.009	-0.008	-0.008	-0.013	-0.009
Education of household head (years in school)	0.098***	0	0.021	-0.026	0.048*
	-0.034	-0.025	-0.024	-0.042	-0.027
	-0.057	-0.054	-0.051	-0.102	-0.059
Plot location (1=hillside and 0=valley)	0.437	0.273	0.189	-0.388	0.227
	-0.302	-0.293	-0.266	-0.529	-0.316
Plot slope (1=gentle and 0=steep)	0.151	0.499*	0.455*	0.293	0.374
	-0.304	-0.303	-0.272	-0.452	-0.337
Distance of plot to homestead (km)	-0.014	0.078	-0.014	-0.016	-0.001
	-0.044	-0.067	-0.033	-0.057	-0.035
Tenure status (1=freehold, 0=otherwise)	0.624	-0.393	0.036	1.225	0.241
	-0.526	-0.297	-0.29	-0.995	-0.317
Crops grown	0.873***	-0.527**	0.554**	-0.015	0.193
(1= annuals, 0=perennials)	-0.266	-0.245	-0.233	-0.429	-0.289
Marginal success probability	73.90%	70.70%	40.70%	94.90%	15.20%

Number of observations = 150 Log Likelihood = - 331.356 chi2(10)=14.985 prob>chi2 = 0.133. Coefficients are reported for each variable and the standard errors are in parenthesis. ***means significant at 1%, **significant at 5%, and * significant at 10%.

Uganda. The use of terraces is also more associated with annual crops.

Results further show that the probability of using organic fertilisers was positively and significantly associated with household size (at 10%), the slope of the plot (at 10%) and negatively associated with the type of crops grown (at 5%). Larger households are more likely to use organic fertilisers. This is because the use of organic fertilisers such as compost, crop residues, animal manures, among others, are all labour intensive in terms of preparation and carrying to the fields. This is consistent with the findings by Sserunkuuma (2005) where households with larger families (higher endowment of family labour) were more likely to use manure and crop residues because of the labour-intensive nature of the practices. Organic fertilisers are more likely to be used on gently sloping plots rather than steeper plots probably because of the likelihood of being eroded away by runoff on steeper slopes. This is confirmed by Mbabazi *et al.* (2003) who found that the use of manure was mostly confined to plots close to the homesteads and/or on plots located on gentle slopes where the surface run-off was very minimal.

The decision to use trenches for land management was also positively and significantly associated with the household size (at 10%), the slope of the plot (at 10%) and negatively associated with the type of crops grown (at 5%). Larger households are more likely to dig trenches for soil and water conservation probably because it is labour intensive. Trenches are also more likely to be used on gently sloping plots rather than steeper plots because they are commonly used to control soil and water runoff. This result is not as expected, it points to the farmers' difficulty and relativity in estimating the slope of a plot. It is therefore possible that some of slopes were not really gentle but tending towards steep. These results corroborate findings of Mbabazi *et al.* (2003) that farmers were digging trenches for soil conservation mainly on the steep slopes either collectively in groups or sometimes with the help of neighbours, and many households had also moved from such points to gently sloping mid-slopes.

Farmer's decision to use agroforestry was only positively and significantly (at 10%) associated with education level of the household head. All the other variables except distance of the plot from home were positively associated with the decision to

use agroforestry. The more educated farmers were more likely to use agroforestry land management practices. They are more likely to have obtained such knowledge from school and then apply it on their farms compared to the less educated. Pender *et al.* (2004b) and Nkonya *et al.* (2008) noted that education contributes to greater land use management.

Lastly, the decision to use crop rotation was not significantly associated with any of the selected variables, indicating that the decision has nothing to do with the terrain or crop type or farmer characteristics in the model. However, although not significant, the decision to choose crop rotation for land management was positively associated with all other variables except distance of plot from homestead. This suggests that plots that are farther from home are less likely to be rotated with other crops.

Conclusion and Recommendation

Based on these results, we confirm the hypothesis that plot characteristics are important determinants of choice of land management practices only for the use of trenches and organic fertiliser; with slope gradient of the plot being the major factor. We also confirm the hypothesis that education level positively and significantly influences farmer's choice of land management practices only for the use of terracing.

The probability of choosing terracing as a land management practice is significantly and positively associated with age, education level and crop types, choosing organic fertilisers and/or trenches for land management is positively and significantly associated with the household size, the slope gradient of the plot and negatively associated with the crop types. In addition, the decision to use agroforestry is positively and significantly associated with education level of the household head.

In line with recent global concerns on climate change and achieving the Millennium Development Goals, strategies to encourage wider education at all levels such as adult education, Universal Primary Education, Universal Secondary Education, government support for tertiary education need to be strengthened to increase awareness and provide information concerning sustainable natural resource management as a whole, which also includes proper land use and management strategies.

In addition, since extension training is a form of education, extension programmes to improve awareness on land management practices and crop choices should be promoted. Extension training and services linked to crop types (annuals and perennials) need to be strengthened since crop types are important determinants of land management decisions. Training and extension services need to focus on the best practices to use based on the slope gradients of plots. Traditional extension services through NAADS, local governments and other demand-driven advisory services that are currently being promoted need to be strengthened. Such institutional support to provide technical information and other crucial support that is necessary for adopting new technologies is an important incentive for farmers to adopt improved land management practices.

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