Uganda Journal of Agricultural Sciences, 2004, 9 :303-311 ISSN 1026-0919

The socio-economic analysis of land use changes and soil conservation in central and western Uganda

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Abstract

Decreasing agricultural land, inappropriate land use practices and declining rural family living standards are closely interrelated problems in Uganda. This study analyzes forces driving family resource use changes and decision-making while pursuing better opportunities in two zones in Uganda having varied soil conservation adoption. Conservation here entails use of soil erosion control measures. Intensive conservation designates 50% land mulching and 40% earth-bunds presence otherwise lower proportions constitute low conservation. Data collection and analyses of 100 randomly selected families in this study followed farming systems approaches. This covers farm level aspects, family decision-making process and linkages between land rights, degradation and conservation. Comparative land allocation trends spanning 20 years indicate increasing hectarages of crops and pastures in the two zones, though more rapidly in intensive soil conservation areas. Contrary forests hectarages decreased indicating that crop and pasturelands increased at the expense of forestland. However, the unusable land size, a surrogate for land degradation during the same period escalated. This elucidates low farm crop yields observed. Farmers are adopting various measures to improve and conserve land albeit different constraints. Further analysis reveals that proportionally land farmed with conservation is positively and significantly motivated by land degradation severity in both zones, but dampened by accessible land size. Although cropped area and credits enhanced conservation in intensive and low conservation zones respectively, the latter and former depressed it in the respective zones. Consequent impacts of this reflect the 3 times higher farm incomes earned (Ug. Shs) in intensive zone than in low conservation locations. This translates subsequently into total family incomes of 200% higher in intensive zones compared with that recorded in low conservation zones. These results attest to the potential of soil conservation adoption on improving living standards of farmers and providing sustainable land management options in face of land use changes.

Keywords: Adoption, family resource use, soil erosion control measures

Introduction

Decreasing agricultural land, inappropriate land use practices and declining rural family living standards are closely interrelated problems in Uganda (MAAIF, 1998). These characterise the general trends and patterns of development for most parts of Uganda in the last 20 years. However, changes that have had significant impact on land use and management include extension of cultivation into marginal areas, soil erosion, nutrient mining and deforestation, declining use of fallows, limited investment in conservation measures, and limited use of organic and inorganic inputs (Gold *et a*l., 1999). Several fundamental factors are hypothesized to be driving this situation. The most driving forces are rapid population growth, limited infrastructure, market developments, high weather risks, and limited awareness of appropriate technologies, land fragmentation and land tenure insecurities (Bashasha *et al.*, 2001). These constraints singly or in combination have put much pressure on land beyond its capacity and are accelerating overuse and misuse. This has consequently developed into a series of crop and livestock production systems that in turn are giving rise to complex and none sustainable land uses practices (Pender *et al.*, 1998). However, soil and water conservation practices present opportunities for reversing soil degradation (MAAIF, 1998). Generally, in Uganda there is a paucity of information on land use changes and how this will impact the living standards of farmers in the long run.

Therefore, the objectives of this study were; (i) to identify the land use changes in the last 20 years in the two areas with different levels of soil conservation in Uganda, (ii) to identify soil management and conservation techniques with a view of recommending appropriate ones to farmers (iii) to

determine quantitatively factors that influence farmers' decision-making on land and soil conservation, (iv) to identify potential effects of adopting soil conservation strategies on living standards of families.

Materials and methods

Study area description and selection criteria

The study was conducted in Nangabo (Wakiso district) and Bugamba (Mbarara) sub counties in central and western Uganda respectively. The latter is referred to as intensive soil conservation zone while the former is low conservation zone (Table 1).

The purpose of this research was to elicit understanding of the predominant land use systems in the area and their relationships with soil conservation in order to suggest appropriate strategies for improvements. Thus, the selection of the study area considered the existing dichotomy in the agricultural systems based on intensity of soil conservation usage. On this basis the two areas can be characterized as follows: (i) Low soil conservation zone covering central region is classified as an area of high potential with good market access. It's a nerve centre for production and marketing of key traditional exports, mainly coffee and non-traditional export crops (beans, fruits, vegetables and flowers) because of its proximity to Kampala city. The region is generally flat with gentle rolling hills; (ii) Intensive soil conservation zone covers the western region, an area of high potential but poor market access, fairly mountainous, dominated by non-traditional export crops, cattle and high population densities.

Sample selection and research design approach

A multi stage random sampling procedure was adopted in this study for the purposes of data collection. Two districts Mbarara and Wakiso and their respective sub-counties of Bugamba and Nangabo were purposively selected to represent the areas with the problem of land degradation and using conservation measures. Lists of all villages were obtained from sub-county chiefs and with assistance of sub-county agricultural officials villages were stratified into two groups on the basis of landholding size, livestock herd and intensity of conservation. Then, Ngugo and Rwenkwanzi villages in Bugamba were randomly selected to represent areas of intensive soil conservation while Bamba and Jokolera lower levels of conservation (Table 1). At the village level, lists of all families were obtained from local councils and again through randomisation techniques, 25 families per village were selected. Over all, 100 families were randomly selected for formal interviews, 50 families from each of the two studied zones. Family heads were interviewed.

Data collection

Data were collected by administering pre-tested questionnaires to a total of 100 randomly selected families in the two zones between March and August, 2003. Data on socioeconomic characteristics of farmers as well as the quantity and costs of inputs used in the production process were gathered. Data measurements and estimates of the inputs, hectarages and units refer to the 2002 agricultural year unless otherwise specified.

Data Analysis

Before analyses data were examined for extreme value and missing ones by Box and Whisker plots tests. Econometric and descriptive statistical analyses were performed on data to determine the relationships between factors. Statistical differences between the two farming systems were compared by non parametric Mann – Whitney tests using SPSS software. A significance level of 0.1 is used unless otherwise stated.

Results and discussions

Land use changes in areas of intensive and low soil conservation in Uganda

Results of analyses indicate that, there has been a lot of land use changes in central and western Uganda as characterised by the size of land allocated to various farming activities (Figs. 1-4). For instance trends of land allocation to crop farming in the last 20 years indicate that both in the intensive and low soil conservation zones the hectarages increased appreciably though more rapidly in the intensive soil conservation areas (Fig. 1). For instance, farmers land allocated to pastures alone for livestock feed production is as shown in Fig. 2. These changes can be explained by the increasing opportunities for commercialisation of food crops especially bananas and dairy products (milk) in the intensive and low soil conservation zones respectively. This observation is consistent with findings from earlier works in Uganda (Mugisha and Ngambeki, 1994; Gold *et a*l., 1999; Bashasha *et al.*, 2001). Pender *et al.* (2000) while investigating the development pathways in Uganda attributed the changes to developments in comparative advantages wrought about by urbanisation and marketing infrastructure and accessibility. Meanwhile, farm hectarages under planted forests (Fig. 3) decreased in both zones that were studied in the last 2 years. Pointing perhaps to the fact that crop and pasturelands could have increased at the expense of forestland. However, the unusable land size (Fig. 4), a surrogate for land degradation occurring during the same period escalated. Land uses that are accelerating this situation are brick making, soil erosion, soil mining and continuous crop growing without fallows and rotations.

Table 1. The characterization and description of the study areas into two conservation zone

Descriptions	Intensive soil conservation zone	Low soil conservation zone
Populations densities	High	Low
Crop yields	High	Low
Soil fertility decline	Relatively low	High
Soil erosion	Relatively high	Relatively low
Natural forest cover	Low	High
Dominant crops	Perennial crops mainly bananas	Annual crops mainly cassava and sweet potatoes
Livestock size	Large	Small
Infrastructure and access to markets	Poor	Good
Topography	Hilly with steep slopes	Hilly with gentle rolling slopes

Source: MAAIF (1998)

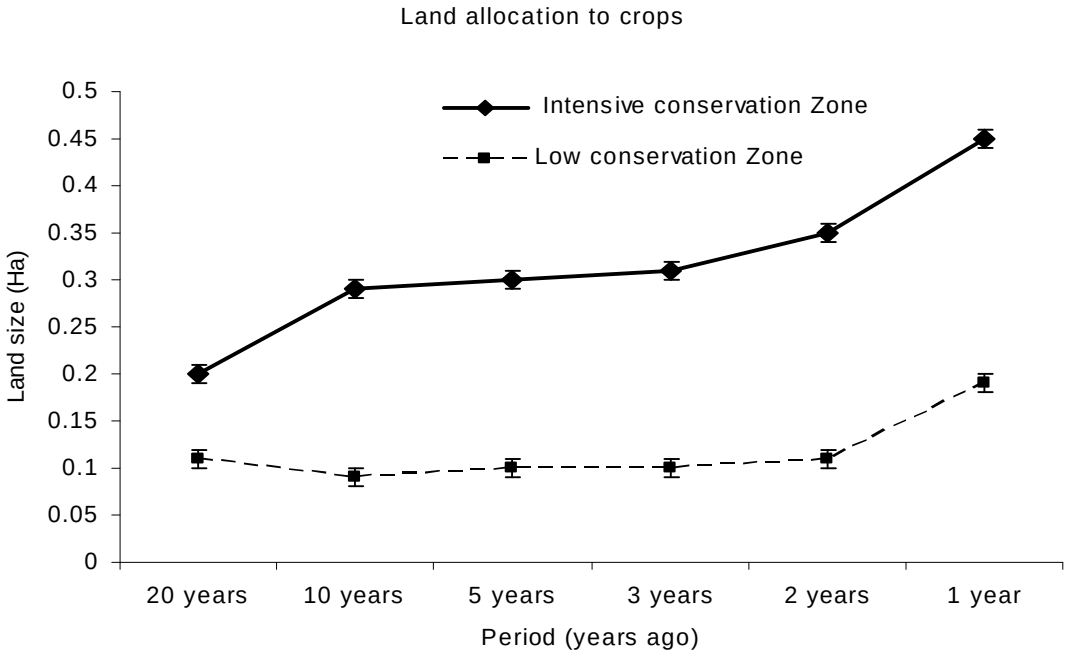

Figure 1. Trends of farm land allocation to crops in the last 20 years in the two study zones in Uganda

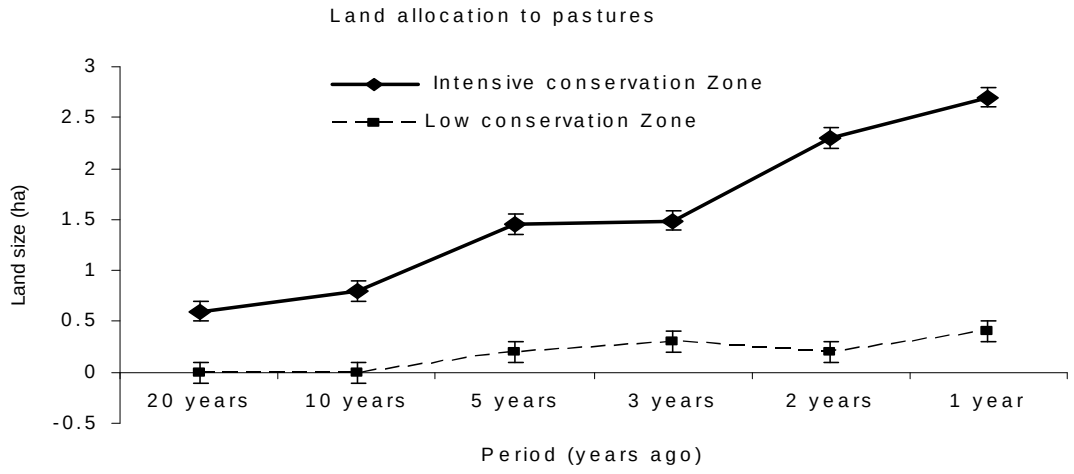

Figure 2. Trends of farm land allocation to pastures in the last 20 years in the two study zones in Uganda

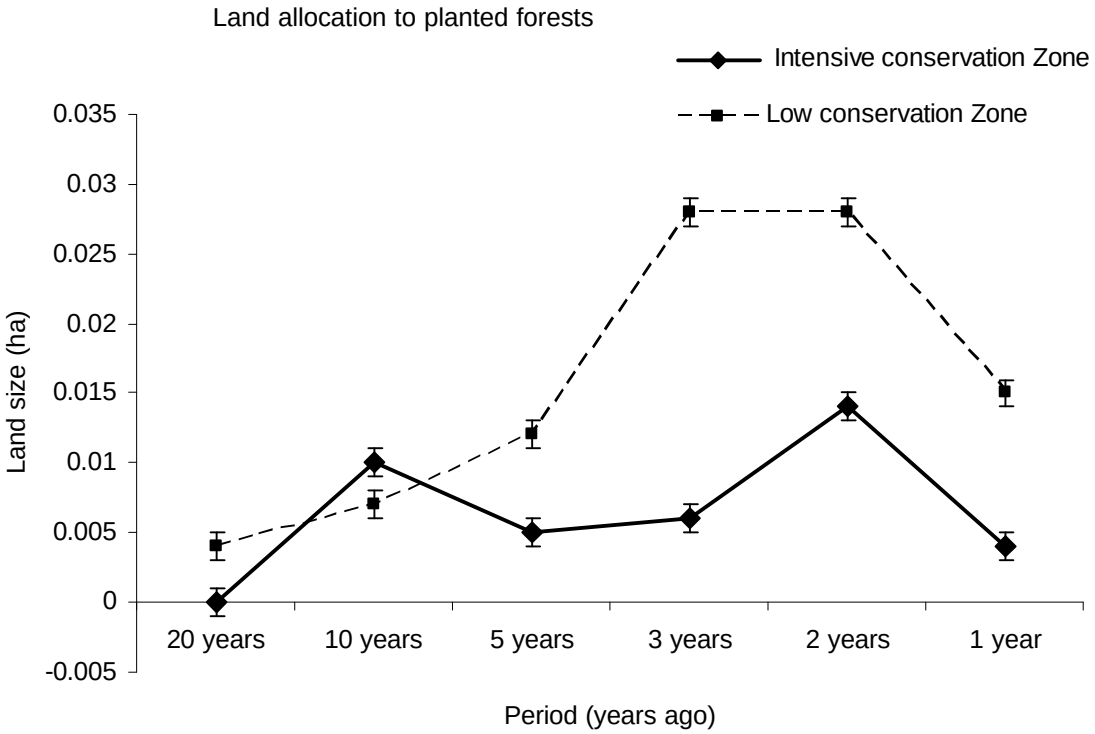

Figure 3: Trends of farm land allocation to planted forests in the last 20 years in the two study zones in Uganda

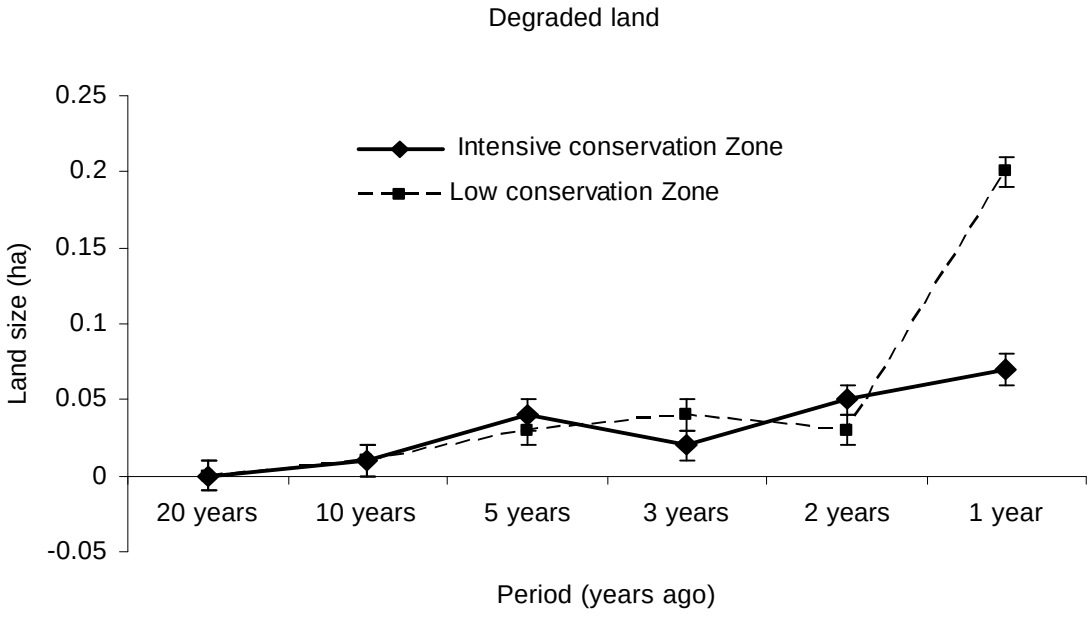

Figure 4: Trends of farm land that has become unusable (degraded) in the last 20 years in the two study zones in Uganda

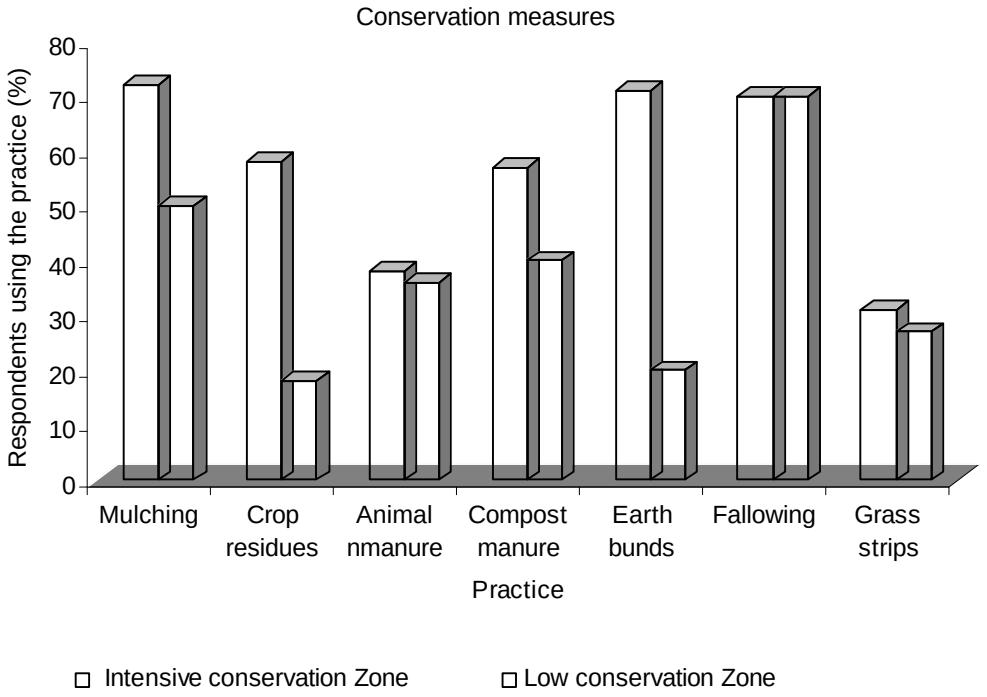

Figure 5. The percentage of farmers using the various conservation methods in the two study zones in Uganda during 2002

. Land degraded through brick making is motivated by high prices offered in the construction industry sector but this land remains unusable for a long time besides being a physical hazard to farm workers and animals. This then raises new questions of sustainability of this land use practise. Sserunkuma *et al.* (2001) while studying the coping strategies of farmers to low and declining productivity in the banana- coffee lakeshore farming systems expressed worries concerning the widespread proliferation of brewing bananas K*ayinja* that is depleting the soils at an alarming rate. *Kayinja* is a heavy feeder and is accelerating soil mining in central region. Farmers believe it is responsible for '*Lunyo*' a soil condition characterised by low productivity present in the low conservation zone (Walaga *et al*., 2000). Additionally the increasing level of drunkardness is hampering other farming activities. On the positive note, however, the increase in livestock farming will bring increased utilisation of crop by -products which will in turn be converted into animal manure that will be recycled to soil and appears will offer synergetic interaction between the two farm enterprises while ensuring prospects of sustainable agricultural growth and natural resource use. The complex and often site specific effects of the land use changes implies that no 'one size fits all' strategy is likely to be effective in dealing with the problems associated with land use changes and subsequent land management options. Therefore, livestock production could be promoted in both zones but brick making should be discouraged in the low soil conservation zone.

Farmers' response to land degradation problem in areas of intensive and low soil conservation in Uganda

A number of soil conservation technologies and practises are employed by farmers in the two study areas (Fig. 5). These include mulching, crop residue application, animal refuse use, compost manuring, earth bunds building, fallowing and grass strip planting. Generally, all these practises were used more by farmers in the intensive soil conservation than in low zones, save for fallowing which was reported to be used by the same percentage of farmers in both zones (Fig. 5).This observation could apparently be attributed to the benefits derived from pursuing conservation strategies. Farmers in intensive zone obtain higher crop yields and are more positively pre-dispositioned to take on a wide range of soil enhancing practises when advised by the extension workers as compared to their counterparts in the low soil conservation zone who derive more benefits from off farm activities and brick and sand selling to Kampala city. Studies in Uganda and elsewhere (de Graaff, 1993; AHI, 1997; Walaga *et al*., 2000; Bagamba *et al*.,2001; Miiro *et al*., 2002; Regassa, 2002) indicate that technologies are adopted and adapted according to the returns they bring, labour

requirements and availability, the mount of land involved and the many other demands on farmers' time and resources. The factors in the two study zones that influence decisions on land use with conservation measures are investigated in the next section.

Determinants of land conservation in areas of intensive and low soil conservation in Uganda

A number of factors are hypothesised to influence the amount of land that farmers cultivate with soil conservation measures. Therefore, to quantify the effect of these factors, linear regression model was used to estimate the influence of these factors on the amount of land farmed with conservation. The linear model was adopted because of its simplicity in aiding data interpretation. However, prior to model application, data were subjected to residual error trend analysis which revealed absence of any which revealed absence of any error trends an indication that non linear models were not appropriate for factor estimations (Amemiya, 1981).The model is mathematically specified as;

$LC = a + ßx1 + ßx2 + ßx3 + ßx4\ ßx5 + ßx6 + ßx7 + ßx8 + ß\,x9 + ßx10 + ßx11 + \mu_{ij1..11}$

Where LC= land farmed with soil conservation measures (%) a = Constant (intercept), ßx1= size of cropped area (ha), ßx2= Size of degraded land (ha),ßx3= Size of intercropped area (ha), ßx4= Time of moving between land fragments (hours), ßx5 = land owned (ha), ßx6= Size of livestock herd, ßx7= Farm income (%), ßx8 = Access to credit (Ug. Shs), ß x9= Marital status of the family head (1) married (0) not married, ßx10= Farm location (1) flat (0) sloping area, ßx11= Land rights (1) full (0) no rights, and $\mu_{ij1..11}$ = error term. Because explanatory factors were hypothesized to be different for the two areas, therefore the model was run separately for the two zones.

Results of 11 variables included in the linear regression model indicate that only four factors significantly ($P \leq 0.1$) explained the size of land that is farmed with soil conservation measures in the two study areas (Table 2). The model explained 66% and 52% of the variations in land conserved in the intensive and low soil conservation zones, respectively. The significant factors include size of cropped area, size of degraded land, size of land under intercrops and the size of total land owned by the family. The other significant factor though only in intensive conservation zone was the amount of credit accessible to the family. Farmers in this zone, grow crops of which a bigger proportion is sold to the markets, therefore are able to repay their loans and credits. However, credit had a negative effect in that, upon acquiring loans, farmers prefer to invest it in off farm activities like trading than invest it in soil conservation and land improvements.

Farm land that is under crops significantly and positively influenced the size of land that was farmed with soil conservation measures in both zones. The more the land is allocated to crops the more the land that was farmed with conservation. For example, for every 1 ha land under crops, the land conserved increased by 482.39% in the intensive conservation zone and 295.15% in the low soil conservation areas. This is because some crops like banana require proper agronomic management to give reasonable yields. This crop is grown widely in both zones, possibly the reason for this positive response.

On the other hand the size of total land owned significantly and negatively affected the conserved land in both zones. The bigger the size of land owned, the smaller the land that was farmed with conservation measures proportion wise. For instance, for every 1 ha land owned, the land conserved declined by 1.29% and 1.16% in the low soil conservation areas. This could be attributed to the fact that, larger land requires more investments in terms of labour and money for soil conservation structures and practises and yet these are major constraints in both areas. Meanwhile smaller farms could affordably be serviced by family available labour without stretching it beyond its capacity.

Another important factor that appeared to significantly and positively influence the size of land conserved was the extent of land degradation on the farm. The bigger the size of land that was degraded the bigger the proportion of land that became conserved, in the intensive conservation zone for every 1 ha land degraded, the conserved land tended to increase by 448.90% while in the low conservation zone the corresponding increase was 220.23%. Degraded land is associated with poor yields and subsistence food production deficits, therefore farmers respond to this threat by adopting soil conservation measures. The potential effect of adopting the soil conservation on family living standard as indicated by family incomes is examined in the following section.

The Potential of adopting Soil Conservation on farming families' living standard in areas of intensive and low soil conservation in Uganda

Farmers' decisions on land management are not separate from decisions on production, consumption as well as social control. In farming systems approaches Doppler, (1996; 2000) and Regassa (2002) indicate that in countries where agricultural sector is dominated by farming families understanding the complex system in which farmers live and make decisions is very crucial as these have far reaching implications for soil and water conservation. For most farmers the main concern is how to sustain and improve their living standards through improved production, using the limited resources of land, labour, capital and management skills available to them.

Table 2. Factors influencing farming land with soil conservation measures in two zones with varying levels of conservation in Uganda during 2003

Variable	Intensive soil conservation zone			Low soil conservation zone		
	ß	t-test	significance	ß	t-test	Significance
Constant	8.48	0.15	0.88	76.26	2.05	0.04
Size of cropped area (ha)	482.39	6.03	5.10E-07	295.15	5.65	1.93E-07
Size of degraded land (ha)	448.90	2.83	0.01	220.23	2.66	0.01
Size of intercropped area (ha)	-12.59	-0.57	0.57	-5.97	-0.43	0.67
Size of owned land (ha)	-1.29	-4.84	2.16E-05	-1.16	-6.11	2.62E-08
Time of moving between land fragments (hours)	-39.91	-0.95	0.35	-8.26	-0.26	0.80
Size of livestock herd	-12.62	-0.72	0.47	7.31	0.59	0.56
Farm income (%)	0.49	1.16	0.25	-0.11	-0.59	0.56
Access to credit (Ug. Shs)	-56.64	-1.81	0.08	-11.80	-0.89	0.38
Marital status of the family head (1) married (0) not married	-3.01	-0.19	0.85	-3.26	-0.27	0.79
Farm location (1) flat (0) sloping area	22.73	0.36	0.72	-10.98	-0.74	0.46
Land rights (1) full (0) no rights	-10.65	-0.25	0.80	-11.81	-0.35	0.72
R = 0.81				R = 0.72		
R^2 =0.66				R^2 = 0.52		
Adjusted R^2 = 0.56				Adjusted R^2 = 0.46		

Table 3: Analysis of family incomes and share of contribution by farm and off farm incomes in the study area during 2002

Value (, 000 Ug. Shs)	Intensive soil conservation zone (n = 50)	Low soil conservation zone (n = 50)	Overall mean (n = 100)
Farm income	2446.47a (2546.88)	784.433b (838.60)	1616.12 (2064.13)
Farm income per family labour unit	3.26	1.4	2.34
Farm income per Ha of land	1411.38	676.81	1044.09
Off farm income	1085.92 (1805.61)	1078.92 (1382.57)	1082.42 (1599.93)
Family income	3535.73a (3699.04)	1861.35b (1565.76)	2698.54 (2948.52)
Family income per person	734.26	398.46	566.36
Family income per family labour unit	4.81	4.48	4.64
Farm income per Ha of land	1962.30	1516.52	1739.41

Figures in parentheses are Standard deviations from the mean; Figures with similar letters long the rows a, b, are not significantly different from each other at 0.1 Probability level by Mann – Whitney none parametric tests

The implication of this for soil conservation is that the focus should be on improving the living standards of family, combating productivity losses, rather than simply preventing soil loss per say (Doppler, 1996). Therefore, soil conservation practises and activities may have direct effects on farm and family incomes. This aspect was examined in the two zones with varying levels of soil conservation. Family income is constituted from farm and off farm incomes and can be both cash and what is available in kind. It therefore represents income generating power of the family owned resources (Lubwama, 1999) and reflects the decision making abilities of the family (Doppler, 2000). Farm incomes were calculated as the differences between total annual gross revenues and annual farm expenses. The revenues were calculated as the total value of products valued (computed) at farm gate prices irrespective of whether the products were consumed in the home or sold in the market. Expenses include costs of inputs such as seed, manure, pesticide, hired labour, transportation and land and equipment rental rates. Off farm income was calculated as the revenue from all activities that had nothing to do with farming on the farm.

Results of family, farm and off farm incomes recorded in the study area are presented in table 3. Annual total off farm income though important was not significantly different between the two study zones. On the other hand, total annual farm income was significantly ($P \leq 0.1$) different between the two studied zones being 2.4 million Ug. Shs in the intensive conservation zone and 0.8 million Ug. Shs in the low soil conservation zone. This represents three fold more farm incomes earned in the intensive zone than in low conservation areas (Table 3). Similarly when farm income per labour unit and land used were considered, they were highest in intensive zone as compared to low conservation zone. This wide gap can be explained by the type of farming activities and amounts produced in the two zones. In the intensive zone, farmers grow bananas extensively and have a larger livestock herd. These contribute higher revenues than annual crops cassava and sweet potatoes that dominate in the low conservation zone. This creates differences in the family incomes enjoyed in the two zones. For instance the average annual family income is 3.5 million and 1.8 million Shs in intensive and low soil conservation, respectively. The corresponding family income person per year was 0.7 and 0.4 million Shs, in that same order. While annual family income per labour unit was 48100 and 44800 Shs in intensive and low soil conservation, respectively. This translates into almost 200% more family incomes enjoyed by families in intensive conservation zone as compared to low conservation usage zone. This difference could solely be explained by the differences earned from the farm income as off farm showed no significant differences in the two areas. By adopting soil conservation in the low conservation area, it is possible to improve the living standard of families through farming by increasing farm incomes.

Conclusions

It is clear from this study that a lot of land use changes occurred in Uganda in the last 20 years, as characterised by farmers increasingly allocating more land to crops and livestock production. At the same time land degradation has increased rendering some land unusable. Some land uses like livestock production are commendable as they will contribute to replenishing nutrients lost through soil mining while others such as brick making should be discouraged as they will have negative effects.

It can be concluded from this study that the factors that influence soil conservation usage are size of cropped area, size of degraded land, size of land under intercrops and the size of total land owned by the families as well as the amount of credit accessible to the family. Families in zones that apply soil conservation earn three times more farm incomes that in turn reflect the two times more family incomes enjoyed by those families. This study has demonstrated the potential of soil conservation adoption on improving living standards of farmers and the prospects of sustainable land management options in face of land use changes.

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