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Full Length Research Paper

Use of soil conservation practices in the Southwestern highlands of Uganda

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The objective of this study was to determine the nature and extent of use of soil conservation practices, and examine the factors determining their adoption by farmers in Southwestern Uganda. We collected data from 853 households in eight sub counties spread out in three districts (Kabale, Kisoro and Ntungamo) through household interviews. The study area was divided into three categories (low, medium and high) depending on assessment of the level of intervention by development projects in the last 15+ years. The various soil conservation measures used include crop rotation, intercropping, use of cover crops, manure application, trenches/terraces, alley cropping/spacing, mulching, conservation tillage, water harvesting and application of synthetic fertilizers. Generally, the level of use of soil conservation practices can be rated as "moderate" The level of adoption of the soil conservation practices was independent of previous levels of intervention by development projects. The major socio-economic factors affecting adoption of soil conservation practices in Southwestern Uganda are total male as well as total labour force in the household, household size, membership to farmer association, visitation by extension agents and total land size owned. Improvement in soil productivity requires farmers' collective action, for example, through formation of innovation platforms to hasten technology diffusion.

Key words: Soil conservation, highlands, Southwestern Uganda.

INTRODUCTION

An estimated 75% of the world's poor and hungry live in rural areas and depend directly on agriculture for their livelihoods (Toby et al., 2008). About 300 million people in sub Saharan Africa (41% of the population of sub Saharan Africa) live below the poverty line (World Bank, 2007), representing the highest poverty rate in the world. Low inherent soil fertility, soil erosion especially in the highland areas are major cause of poor agricultural performance (Wortmann and Kaizzi, 1998; Woelcke and Berger, 2002; Esilaba et al., 2005). The most important forms of degradation are soil erosion, caused by both water and wind, and soil nutrient depletion, caused by overgrazing, deforestation, crop production on fragile lands without sufficient soil cover or use of conservation measures, declining use of fallow, and limited replenishment of soil nutrients (Stoorvogel and Smaling, 1990; Smaling et al., 1997; Nkonya et al., 2008).

According to Esilaba et al. (2005), nutrient depletion is most intense in East Africa because of high uptakes of nutrients in harvested products without significant replenishment, erosion and the relatively high inherent fertility of the soils. The relatively high population and steep slopes of the region make these phenomena peculiar to East Africa. Several studies in Uganda (Nkonya et al., 2004; Nkonya et al., 2005; Esialaba et al., 2005; Wortmann and Kaizzi, 1998) have reported negative nutrient balances in the small-scale farming systems. Smaling et al. (1997) reported losses of up to130 kg N, 5 kg P and 25 kg K ha^{-1} per year in the East

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African highlands through soil erosion due to steep slopes, and crop harvest due to continuous cultivation to feed the relatively high population of the region. Wortmann and Kaizzi (1998) found that estimated nutrient balances for small-scale farming systems in eastern and Central Uganda were negative for all crops except for nitrogen (N) and phosphorus (P) in the banana-based land use type (LUT). Consequently, there is a net negative nutrient balance for almost all nutrients as noted by Nkonya et al. (2005) that only 5% of households in Eastern Uganda had positive total NPK balances (Esialaba et al., 2002).

Efforts to ensure sustainable agricultural productivity have for long been promoted, especially in the southwestern highlands of Uganda using various approaches. Some of the popular projects that existed in the last 10 years include the land care project under the then International Center for Research in Agroforestry (ICRAF, currently World Agroforestry Center) and Internal Center for Tropical Agriculture (CIAT), whose focused was on soil conservation. The Area-Based Agricultural Modernization Program (AAMP) under the local government implemented various interventions including improving access to market through opening up feeder roads, provision of inputs and technical services. And National agricultural Advisory Services (NAADS) also under local government supports demand-driven and market-led agricultural extension services.

It is noteworthy that the level of utilization of land conservation practices varies widely as do the socio-economic characteristics of farming households. A recent study by IFPI showed that land management practices in Kabale are generally low and this showed linkage with poverty (Nkonya et al., 2008). According to Tittonell et al. (2005) and Buyinza et al. (2007), the degree of adoption of land management practices, and the level of degradation, varies from one farmer to another depending on biophysical, socio-economic and institutional factors. In many cases, the conditioning factors are site-specific and require site specific information to diagnose and arrive at appropriate recommendations for overcoming the problem.

Despite the numerous efforts government and NGOs towards mitigating soil productivity decline, implementtation of best practices by farming communities remains meager probably due to limited follow up by extension agents, highly cost of inputs such as fertilizers and labour intensiveness of some methods such as trenches (Woelcke and Berger, 2002). Nkonya (2002) reported that in 2000, between 40 and 55% of the households in Southwestern Uganda used at least one soil conservation practice on their plots. However, use of manure and synthetic fertilizers were used by none and 11% of the households, respectively. This study attempts to establish whether there has been a change in utilization of soil conservation practices in the region.

We envisage that contrary to colonial times where rule enforcement was strict, the current limited implementtation of land management policies has retarded utilization of land conservation practices and that even after 10+ years of high activity of development projects, there is no significant difference in the level of utilization of these practices. The objectives are to (1) determine the extent of utilization of soil conservation practices, and (2) assess the factors determining their utilization by farming households in the southwestern highlands of Uganda. This study was part of the larger sub Saharan Africa Challenge Program in the Lake Kivu Pilot Learning Site.

STUDY AREA AND METHODS

Study area

The study was conducted in eight sub counties (Bubare, Hamurwa, Bufundi, Chahi, Nyakabandde, Rubaya, Itojo and Kayonza) spread out in three districts in Southwestern Uganda (Figure 1), which is one of the three Pilot Learning sites of the sub Saharan Africa Challenge Program (SSA-CP). The Lake Kivu Pilot Learning Site (LKPLS) is located on the border region between Uganda, Rwanda and the Congo. It is a highland agro-ecological zone (AEZ) characterized by steep slopes, deep good volcanic soils and ample rainfall that offers good potential for agriculture growth. The area receives mean annual rainfall varies from 900 to 2,200 mm and has medium to long length growing periods (180 to 270 days).

The principal crops grown include sorghum, millet, Irish and sweet potatoes, peas, maize, beans, bananas, tea, coffee and other tree species for fruit and forest products. Despite the apparent rich natural resource endowment, the Lake Kivu region is considered one of the poorest and most densely populated areas of Africa, with densities ranging from 400 to 700 persons/km^2 (FARA, 2009). This has led to over-exploitation of the natural resource wealth. Over 90% of the population derives its livelihood from agriculture and other enterprises based on natural resources on less than 0.6 ha per family of six (FARA, 2009). Nearly 60% of the land area is intensively cultivated and poverty in the region is directly linked to the low and deteriorating productivity and profitability of these enterprises. The region has also experienced recurrent volatility of conflicts with sporadic conflict still continuing in some parts of DR Congo and climate change. The principal challenge in LK is thus to contribute to improved food and nutrition security, increased household incomes and improved quality of the PLS natural resource base by applying Integrated Agricultural Research for Development (IAR4D4) to develop, test and promote technological, institutional and policy innovations based on integrated watershed management (IWM) concept.

Site selection and data collection

The site selection process followed a seven-stage process: (1) Census of the sub-counties; (2) Definition of low and high market access; (3) Modeling of market access; (4) Identification of candidate sites; (5) Develop diagnostic tool for site selection; (6) Appraisal of candidate sites, and (7) Final selection of sites (Farrow et al., 2008). In selecting the sites, it was necessary to ensure that some sites have had as little as possible outside Research and Development (R&D) interventions, while also finding other sites that have a similar context to the former, but which have experienced more R&D interventions. More information regarding the characteristics of the LKPLS can be found in Thornton et al. (2006).

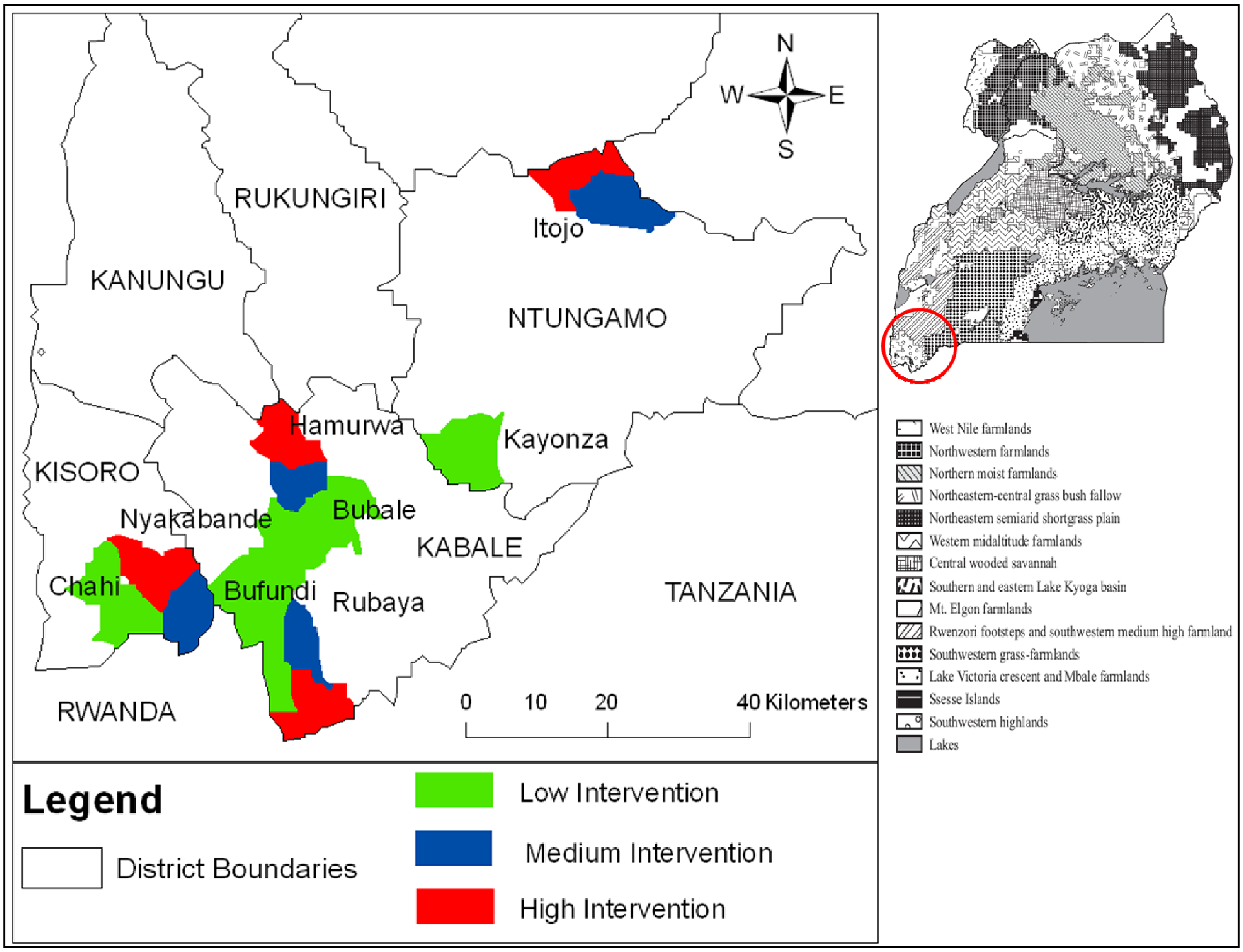

Figure 1. Location of study sub sites in Southwestern Uganda.

Selection of households followed a stratified and random sampling design to compare the soil conservation situation of households and communities under the following three categories of communities: (1) IAR4D, (2) Conventional and (iii) No intervention of ARD.

In each of the above categories, between 5 and 10 villages were selected randomly and from each, 10 households were selected, using random numbers, for the household interviews. The number of villages and households selected was based on Miguel and Kremer (2004) methodology of randomizing treatments across schools (districts and village communities) and not individual farm households because this method captures spillovers and externalities benefits that would be underestimated if a treatment is only randomized at the individual level. The distribution of the sampled household by treatment category is shown in Table 1.

Data analysis

To determine the overall degree of utilization of soil conservation strategies, the locally available soil conservation practices were identified. A score of 1 was allocated to a practice utilized while 0 was for non-utilization. An aggregate of all the scores for each farmer were divided by the number of practices utilized on each farmland to obtain an index of the level of utilization. This index formed the parametric dependent variable.

The variables hypothesized to affect utilization of soil conservation practices included: (1) Level intervention by development organizations (Low, moderate, high); (2) Sex of household head (male, female); (3) Age of household head; (4) Highest level of education in the household; (5) Number of males between 16 and 58 years, representing the active male labour force; (6) Number of females between 16 and 58 years, representing the female labour force; (7) Type of household (monogamous, polygamous); (8) Membership to farmer groups; (9) Visitation by extension agent(s) in the last two years; (10) Visitation to extension agent(s) in the last two years; (11) Total farmland, and (12) landscape position of plot. Stepwise binary logistic regression analysis was used to determine which of these factors influenced utilization of soil conservation practices.

RESULTS AND DISCUSSION

Descriptive statistics

The results show that approximately 78% of the households were male-headed and of these, 90% (70% of total) are monogamous (have one wife) (Table 2).

Table 1. Distribution of sampled households in the southwestern highlands of Uganda.

Treatment	Sub county	Number of village	Number of household*	Male	Female
	Bubare	5	45	30	15
	Bufundi	10	98	82	16
Low	Chahi	10	103	82	21
	Kayonza	5	44	33	11
	Total	*30*	*290*	*227*	*63*
	Hamurwa A	5	47	42	5
	Itojo A	5	37	20	17
Medium	Nyakabande A	10	96	74	22
	Rubaya A	10	96	74	22
	Total	*30*	*276*	*210*	*66*
	Hamurwa B	5	48	40	8
	Itojo B	5	48	40	8
High	Nyakabande B	10	98	73	25
	Rubaya B	10	93	76	17
	Total	*30*	*287*	*229*	*58*

*Although we targeted 10 households per village, we did not use all of them for analysis due to various shortcomings in the data.

About 81% of the female headed households were widowed while the others were either single or divorced. The single female-headed households are usually young girls that have either completed school but have not yet married and may be taking care of their younger brothers and sisters, whose parents live in more remote areas. The level of education of about 70% of the household heads does not go beyond primary school. Although very few (only 2%), household heads had undergone some adult education. About 50% of the sampled households have primary level education. Education, skills and experience may increase adoption of improved land management practices since educated farmers may better understand extension messages and the effect of land degradation on productivity.

On the other hand, education may increase farmers' opportunities to be engaged in non-farm activities, which would compete with agriculture for farmers' scarce factors of production, time, and cash (Scherr and Hazell, 1994). Nkonya et al. (2005) reported that education of the household head showed a negative relationship with nutrient inflows from off-farm grazing and Biological Nitrogen Fixation (BNF). Nkonya et al. (2004) also show that farmers who have completed primary education are less likely to apply household residues and much than those who did not complete primary education. This is consistent with the theory that education increases farmers' opportunities to be engaged in non-farm activities. Such options may reduce the farmers' incentive to invest in soil conservation practices.

About half of households have at least one member belonging to a farmer group. 85% of the sampled households have not been visited by an agricultural extension worker in the last two years and only 6% have made an initiative to visit an extension worker to seek agricultural information. This shows that extension workers hardly reach many farmers to provide knowledge about conservation practices. The farmers also do not seek this information from extension workers. This implies that a lot of effort is still required to sensitize farmers on the need to seek extension advice where they feel they require it. Luckily, this is the notion of the NAADS program that started about a decade ago but still spreading out slowly. Contact with extension agents and other sources of agricultural knowledge may increase adoption of soil fertility technologies, hence leading to higher nutrient balances. This is because extension contact and other technical support increase the feasibility of adopting new technologies (Swinkels and Franzel, 1997). Our findings support those of Nkonya et al. (2005), who found that in Eastern Uganda, access to extension services significantly influences soil nutrient inflows at farm level. Government should allocate more funds for agricultural extension services. However, the assumption that farmer know what to demand for is not entirely true. In some cases, farmers need to be advised on the most appropriate interventions to undertake. The innovation platforms under the proposed IAR4D approach will hopefully play a key role in helping farmers to overcome this limitation. The age of the household heads ranged between 18 and 95 years with an average of 46 years (Table 3). The average number of the household labour force is about three while the average household size is six people. The land owned by each

Table 2. Household characteristics of respondents-categorical variables (N = 853).

Variable	Levels of variable	Frequency	Percentage
Sex of household head	Female	187	21.9
	Male	666	78.1
Household type	1 = male headed (monogamous),	601	70.5
	2 = male headed (polygamous),	80	9.4
	3 = female headed (husband absent),	20	2.3
	4 = female headed (widowed),	132	15.5
	5 = female headed (divorced),	5	0.6
	6 = female headed (single),	5	0.6
	7 = male headed (single),	3	0.4
	8 = male headed (divorced),	1	0.1
	9 = male headed (widowed)	5	0.6
Level of education of household head	1 = no formal education	268	31.4
	2 = Adult education	17	2.0
	3 = some primary education	321	37.6
	4 = completed primary education	112	13.1
	5 = some vocational training	11	1.3
	6 = completed vocational training	7	0.8
	7 = some secondary education	58	6.8
	8 = completed secondary education	20	2.3
	9 = College education	33	3.9
	10 = University education	6	0.7
Highest level of education in the household	1 = no formal education	105	12.3
	2 = Adult education	6	0.7
	3 = some primary education	286	33.5
	4 = completed primary education	125	14.7
	5 = some vocational training	12	1.4
	6 = completed vocational training	18	2.1
	7 = some secondary education	138	16.2
	8 = completed secondary education	71	8.3
	9 = College education	56	6.6
	10 = University education	36	4.2
Membership to farmer organizations	No	416	48.8
	Yes	437	51.2
Visited by extension agent in the last 2 years	No	727	85.2
	Yes	126	14.8
Visited extension agent in the last 2 years	No	800	93.8
	Yes	53	6.2

household ranged from 0.02 to 24 ha, with an average of 2.7 ha per household. Farmers in Ntungamo (Kayonza and Itojo) have relative higher land holdings because the population density is lower (about 150 persons /km^2) compared to Kabale and Kisoro (about 250 persons persons /km^2). The average value for the household land holding is higher than the national value of about 0.8 to 1 ha.

Soil conservation practices adopted by farmers

Various soil conservation practices are utilized by farmers in Southwestern Uganda (Table 4). These include cultural methods (crop rotation, intercropping and use of cover crops) of soil conservation dominate the list of practices that farmers use. Manure application, trenches/terraces, alley cropping/spacing, mulching, conservation farming,

Table 3. Household characteristics of households – continuous variables.

Variable	Mean	Std. Dev.	Min	Max
Age of household head	46.14	16.05	18	95
Number of males between 16 and 58	1.44	1.24	0	9
Number of females between 16 and 58	1.50	1.12	0	9
Total members between 16 and 58	2.83	2.04	0	11
Household size	6.13	2.78	1	20
Total land size owned by household	2.68	4.93	0.02	24

Table 4. Soil conservation practices used by farmers in Southwestern Uganda.

Soil conservation practice	Adopters (N = 853)		Level of intervention by projects		
	Frequency	%	Clean	Conventional	IP
Crop rotation	687	80.5	228	242	217
Intercropping	616	72.2	189	211	216
Cover crops	602	70.6	201	202	199
Manure application	549	64.4	163	198	188
Trenches/terraces	529	62.0	167	191	171
Alley cropping/spacing	434	50.9	152	138	144
Mulching	432	50.6	147	161	124
Conservation farming	396	46.4	144	128	124
Water harvesting	365	42.8	118	122	125
Chemical fertilizer	89	10.4	19	31	39

and water harvesting are also common practices that are used by 43 to 65% of the households. Crop rotation in most cases involved the temporal exchange between bean/maize and potatoes in the same plots. Maize and beans are normally grown as intercrops. In some cases, where the land is considered marginal, sorghum is used because it is a low-cost crop, followed by potatoes.

The planting of sorghum helps to keep the garden productive compared to leaving it in a short fallow. By the time the season for planting of potato is on, the fields are already clean. Crop rotation has several advantages that include improvement in soil quality, reduction of sheet-and-rill or wind erosion, management of the balance plant nutrients, increase in cropping system diversity, management of crop consumptive use of water, manage saline seeps, manage plant pests (weeds, insects, and diseases), provide food for domestic livestock, provide food and cover for wildlife, including pollinator forage, cover, and nesting (Green et al., 2005).

Common non-synthetic nutrient sources used by farmers include plant (crop) residues, cover crops (e.g. beans), green manures, animal manure, mulches and household waste. Farm yard manure is obtained locally from livestock owned by farmers. The various types of livestock owned by farmers are shown in Table 5. The data shows that only about 23% of the households own cattle, and on average, each has about 3 cows. This is so small to supply sufficient nutrients to the farmers' crop fields because the fields receive only 112 kg N/year from each cow as shown in Table 6. The use of non-synthetic nutrient resources for soil fertility improvement in SSA has been in practice since earliest times; though the strategies by which these materials were applied may differ from recent conventional methods through technology development and adaptive strategies to meet peculiar modern needs (Omotayo and Chukwuka, 2009). Brisbin and Runka (1995) provide values of NPK that different animals supply in excreta (Table 6). Some farmers used composited manure while others use it fresh from the kraals/crop fields. The amount can be small if these are the sole sources of nutrients. However, most farmers use this in combination with other methods aforementioned.

Application of chemical fertilizers is practiced by only 10% of the households. Most farmers practicing crop rotation and conservation tillage in isolation may be better off carrying out the two practices integrative rather than in separately. Because the soils are highly weathered, their cation exchange capacity (CEC) is generally low. Whereas conservation tillage would maintain soil structure and improve organic matter, crop rotation would enhance nutrient replenishment through processes such as biological nitrogen fixation for example if legumes are included in the rotation. Since soil organic matter levels

Table 5. Livestock ownership among farmers in southwester highlands of Uganda.

Type of livestock owned	Number of farmers owning	Percentage of farmers owning	Average number of animals owned per farmer
Cross breed cattle	36	4.2	3
Exotic chicken	13	1.5	2
Improved goats	28	3.3	7
Improved pigs	12	1.4	2
Improved sheep	18	2.1	3
Local cattle	193	22.6	3
Local chicken	202	23.7	3
Local goats	308	36.1	3
Local pigs	63	7.4	2
Local sheep	124	14.5	3

Table 6. Nutrients excreted by different livestock types.

Livestock type	Nutrients excreted ((kg/animal/year)		
	N	P	K
Dairy (bulls)	112	20.1	76.4
Cows	116	13.1	97.1
Heifers	42	47.2	37.4
Calves	20	21.9	14.9
Milking centre (per milking cow)	1.7	1	2.4
Poultry (chicken (1000's)	0.6	0.23	0.28
Turkeys (1000's)	0.86	0.27	0.43
Other (1000's)	0.6	0.23	0.28
Poultry (pullets - 1000's)	0.34	0.1	0.12
(Layers) (1000's)	0.8	0.23	0.28
Swine (boars)	24.3	7.5	9.5
Sows	18.3	5.6	7.1
Other	7.2	2.4	4.6
Beef (bulls)	112	20.1	76.4
Cows	78	13.5	39.8
Heifers	44	14.4	33.2
Steers	50	16.2	36.5
Calves	20	21.9	14.9
Horses	45.5	7.6	28.4
Sheep (ram)	11	1.6	8
Ewes	11	1.6	8
Lambs	4.4	0.6	3.2
Goats	11	1.6	8

Source: Brisbin and Runka (1995). *Agricultural Nutrient Pathways.* Component project of Management of Livestock and Poultry Manures in the Lower Fraser Valley (REPORT 3 DOE FRAP 1995-28).

are more sensitive to tillage than to long rotations with perennial vegetation (Sherrod et al., 2003; Liebig et al., 2007) reducing or eliminating tillage from a management system will increase soil organic matter quicker than rotations with several years of perennial vegetation. The effects of this practice can be enhanced by utilizing animal wastes or applying mulches to supplement the biomass produced by crops in the rotation. Chemical fertilizers are normally used on potatoes and vegetables because they are high value crops but are never used on

Table 7. Determinants of adoption of soil conservation practices in southwestern highlands of Uganda.

Variable	Coef.	Std. error	z	P>|z|	95% Conf. interval	
					Lower	Upper
Level of intervention	-0.006	0.008	-0.750	0.455	-0.022	0.010
Sex of household head	0.037	0.023	1.600	0.109	-0.008	0.083
Age of household head	0.001	0.001	1.680	0.094	0.000	0.002
Education level of household head	-0.002	0.004	-0.490	0.622	-0.009	0.006
Highest level of education in household	-0.001	0.003	-0.340	0.736	-0.007	0.005
Number of males (16-58 years)	0.019	0.009	2.120	0.034*	0.001	0.037
Number of females (16-58 years)	0.018	0.010	1.800	0.072	-0.002	0.037
Household type	0.005	0.007	0.660	0.507	-0.009	0.018
Membership to farmer association	0.038	0.014	2.720	0.007*	0.011	0.066
Visited by extension agent	0.076	0.021	3.630	0.000*	0.035	0.117
Visited extension agent	0.038	0.030	1.260	0.207	-0.021	0.097
Total land size owned	0.011	0.003	3.600	0.000*	0.005	0.016
Constant	0.400	0.045	8.960	0.000	0.313	0.488

**significant at 5%,* R chi^2 (10) = 26.22, Prob > chi^2 = 0.0035, Log likelihood = -15.377167, Pseudo R^2 = 0.4602.

such crops as sorghum that is considered a low-value crop. Terracing and trenches ordinarily should have been the common soil conservation practices in this area due to the high level of soil erosion in the hilly parts characterizing this agro-ecological zone. Ironically, however, farmers prefer methods that are not labour intensive, such as alley cropping. What is noteworthy is that except for synthetic fertilizers, the other methods of soil conservation do not require purchase of externals inputs. This could have two important implications: First, the methods are locally adaptable to farmers' situation of limited financial capability since no additional cost is incurred to purchase inputs. Second, the methods used, we believe, may not meet the sustainability requirements of the farming systems because there is significant nutrient mining through crop harvests. These nutrients should be replenished with external inputs or fallowing with improved crops such as *Mucuna, Sesbania* spp., *Alnus* spp., among others. Tittonell et al. (2005) reported that in the highlands of western Kenya, the frequency of utilization of soil management practices such as fallow and crop rotations varied between sub-locations and farm types, and were normally constrained by land size due to the double cropping system.

Nkonya et al. (2005) found out that for most farmland in Eastern Uganda, the major source of nitrogen inflow is symbiotic N-fixation, which contributed about 22% of the 86 kg ha^{-1} of nitrogen inflow. The large contribution of symbiotic nitrogen fixation is common for households who plant leguminous crops and do not apply inorganic fertilizer. This is the case for most farmers in the study area. However, biomass transfer through off-farm grazing is the second most important source for phosphorus and the most important for potassium.

Our results show no significant association between soil conservation practice and the level of intervention of development projects. These results are consistent with the hypothesis that the efforts of past extension services should have spread out from the points of demonstration to the neighborhood. Even though this is the case, the efforts seen to be meager and more needs to be done to realize significant reduction in soil erosion, nutrient depletion. The methods currently being used may contribute but not enough to offset the negative nutrient balances. The reason for the no difference could be due to the high cost and labour requirements of most methods promoted by development organizations.

Determinants of adoption of soil conservation practices

Out of the 12 variables tested, only four showed significant influence on adoption of soil conservation practices (Table 7). The level of intervention did not influence the level of adoption of the technologies, implying that the efforts of earlier research and development projects did not create a real difference in the area. Otherwise, we would expect that those areas where projects had been operational, the level of adoption is higher. This confirms our postulation that development efforts have not delivered desired outputs to famers. In the context of the sub Saharan Africa Challenge program, stakeholder involvement in the articulation of critical challenges in a value chain, formu-lation and implementation of strategies to overcome the challenges and knowledge-sharing are major ingredients of a successful research for development process.

The number of household male aged between 16 and 58 represent the effective labor force in the household and the positive relationship with the likelihood of adoption is because they provide labour on the farm. The concern in many parts of Uganda is that this category of people are migrating to cities to look for better jobs given the recent rise in prices of basic commodities. Adetola (2009) found out that age of the household head, years of schooling and land area, did not affect the probability of adoption of an irrigation technology in Ghana. This, we believe, could be due to variability in farmers' varied options in the production function. Membership to farmer association showed increased likelihood of adoption of soil conservation practices. The social networks that come with participation in group activities increase household access to knowledge and information of technologies and associated benefits. The recent efforts to encourage formation of farmer associations such as the SACCOs (Saving and Credit Organizations) should be extended to cover other aspects such as input purchases and sale of produce (marketing groups).

Similarly, visitation by extension workers in the last two years increased utilization of soil conservation practices for similar reasons as for group membership. This study lends support to previous literature (Sheikh et al., 2003; Saeid et al., 2010), which demonstrate that increasing contact with extension workers increase the level of adoption of technologies. The challenges for extension agents have always been limited facilitation to reach the remotely located majority farmers and the small number of staff. In the study area, and Uganda generally, the public-funded extension workers are employed at sub county level and each sub county has, on average, 5000 households. The reason for no difference in utilization of soil conservation practices based on level of intervention by development projects in this study could be due to the farmer-to-farmer interactions that encourage learning and hence increased utilization of conservation practices. This shows the immediate advantage of having innovation platforms as they would foster farmers and other stakeholders to learn from and encourage each other on how to overcome soil fertility decline as a common challenge.

Total landholding owned positively affected utilization of conservation practices possibly because farmers with larger landholding are usually rich and employ hired labour on the farms as compared to small-scale farmers, who rely on family labour. For the latter case, the common measures used include the aforementioned cultural practices. It is also likely that at least one or a few conservation measures are applied to at least one or part of the so large land the household possesses, especially the fragile and/or highly valued ones. Calatrava-Leyva et al. (2005) reported that in the Spanish mountainous areas, adoption of no-tillage as a soil conservation measure was more likely for younger farmers and those that depend on family labour because of the low labour requirements.

As noted earlier, factors that affect technology adoption vary depending on socio-economic and ecological factors. Feder and Umali (1993) analyzed the final stage of the Green Revolution technology diffusion cycle and found out that the agro-climatic environment is the most significant determinant of location differences in adoption rates. The linkage between micro-adoption and the aggregate diffusion process needs to be more firmly established to achieve a clear understanding of diffusion patterns. Also, the impact of policy interventions to promote technology adoption depends on the type of technology, market structure, and the nature and duration of the policy intervention (Feder and Umali, 1993; Sheikh et al., 2003). According to Kiptot et al. (2007), important to note is that adoption is not a straightforward process but rather a continuous one and that farmers may oscillate between testing, adoption, discontinuation and re-adoption. Adoption is complex and influenced by many factors that do not lie solely within the household (Keil et al., 2005; Kiptot et al., 2007; Mazvimavi and Twomlow, 2009).

CONCLUSIONS AND RECOMMENDATIONS

The various soil conservation practices that farmers are using include crop rotation, intercropping, cover crops, manure application, trenches / terraces, alley cropping / spacing, mulching, conservation farming, water harvesting and chemical fertilizer. Although soil erosion is a major source of soil fertility decline, only few farmers are making effort to reduce it. The level of use of the conservation practices is independent of previous efforts of development projects. Generally, level of use of soil conservation practices can be rated as "moderate". The major socio-economic factors affecting adoption of soil conservation practices in Southwestern Uganda are total male as well as total labour force in the household, household size, membership to farmer association, visitation by extension agents and total land size owned. Extension agents should encourage farmers to implement soil conservation practices especially erosion control at landscape level and application of locally available nutrient sources to the farmer fields. This, we believe, is possible through the formation of innovation platforms to hasten technology relevance and diffusion, acceptability to all stakeholders in the value chain.

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REFERENCES

Adetola IA (2009). Factors Influencing Irrigation Technology Adoption and its Impact on Household Poverty in Ghana. J. Agric. Rural Dev. Trop. Subtrop., 109(1): 51–63.

Buyinza M, Nabanoga G, Asiya-Nagula, Nabalegwa MW (2007). Land Conservation Initiatives around Mt. Elgon National Park, Eastern Uganda. Indones. J. Geogr., 39(2)121-135.

Calatrava-Leyva J, Agustín FJ, González-Roa CM (2005). Adoption of soil conservation practices in olive groves: The case of Spanish mountainous areas Paper prepared for presentation at the XI International Congress of the EAAE (European Association of Agricultural Economists), Denmark, August 24-27, 'The Future of Rural Europe in the Global Agri-Food System', Copenhagen. 24661: 9.

Esilaba AO, Byalebeka JB, Delve RJ, Okalebo JR, Ssenyange D, Mbalule M, Ssali H (2005). On farm testing of integrated nutrient management strategies in eastern Uganda. Agric. Syst., 86: 144–165

FARA (2009). Medium-Term Plan, 2008-2010. Sub Saharan Africa Challenge Program. Accra, Ghana. p. 78.

Farrow A, Opondo C, Tenywa M, Rao KPC, Nkonya E, Njeru R, Lubanga L (2008). Selecting sites to prove the concept of integrated agricultural research for development. CIAT Site selection Report, LK PLS, SSA-CP. p. 149.

Feder G, Umali DL (1993). The adoption of agricultural innovations: A review Technol. Forecast. Soc. Change, 43(4): 215 – 239.

Green B , Kaminski D, Rapp B, Celetti M, Derksen D, Juras L, Kelner D (2005). Principles and practices of crop rotation. Saskatchewan Agriculture and Food.

Keil A, Zelle M, Franzel S (2005). Improved tree fallows in smallholder maize production in Zambia: do initial testers adopt the technology? Agroforestry Syst., 64: 225–236.

Kiptot E, Hebinck P, Franzel S, Richards P (2007). Adopters, testers or pseudo-adopters? Dynamics of the use of improved tree fallows by farmers in western Kenya. Agricultural Syst., 94: 509–519

Liebig MA, Tanaka DL, Krupinsky JM, Merrill SD, Hanson JD (2007). Dynamic cropping systems: Contributions to improve agroecosystem sustainability. Agron. J., 99: 899-903.

Mazvimavi K, Twomlow S (2009). Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. Agricultural Syst., 101: 20–29.

Miguel E, Kremer M (2004). Worms: Identifying impacts on education and health in the presence of treatment externalities. Econometrica 72 (1): 159-218.

Nkonya E, Pender J, Kayuki CK, Kato E, Mugarura S, Ssali H, Muwonge J (2008). Linkages between Land Management, Land Degradation, and Poverty in Sub-Saharan Africa: The Case of Uganda. International Food Policy Research Institute, Washington D. C. Res. Rep., p. 159.

Nkonya E (2002). Soil conservation practices and non-agricultural land use in the south western highlands of Uganda. A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission The International Food Policy Research Institute (IFPRI) 2033 K Street, N.W. Washington, D.C. 20006. p. 31.

Nkonya E, Kaizzi C, Pender J (2005). Determinants of nutrient balances in a maize farming system in eastern Uganda. Agricultural Systems 85: 155-182.

Nkonya E, Pender J, Jagger P, Sserunkuuma D, Kaizzi C, Ssali H (2004). Strategies for sustainable land management and Poverty reduction in Uganda. International Food Policy Research Institute (IFPRI) Washington, DC. Res. Rep., p. 133.

Omotayo OE, Chukwuka KS (2009). Soil fertility restoration techniques in sub-Saharan Africa using organic resources. Afr. J. Agric. Res., 4(3): 144-150.

Saeid F, Bondarian N, Mosayeb B, Arezoo M (2010). Effective factors of adoption of soil testing for nutrient fertilizer in Shatireal township of Esfihan province, Iran. Res. J. Soil Water Manag., 1(2): 38-44.

Scherr S, Hazell P (1994). Sustainable agricultural development strategies in fragile lands. Environment and Production Technology Division Discussion, Washington, DC: International Food Policy Research Institute. p. 1.

Sheikh AD, Rehman T, Yates CM (2003). Logit models for identifying the factors that influence the uptake of new 'no-tillage' technologies by farmers in the rice–wheat and the cotton–wheat farming systems of Pakistan's Punjab. Agric. Syst., 75(1) 79-95.

Sherrod LA, Peterson GA, Westfall DG, Ahuja LR (2003). Cropping intensity enhances soil organic carbon and nitrogen in a no-till agroecosystem. Agron. J., 67: 1533-1543.

Smaling EMA, Nandwa SM, Janssen BH (1997). Soil fertility in Africa is at stake. In: Buresh, R.J., Sanchez, P.A., Calhoun, F. (Eds.), Replenishing Soil Fertility in Africa. Soil Science Society of America Special Publication No. 51. Soil Science Society of America, American Society of Agronomy, Madison, Wisconsin, USA, pp. 47-61.

Stoorvogel JJ, Smaling EMA (1990). Assessment of soil nutrient depletion in sub-Saharan Africa: 1983–2000. The Winand Staring Centre, Wageningen, The Netherlands. 2: 585.

Swinkels R, Franzel S (1997). Adoption Potential of Hedgerow Intercropping in the Maize-based Cropping Systems in the Highlands of western Kenya. Part II: Economic and farmers evaluation. Exp Agric., 33: 211–233.

Thornton PK, Stroud A, Hatibu N, Legg C, Ly S, Twomlow S, Molapong K, Notenbaert A, Kruska R, von Kaufmann R (2006). Site selection to test an integrated approach to agricultural research for development: combining expert knowledge and participatory Geographic Information System methods. Int. J. Agric. Sustainability, 4: 39–60.

Tittonell P, Vanlauwe B, Leffelaar PA, Rowe EC, Giller KE (2005). Exploring diversity in soil fertility management of smallholder farms in western Kenya I. Heterogeneity at region and farm scale. Agric. Ecosyst. Environ., 110: 149–165.

Toby EK, Leakey RRB, Anne-Marie I, Heinemann JA, Rosenthal E, Nathan D, Jiggins J (2008). Agriculture at a Crossroads. Sci., 320: 320-321.

Woelcke J, Berger T (2002). Land management and technology adoption in Eastern Uganda: An integrated bio-economic modelling approach. In: Paper presented at The 164 A.O. Esilaba et al. / Final Workshop on Policies for Improved Land Management in Uganda, April 17–19, IFPRI. Agric. Syst., 86(2005) 144–165.

Wortmann S, Kaizzi CK (1998). Nutrient balances and expected effects of alternative practices in the farming systems of Uganda. Agric. Ecosyst. Environ., 71: 117–131.

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