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Is Soil Degradation to Blame for the Rural Poverty in Southeastern Uganda?

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Abstract: This study examines the effect of soil conservation practices and household characteristics to poverty levels among the farming community in southeastern Uganda. Using random sampling method, 120 respondents from the districts of Kamuli, Iganga and Jinja were selected and interviewed. The Logistic regression results reveals that settlement in Jinja district and being educated significantly reduced poverty while household size increased it ($p<0.05$). Increasing the number of fertile land areas under fallow significantly reduces probability of being poor ($p<0.01$). Farmers that use crop rotation, vegetative cover crops and organic manure have significantly lower probability of being poor compared to those using zero tillage ($p<0.05$). Adoption of improved soil conservation practices will assist farmers to increase agricultural outputs and reduce their poverty levels while fertilizers should be made available at affordable prices. Site-specific research to address soil-related constraints and socio-economic and political issues is needed to enhance and sustain production.

Key words: Agriculture, fertilizers, rural poverty, crop rotation, probability, Uganda

INTRODUCTION

Agriculture is the largest sector of the Ugandan economy. About 80% of the population depends on it as the main source of income and livelihood. The agriculture resource base has been both shrinking and degrading with the increasing population pressure and marginal land with steep and very steep slopes increasingly being brought under cultivation. This has led to intense land degradation due to soil erosion in the hills and mountains (Bagoora, 1988).

Access to land and its fertility status are of paramount importance to enhancing the welfare of rural people in rural parts of Uganda (Buyinza and Nabalegwa, 2008). The use of land for agricultural production is one of the strongest influences affecting environmental quality in many developing countries. Specifically, practices like unguided application of agrochemicals, bush burning and uncontrolled farm mechanization affect the quality of soil and vegetative covers, thereby resulting into land degradation. Policy makers are now confronted with the challenges of finding a way of stimulating economic growth and reduce poverty while the issue of natural resource degradation requires an urgent attention.

The general consensus is that although, these goals cannot be abandoned, the welfare of future generations is seriously threatened because resources are not managed in sustainable ways (Scherr, 1997). The gravity of the problem can be well conceptualized if one realizes that agriculture is the principal engine for economic growth and development and it is the main source of livelihood for tile rural poor in many developing countries (Maxwell, 1995). Therefore, given the projections of population growth, agricultural land expansion, agricultural intensification and poverty in the next few decades, there exists a serious, conflict between tile goals of environmental protection and poverty reduction (Kanbur, 2001).

The problems of poverty and environmental degradation in many developing countries are closely related (World Commission on Environment and Development, 1987). Because of increased population pressure, the long time needed for regenerating natural resources once degraded and persistent economic hardship in many African nations, natural resource degradation is a common phenomenon among the poor as they try to escape the scourge of poverty (Maxwell, 1995; Nyirenda *et al*., 2001). No doubt, poor farmers face the consequences of land degradation and are implicated in some of its processes. Specifically, rich farmers own more land than the poor arid are able to clear large expanse of forests, use large quantities of agrochemicals and open up/expose soils to erosion through agricultural mechanization. In like manner, poor farmers play some important role in unsustainable agricultural intensification, expansion of farming into marginal lands and overexploitation of forest resources. However, because they lack sufficient asset base to buffer its effects, the poor are more seriously affected by the consequences of environmental degradation (Wortmann and Kaizzi, 1998). In Uganda, increasing poverty level despite several past policy interventions is a matter of serious concern. For instance, analysis of 2003/2004 data revealed that national poverty incidence is 58% with rural area having 64% while urban has 35% (UBOS, 2002). This situation poses a daunting challenge to the achievement of the Millennium Development Goals (MDGs). Therefore, given the several forms of environmental degradation, the general consensus is that for any meaningful economic growth and development to be experienced, Uganda needs to first and foremost address widespread poverty especially among its rural populace.

Moreover, Ugandan small-scale farmers largely depend on traditional methods of farming. These farmers are facing various land use constraints which is one of the major sources of decline in agricultural productivity. Suppose rural households choose to stay on degraded land without appropriate soil conservation practices, its declining productivity will not be able to support growing rural populations not to consider the nation as a whole. Therefore, shortage of good quality agricultural land for smallholders is a major problem (UNDP, 2005). Consequently, some households are forced to abandon existing agricultural areas in search of new forest land. Where land is scarce, land fragmentation and continuous cropping persist with little or no soil conservation investments (Nabalegwa *et al*., 2007).

It should be stressed that poverty influences households decisions for any investment in soil conservation practices (Buyinza and Nabalegwa, 2008). Therefore, decline in the welfare of people could degenerate into serious ecological crises with serious implications on the environment (World Commission on Environment and Development, 1987). An attempt was made in this study to determine the effect of land degradation and use of soil conservation approaches on the poverty level of rural households in southeastern Uganda. The key study questions included: How does ownership of fertile/degraded land affect the poverty level of the farmers? What influence does use of soil conservation have on poverty level across the different socio-economic groups?

MATERIALS AND METHODS

Study area and sampling procedures: The study was carried out in southeastern part of Uganda. The study districts were Jinja, Kamuli and Iganga. Climatically, these districts enjoy tropical climate with two distinct seasons; rainy season from April-October and dry season from November-March. The traditional practice of slash and burn agriculture predominates and this is expected to be followed by a period of fallow for the soil to regain the lost fertility. However, with growing population and scarcity of land, the practice of fallowing is gradually being phased out and this aggravates land degradation.

Multi-stage sampling method was used to select the households for the survey. At the 1st stage, 3 districts were randomly selected from the seven districts that form eastern Uganda region. The 2nd stage involved selection of 2 sub-counties from each district and from these sub-counties we selected 2 villages from each. In Jinja district, data were collected from 4 villages of Buwenge sub-county. A total of 100 households were sampled from the 4 villages of Jinja. In Iganga district, a total 100 farming households were sampled from 4 villages of Nakalama sub-county. Finally, in Kamuli district, a total of 103 farming households were sampled from 4 villages of Bugulumbya sub-county. Agricultural data were obtained for the 2005 cropping season.

Econometric analysis and model description

Effect of land on income inequality: The study used descriptive analytical methods like percentage, mean and frequency. The Gini-coefficient was used to analyze the distribution of the different categories of land owned by farmers. To calculate Gini-coefficient, Boardman *et al*. (2001) noted that where items are ordered so that $Y_1 \leq ;Y_2 \leq ;Y_3 \leq .... \leq Y_n$ the Gini-coefficient can be computed as:

$$I_{Gini}(Y) = \sum_{i=1}^{n} a_i(Y) Y_i \text{ and } a_i(Y) \frac{2}{n^2 u}\left(i - \frac{n+1}{2}\right) \quad (1)$$

Where:

n = The number of items
I = The rank (1...n)
μ = The mean of the items. The closer this value is to 1, the higher the inequality

Description of econometric analysis: In order to analyze the land ownership/use, socio-economic and soil conservation factors that explain poverty among the farmers, descriptive statistics were run to describe the farmers socio-economic characteristics while logistic models were used to estimate the intensity of effect between size of landholding, application of land management practices and poverty levels. Following Foster *et al*. (1984), poverty line was computed as the 2/3rd of the mean per capita monthly expenditure of all the members of the sampled households. The FGT index allows for the quantitative measurement of poverty status among sub-groups of population (i.e., incorporating any degree of concern about poverty) and has been widely used (Kakwani, 1977). Preferring higher status, humans dislike inequality and household intolerance to inequality increases with inequality (Bolton and Ockenfels, 2000). The Atkinson inequality aversion parameter (Atkinson, 1970) is incorporated in the estimation of income inequality to measure this intolerance. The measure takes values ranging from zero to infinity. Increases in the parameter signal increased household intolerance to inequality and that the households attach more weight to income transfers at the lower end of the distribution and less weight to transfers at the top.

The headcount ratio measures the ratio of the number of poor individuals or simply measures the poverty incidence (i.e., the percent of the poor in the total sample).

The analysis of poverty incidence using FGT measure usually starts with ranking of expenditures in ascending order $Y_1 \leq: Y_2 \leq: \ldots. \leq: Yn$:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right]^\alpha \tag{2}$$

Where:

- P_α = Non negative poverty a version parameter which can be zero for poverty incidence, one for poverty gap or two for poverty severity
- y_i = The per-capital expenditure of ith poor household and i = 1, 2,... q
- n_i = Total number of individuals in the population
- q = Total number of poor individuals/households below the poverty line
- z = Poverty line

The FGT is made up of three basic measures when α = 0, 1 and 2 and these are the head count poverty measure, poverty gap index and the measure of poverty severity, respectively. The Probit model was applied using the Maximum-Likelihood function (Boardman *et al*., 2001; Maddala, 1983) and was estimated using the LIMDEP 7.0 statistical package can be stated as:

$$\begin{aligned} p_1 = {} & \beta_1 + \beta_2 DST_1 + \beta_3 GND_1 + \beta_4 MRG_1 + \\ & \beta_5 HHS_1 + \beta_6 EDU_1 + \beta_7 ANM_1 + \beta_8 VEG_1 + \\ & \beta_9 PCL_1 + \beta_{10} PFL_1 + \beta_{11} EDC_1 + \beta_{12} EDF_1 + \\ & \beta_{13} TRC_1 + \beta_{14} MLC_1 + \beta_{15} CLA_1 + \beta_{16} CRT_1 + \\ & \beta_{17} ORG_1 + \beta_{18} ZRO_1 + \beta_{19} FRT_1 + \beta_{20} CVC_1 + \\ & \beta_{21} SPD_1 + e_1 \end{aligned}$$

Where:

- P_1 = Poverty status dummy (poor = 1, 0 otherwise)
- DST_1 = District dummy variable (Jinja = 1, 0 otherwise)
- GND_1 = Sex (Male = 1, 0 otherwise)
- MRG_1 = Marital status dummy (married = 1, 0 otherwise)
- HHS = Size of the household
- EDU_1 = Education dummy (formal education n = 1, 0 otherwise)
- ANM_1 = Land area under livestock farming (ha)
- VEG_1 = Land area under vegetable production (ha)
- PFC_1 = Productive food cropland area (ha)
- PFL_1 = Productive fallow cropland area (ha)
- EDC_1 = Eroded coffee cropland area (ha)
- EDF_1 = Eroded food crop land area (ha)
- TRC_1 = Tractor/Harrowing (yes = 1, 0 otherwise)
- MLC_1 = Mulching (yes = 1, otherwise = 0)
- CLA_1 = Cleaning clearing (yes = 1, 0 otherwise)
- CRT_1 = Crop rotation (yes = 1, 0 otherwise)
- ORG_1 = Organic manure (yes = 1, 0 otherwise)
- ZRO_1 = Zero tillage (yes = 1, 0 otherwise)
- FRT_1 = Fertilizer application (yes = 1, 0 otherwise)
- CVC_1 = Cover crop (yes = 1, 0 otherwise)
- SPD_1 = Frequency of social-psychological disorder during cropping season
- e_1 = Error term

We tested the hypothesis that number of fertile land under fallow does not significantly reduce poverty. It should be noted that also, many independent variables were initially proposed but some collinear ones were later removed. We determined the level of variable collinearity using the SPSS 100 statistical package. With these, the tolerance levels of the variables were determined using the variance inflating factors (Kanbur, 2001; Kakwani, 1977). Variables with low tolerance were therefore removed.

RESULTS AND DISCUSSION

Demographic and household socio-economic characteristics: Descriptive analysis of the household demographic attributes shows the following: 84% are males, 38% are married, 52% acquired formal education, 38% are engaged in agroforestry farming. The average age is 56 years and average household size is 7 (Table 1). The farming households reported an average of 24 years of farming experience. As retlected by the standard deviation and coefficient of variation, wide variations exist among these data.

The farmers awareness of the agricultural technologies varied. Table 2 shows that the most popular technologies were improved fallows (92%); hedgerow intercropping (87%), vegetative practices (84%), use of improved simsim varieties (85%) and poultry management technology (80%). The results further show that farmers

Table 1: Farmers household demographic attributes

Socio-economic characteristics	Mean	SD	Coefficient of variation
Age	56.00	13.10	309.14
Household size	7.04	2.32	301.44
Farming experience	23.58	11.24	189.22
Per capita expenditure	33,235.00	24,975.00	1,729.00
Social-psychological disorder days	3.42	3.01	89.17
Agroforestry rotation cycles	4.02	1.08	280.42

Table 2: Farmers awareness of selected agricultural technologies (n = 120)

	Awareness	Perception	
Technologies	Aware (%)	Relevance (%)	Relevance index
Agroforestry technologies (0.82)			
Improved fallow**	92	87	0.95
Hedgerow intercropping*	87	53	0.61
Multistorey	42	25	0.60
Homegarden**	50	60	1.20
Clonal coffee[ns]	30	12	0.40
Soil and water conservation (0.44)			
Contour ploughing*	76	12	0.16
Trash lines[ns]	66	18	0.27
Terraces*	78	58	0.74
Vegetative practices	84	12	0.14
Compost and green manure[ns]	60	53	0.88
Improved crop varieties (0.98)			
Banana**	80	73	0.91
Cassava**	75	82	1.09
Beans**	76	75	0.99
Simsim*	85	70	0.82
Maize**	74	83	1.12
Livestock technologies (0.92)			
Multiplication of goats*	74	58	0.78
Cattle cross-breeding*	68	63	0.93
Fish ponds management[ns]	45	42	0.93
Poultry management**	80	87	1.09
Feed grinder (350 kg h^{-1})	76	67	0.88

** = 0.01 level of significance, * = 0.05 level of significance, ns = not significant

had little or no information with regard to improved clonal coffee varieties (30%), multi-storey (42%) and fish pond management (45%) technologies.

The farmers were asked about the local community's indicator of soil resource quality. The results in Table 2 shows that based on the agroforestry farming component, most of the farmers (57%) judge soil fertility status using the previous agroforestry yields (forestry and agricultural crop yields). However, 42% consider the colour of the soil while only 12% would judge fertility based on intensity of weed growth.

With regard to food crops, 86% of the farmers judge fertility levels with the performance of cassava crop while 76% used the easiness to tillage. Zero-order correlation between farmers awareness and perception of agricultural technologies shown in Table 3. Similarly, 72% considered the number of years the land has been continuously used for crop cultivation without fallowing (Table 4). The findings concur with that of Jama *et al.* (1997) who identified four systems to enhance productivity of small landholders of the sub-tropics. These include: mixed farming systems that provide animal manure to recycle nutrients and enhance soil fertility through integrated nutrient management, agro-forestry systems that create diverse farming systems, conserve soil and water resources and recycle nutrients from sub-soil to the surface, water-based systems, mostly for cultivation of rice and associated crops that renew soil fertility through supply of silt and alluvial material carried in irrigation canal and water harvesting and recycling in dryland systems and fertilizer-based systems that enhance soil fertility through judicious use of chemical fertilizers.

Table 3: Zero-order correlation between farmers awareness and perception of agricultural technologies

Technologies	Correlation coefficient (r)	p-value
Agroforestry technologies	0.58	<0.05
Soil and water conservation technologies	0.02	>0.05
Improved crop varieties	0.44	<0.05
Livestock technologies	0.42	<0.05

S = Significant at $p<0.05$; NS = Not Significant

Table 4: Farmers indicators for perceiving degraded cash and food crop farms

Characteristics	Agroforestry	Food crop
Porosity and drainage	34.32	50.17
Type of soil	37.29	67.00
Continuous farming (years)	33.33	72.01
Soil color	42.34	48.24
Soil depth	33.99	32.67
Tillage	12.09	76.61
Intensity of weed growth	15.51	29.70
Common weeds	21.45	37.62
Last cereals yields	26.73	81.67
Last cassava yields	30.69	86.22
Last coffee yields	57.02	-
Soil texture	35.97	46.20

The categories of different uses to which farmers subject their land and their distribution (measured by Gini-coefficient) is shown in Table 5. Average coffee cropland is 125 ha with variability index of 69%. However, because the farmers were mainly pre-occupied with food production, average land areas devoted to food production is 1.8 ha. Other uses of land for vegetable cultivation and livestock husbandry take an average of 0.15 and 0.07 ha, respectively. An average of 1.12 ha of the farmers land is kept under fallowing. Similarly, from farmers perception of fertility, 72 and 79% of the farmers coffee cropland and food cropland, respectively are considered to be fertile. Similarly, 78% of the land under fallow is fertile.

Food cropland has the lowest Gini-coefficient (0.39). This shows that they are more equitably distributed. However, land use categories like fallow land, mined coffee cropland, mined food cropland are distributed more unequally due to the largeness of their Gini-coefficient values.

Table 5: Land areas owned by farmers in southeastern Uganda

Land use category (ha)	Mean	SD	Coefficient of variation	Gini coefficient
Coffee cropland	1.34	1.82	6883.00	0.67
Fallowing land	1.12	330.00	3116.00	0.85
Food cropland	1.85	1.70	101.19	0.39
Livestock land area	0.05	0.24	2879.00	0.88
Vegetable land area	0.18	0.34	44.38	0.84
Productive coffee cropland	1.00	1.56	63.93	0.73
Productive food cropland	1.54	1.48	95.71	0.48
Productive fallow land	0.83	3.08	26.81	0.80
Eroded coffee cropland	0.20	0.68	25.32	0.86
Eroded fallow cropland	0.18	1.23	23.01	0.85
Eroded food cropland	0.25	0.73	33.36	0.89

Table 6: Use of some cultural/soil conservation practices in Southeastern Uganda

Cultural/soil conservation practice	Users (%)	Poverty contribution by non-users	Poverty contribution by users
Use cow dung	14.52	29.04	06.60
Burning bush	78.85	12.34	28.37
Tractor farming	12.11	33.33	02.31
Use ploughing	15.17	3102.00	04.62
Use mulching	58.75	17.49	18.15
Use clean clearing	88.28	04.64	30.02
Use crop rotation	67.09	15.84	19.80
Use organic manure	24.42	27.06	06.18
Use zero tillage	32.01	20.46	15.18
Apply fertilizer.	66.34	14.85	20.76
Vegetative cover crop	26.07	28.38	07.47

Table 5 shown poverty analysis using the conventional approach (Foster *et al.*, 1984). The poverty line based on Mean per Capita Household Expenditure (MPCHE) is UGX 20,234/ =. With this, 42% of the farmers were moderately poor (falling below the 2/3rd MPCHE). However, 3% are severely poor (falling below 2/3rd MPCHE). Of the 36 poverty incidence, we proceeded to calculate the contributions of each group of soil conservation users and non-users to this value. It shows 88% used clean clearing, this group contribute 30% to poverty. Clean clearing is a method whereby farmers do not allow crop residues and plants cleared from a farm to decompose on the farm. In this case, these are either gathered at some point outside the farm for decomposition or burning. While, only 12 and 15% of farmers could afford the use of tractor and ploughing, respectively, the group contributed 5 and 2% to poverty, respectively. Soil nutrient enhancing management practices like mulching, crop rotation, use of organic manure, planting of cover crops and application of fertilizers are not so widely used by the farmers. Specifically, the contributions to poverty were 6 and 7% for those using cover crops and organic manure, respectively. However, those using bush burning contributed 28% to poverty (Table 6).

Factors explaining rural poverty: The results of the Probit regression are shown in Table 7. It shows that the data presented a good fit as reflected by the statistical significance ($p<0.01$) of the chi-square (χ^2) of the

Table 7: Probit regression of the determinant of poverty in southeastern Uganda

Factors	Coefficient	t-statistics
Constant	-1.519	-2.620
District	-0.662	-2.901
Sex	0.466	1090.000
House size	0.319	7.082
Marital status	-1.608	-4.378
Formal education	-0.196	-0.843
Livestock land area	1.202	2.128
Vegetable land area	0.019	0.056
Fertile food cropland	-0.089	-1.056
Fertile fallow land	-0.498	-3.503
Degraded coffee cropland	-0.426	-1.240
Degraded food cropland	-0.768	-0.321
Tractor/Ploughing	-0.936	-2.750
Mulching	0.071	0.303
Clean clearing	0.078	0.224
Crop rotation	-0.493	-1.980
Organic manure	-0.542	-2.010
Zero tillage	0.686	2.732
Fertilizer	-0.168	-0.708
Cover crop	-0.524	-2.124
Time sick	-0.013	-0.893

Maximum Likelihood Estimate (MLE). This shows that farmers from Jinja district have lower probability of being poor. Proximity to urban area (Jinja town) may be responsible for this occurrence due to direct market outlets and opportunities for off-farm activities. Similarly, house hold size is statistically significant ($p<0.01$). This shows that increasing household size will increase the probability of the households becoming poor. This is expected because desire to have many children lies largely with poor households and it is generally the cause of poverty. Buyinza and Nabalegwa (2008) noted that in rural parts of Uganda, the net effect of high family size is lower income, little savings and increased poverty. Also, marital status variable is statistically significant ($p<0.01$). This shows that those married farmers have lower probability of being poor.

Increasing land areas devoted to livestock production increases the probability of being poor significantly ($p<0.05$). Similarly, the number of fertile land area under fallow variable is statistically significant ($p<0.01$). This implies that probability of being poor reduces as farmers have enough fertile lands under fallow. The hypothesis that the size of fertile land under fallow does not significantly reduce poverty is therefore rejected.

Those farmers that were using harrowing for land preparation have lower probability of being poor. This is expected because usage of harrowing/tractor for land preparation shows that the farmer has large number of hectares. Cultivation of large number of hectares can lead to higher income if the farms are well managed. The farmers that were using crop rotation have lower probability of being poor and the parameter is statistically significant ($p<0.05$). Theoretically, crop rotation enhances soil nutrients if the pattern of the rotation is well selected. With this, farmers output may increase with consequential reduction in the level of poverty. Also, those using organic manure have lower probability of being poor. In absence of inorganic fertilizers, the only options available to farmers for enhancing the nutrient contents of their farms is to use organic manure. Those farmers were also using zero tillage have significantly higher probability of being poor.

This shows that use of zero tillage may lead to higher level of poverty as farm profit decreases (Nyirenda *et al*., 2001). Ideally, in southeastern part of Uganda, use of zero tillage on already degraded land may lead to reduction in farm profit as more labour is being engaged for weed control. Similarly, zero tillage exposes the plot to direct soil erosion. Where ridges are made, it is possible to control erosion by construction of bunds (Maxwell, 1995). However, those farmers that were using planting cover crops have significantly lower probability of being poor ($p<0.05$). Cover crops rejuvenate the soil nutrients and prevent excessive soil erosion. These may result into increased productivity and poverty reduction.

CONCLUSION

Farmers in the districts of southeastern Uganda are seriously concerned about the dwindling status of their land. Any negligence in land management would make them vulnerable to food security under the situation of shrinking landholding size and undergoing process of land degradation due to interactive natural and cultural factors. Farmers, therefore have increasingly employed different land conservation strategies to maintain the fertility of their land. Increasingly they have adopted different structural and biological land conservation strategies developed by their forefathers and consolidated by line agencies and NGOs and used different organic and inorganic fertilizers to maintain soil fertility.

Soil degradation in southeastern Uganda is recently phenomenon driven by population pressure and scarcity of extra fertile land. As the ultimate goal of policy makers is to reduce poverty, this study investigates the effect of several land ownership and use patterns on the poverty levels of the farmer. The policies implications are that household size increases poverty, therefore efforts to sensitize rural population on the need and way of population control for poverty reduction will yield positive results. Secondly, use of soil conservation practices like crop rotation, planting of cover crops, addition of organic manure hold great potential for poverty reduction. Natural resource managers and technical service providers therefore, need to liase with research institutes in order to disseminate evidence-based soil management techniques to farmers.

RECOMMENDATIONS

Despite the fact that farm land are degrading, not many farmers applied fertilizers on their farms due to its high prices and scarcity. The onus therefore, rests on the government to implement a workable and efficient plan for fertilizer production and distribution. Also, efforts by researchers should be directed at developing crop hybrids that can withstand environmental stress.

The farmers awareness and perception of the relevance of agricultural technologies has a significant impact on the rate of adoption of technologies promoted under the PMA. According to the survey results, most of the agroforestry technologies were perceived to be relevant by the farmers except the clonal coffee this is because compared to traditional coffee, clonal coffee is a high cost technology, hence unaffordable to most farmers.

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