Gender and Soil Fertility in Uganda: A Comparison of Soil Fertility Indicators for Women and Men's Agricultural Plots

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Abstract: The removal of subsidy under the structural adjustment programs of the World Bank has increased the cost of fertilizers and lowered the level of fertilizer input use among the small-scale farmers in Uganda and in many African countries. It is also reported that female farmers lack cash or credit to finance agricultural inputs, as such they apply less fertilizers to their crops than male farmers. In addition there is a perception that female farmers in Africa are allocated less fertile land by their spouses. We conducted this research to determine whether the gender difference in wealth and land allocation between male and female farmers in male-headed households is manifested in soil fertility indicators. We determined chemical fertility levels (fertility indicators) in the composite topsoil samples from 5 woman-owned plots and 5 man-owned plots in Ntanzi village, Uganda, on a Rhodic Ferralsol. A similar study was conducted on 8 woman-owned and 8 man-owned plots in Buggala Island, Uganda, on a Ferralic Arenosol. In total we took topsoil samples from 13 male-headed households, and sampled by horizon 13 soil profiles. No female-headed households (FHHs) were included in this study. Therefore when we use the words "women" or "female" we are referring to married women/females in male-headed households. The FHHs were omitted from this study because they had no consistent comparable "male match" with agricultural plots from which we could take soil samples.

The study showed no statistical significant difference between soil fertility indicators of plots owned by wives vs husbands. The soil data from wives' and husbands' plots had low soil fertility levels of most soil fertility indicators, implying that they had been under comparable poor management practices. On-farm demonstrations of soil nutrient management options are recommended to convince both women and men farmers about the benefits of improved soil fertility technologies.

Introduction

Uganda is blessed with a wide diversity of natural resources: soil, climate, water and vegetation, enabling it to grow a large number of adapted crops. However, most soils in Uganda are older than 500 millions years and are in their final stage of weathering. The predominant minerals in the soils are quartz and kaolinite that don't directly supply nutrients to soils. The soils are acidic and infertile with low cation exchange capacity (CEC). Nutrients

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http://www.africa.ufl.edu/asq/v6/v6i1-2a2.pdf

ISSN: 2152-2448

such as phosphorus occur in inorganic and organic forms that are not readily available to crops. Phosphorus is fixed by oxides of iron and aluminum. Nitrogen that is low in most mineral soils can only be naturally supplied to the soil from the atmosphere by symbiotic biological fixation and slowly from organic matter. Potassium another essential element, is also limiting in these soils because there are no primary minerals that can supply it. Also, due to the low CEC, inorganic cations are easily leached out of the root-zone of most crops.[1]

The total land area of Uganda is 241,000 square kilometers (km2) of which more than 25% is unproductive. These agriculturally unproductive areas include swamps, mountains, national parks, urban centers and open water. Arable land comprises 75% of the total land area, but only 10% can be considered as agriculturally productive land. The remaining land surface is rated as moderate, implying the sort of soils that will support crops under good management.

The land area under cultivation is about 4.6 million hectares (ha), with 4.3 million ha cultivated to food crops, while cash crops cover about 0.3 million ha. The agricultural output comes almost exclusively from about 2.5 million smallholders, 80% of whom have less than 2 ha each. Only tea and sugar cane are grown on large estates that total about 50,000 ha. Both food and cash crops are almost entirely rainfed. The smallholder farms in the rural areas are owned and managed by both women and men farmers.[2]

Over the years, food production has been characterized by subsistence farming. A subsistence production system usually focuses on a maximizing short-term profit, consuming natural stocks of plant nutrients. Such a farming system has resulted in soil fertility degradation through nutrient mining. In the past, when Uganda's population was still low, lost soil fertility was restored through long periods of fallows. With an average land holding of about 2 ha per household, fallows are no longer practical or the periods greatly shortened. Research has clearly demonstrated that fertilizer inputs and appropriate land management practices are important components of technology required to increase crop yields in Uganda.[3]

The removal of fertilizer subsidies under the privatization program in Uganda, in 1992, has greatly increased the production cost for farmers without corresponding increases in producer prices. As a result, fertilizers, more often than not, can only be afforded by the better-off farm households who have access to cash and credit facilities.

Studies conducted in Malawi and Cameroon by Gladwin (1991, 1992) showed that the average female-headed farm household used significantly less fertilizer per hectare than the male-headed farm household. The studies attributed lower fertilizer use by women to the fact that they have less access to cash and credit.[4] However, it is not clear whether these gender differences in soil fertility management would also be reflected in soil fertility indicators measured from fields or farms of women and men who are spouses.

The main objective of this research was to evaluate and compare the soil nutrient levels and other soil fertility indicators from a wife's and a husband's agricultural plots at a male-headed household in the rural areas of Uganda.

MATERIALS AND METHODS

Research Site and field methods

The study was conducted in two agro-ecological zones in Uganda. One study site was located in Ntanzi village in the Lake Victoria Crescent agro-ecological zone. Ntanzi village is located on latitude 0 15' N and Longitude 32 50' E. It has an udic and isohyperthermic soil climate. The soils developed in a sedentary parent material derived from the underlying acid gneisses and granites. The village has a high population density, estimated at 145 people per km2. The soils are intensively cultivated to both food and cash crops. The main food crops include maize, beans, peanuts, sweet potatoes, bananas and cassava. Robusta coffee is the major cash crop. The farmers keep a small number of livestock on their land.

The other agro-ecological zone is Buggala Island where two study sites; Kagulube and Kanyogoga villages are located. Kagulube and Kanyogoga lie on latitude 0 10' S and longitude 32 0' E, and latitude 0 10' S and longitude 32 15' E, respectively. The soils in both locations developed on weathered sandstones. Both villages have very low population densities, estimated at less than 30 people per km2 each. Shifting cultivation is still practiced here. The main crops are generally root crops, such as sweet potatoes and cassava. Bananas and coffee perform poorly. The Buggala Island has an udic and isohyperthermic soil climate. A small number of livestock, especially goats, are kept on the land holdings.

A scouting trip was made to each of the study sites to carry out a situation analysis. The visiting time was also used to make preliminary contacts with authorities and to identify appropriate groups of farmers for discussion, interviews and participation in the project. The field scouting trips were also used to observe landforms, soils, vegetation, cropping patterns, and stages of crop growth in the selected villages. Five married couples (husband and wife) were selected from Ntanzi village for the study, while Kagulube and Kanyogoga villages had 4 couples each, as participating farmers.

A plot of land measuring 50 m x 50 m was selected on the farm of each participating farmer for the purpose of obtaining composite topsoil samples. Five transect lines, running across the slope of the plot, were drawn at 10 m intervals. Along each transect, topsoil samples, 20 cm deep, were taken with a bucket augur (7.6 cm diameter) at 10 m intervals. The five samples obtained from each transect were thoroughly mixed and a representative composite soil sample of one kg was obtained. Five composite topsoil samples were thus obtained for each participating farmer.

Soil pits were located in each village (at each male headed household), based upon discernible changes in topography, vegetation, land use and other indications seen on the ground and from aerial photographs of the villages. The location of the soil pit was selected to ensure that each farmer's sampled plot was truly represented. The soils from 13 profiles were described and sampled by horizon. They were classified based on three systems of classification FAO-UNESCO, USDA, and the local system.[5]

LABORATORY METHODS

The soil samples were air-dried, ground to pass through a 2-mm sieve and stored in glass bottles. Soil pH was measured in soil-distilled water suspensions (1:2) with a pH meter. Mechanical analysis was performed as described by Bouyoucos (1962). Exchangeable cations were determined after leaching soils with I M ammonium acetate. Exchangeable K and Na were analyzed by flame photometry, exchangeable Ca and Mg by atomic absorption spectrometry (Perkin-Elmer, Model 2280). Total exchangeable bases were calculated from the sum of exchangeable K, Na, Ca and Mg. Available P was determined by the method of Olsen et al (1954). Total N was determined by the Kjeldahl method (Bremner 1965). Organic carbon content (OC) was measured by the Walkley-Black method (Allison 1965) and soil organic matter (SOM) was calculated by multiplying OC content by a factor of 1.724.

RESULTS AND DISCUSSION

The soil data for Ntanzi village are presented in Tables 1A, IB, and 2. A representative pedon description and soil characterization based on the laboratory soil analysis are presented in Tables 1A and 1B, respectively. The Ntanzi soil was classified as Rhodic Ferralsols according to FAO-UNESCO (1988). The USDA classification and the local classification of the soil are also included in Table 1B. The taxonomical classification indicate that the soil is highly weathered, and devoid of weatherable minerals. The values of the total bases decrease with soil depth but tend to increase at the 170 cm soil depth indicating leaching of bases from upper horizons. The textural class changes from loam for the topsoil to clay loam for the subsoil implying leaching of clay from upper horizons. Based on recommendations in Table 3, the soil is deficient in SOM at all depths. The soil has low total N, pH, available P, K, and Ca at almost all soil depths. For all parameters listed in Table 2, there was no statistically significant difference in fertility indicator values between data obtained from female and male agricultural plots. However, all soils have low to deficient soil fertility indicator values when compared to data in Table 3. All topsoil samples have a sandy clay loam texture and are acidic. The low nutrient levels in all soil samples imply that the management practices on women and men's agricultural plots have been similar. The low to deficient values of available macro-nutrients (N, P, K, and Ca) suggest that the application of fertilizers should be of benefit to most crops in this village.

Table 1A. Description of a Selected Pedon from Ntanzi Village
Profile: Pit-PN1-Ntanzi

Location:	On Christine Nambi's plot of land in Ntanzi village, Mukono District. The pit is about 50m south of Mrs. Nambi's house and about 30m from the lower boundary of the plot.
Vegetation:	The land is planted to bananas mixed with coffee.
Parent Material:	Sedentary material derived from weathered granites and Gneisses.
Geomorphology:	The profile is located in the middle of a long gentle slope.
Drainage:	Well drained.
Moisture :	Upper 20 cm dry, moist below
Rock out crops:	None
Erosion:	No evidence

Diagnostic characteristics:

FAO-UNESCO:	Oxic B horizon
USDA:	Oxic horizon

Profile Description:

Soil depth (cm)	Horizon description
0 - 3	Un-decomposed and partly decomposed organic materials
3 - 20	Dark reddish brown 5YR ¾ moist, loam; strong, coarse angular blocky; hard, slightly sticky, slightly plastic; many coarse and fine roots, many coarse and medium pores; clear boundary to next horizon (sample number 43).
20 - 34	Dark red 2.5 YR 3/6 moist, clay loam, strong angular blocky; firm, slightly sticky, slightly plastic, few fine roots; many termite channels, many fine pores; clear boundary to next horizon (sample number 46)
34 - 56	Dusky red 10 YR ¾ moist, clay loam; strong angular blocky; firm slightly sticky, slightly plastic; few fine roots; many termite and earth worm channels, many fine pores; diffuse lower boundary (sample number 65).
56 - 85	Weak red 10 YR 4/4 moist, clay; strong angular blocky; firm, sticky, plastic; few fine roots; many termite and earthworm channels; many fine and medium pores; diffuse lower boundary (sample number 48).
85 - 115	Dark red 10 R 3/6 moist, clay loam; strong, angular blocky, friable, sticky, plastic, few fine roots; many fine pores; few channels (sample number 51).
115 - 170+	Weak red 10 R 4/4 moist, clay loam; strong angular blocky; friable, sticky, plastic; many fine roots (sample number 55)

Table 1B. Soil Characterization Laboratory, Makerere University, Kampala, Uganda
Profile: Pit-PN1-Ntanzi

Classification:
FAO-UNESCO: Rhodic Ferralsols, fine textured (5)
USDA: Rhodic Kandiudoxs, clayey, isohyperthemic (10)
LOCAL: Buganda Loam series: a member of Buganda Catena soil association; Lateritic soil (11)

Values of laboratory data for soil samples from Pit-PN1-Ntanzi village

Fertility indicator (Soil parameter)	Depth (cm) 3 - 20	Depth (cm) 20 - 34	Depth (cm) 34 - 56	Depth (cm) 56 - 85	Depth (cm) 85 - 115	Depth (cm) 115 - 170+
Lab NO	43	46	65	48	91	55
pH (H_2O)	4.7	5.0	4.7	5.0	5.0	5.2
SOM (g/kg)	28.9	4.7	5.2	2.5	2.6	2.6
Total N (g/kg)	1.90	0.90	1.00	0.90	1.00	0.70
Available P (mg/kg)	16.80	5.60	14.00	5.60	2.80	28.00
NH_4OAC Extractable Ca (cmol/kg)	3.66	2.76	2.70	2.66	0.72	3.26
NH_4OAC Extractable Mg (cmol/kg)	0.85	1.22	1.04	0.84	0.38	1.40
NH_4OAC Extractable K (cmol/kg)	0.18	0.10	0.17	0.10	0.14	0.17
NH_4OAC Extractable Na (cmol/kg)	0.26	0.02	0.05	0.02	0.05	0.08
Total bases (cmol/kg)	4.95	4.10	3.96	3.62	1.29	4.91
Sand %	46	33	29	33	41	37
Clay %	23	36	39	41	37	33
Silt %	31	31	32	26	22	30
Textural class	Loam	Clay Loam	Clay Loam	Clay	Clay Loam	Clay Loam

Table 2. Mean values of laboratory data for composite topsoil samples from female and male owned agricultural plots from Ntanzi village

Fertility indicator (Soil parameter)	All Wives	All Husbands
pH (H_2O)	5.46 ± 0.12	5.64 ± 0.13
SOM (g/kg)	34.10 ± 5.60	34.60 ± 2.30
Total N (g/kg)	2.20 ± 0.20	2.60 ± 0.20
Available P (mg/kg)	5.89 ± 2.58	6.79 ± 2.57
NH_4OAC Extractable Ca (cmol/kg)	7.12 ± 0.57	7.99 ± 0.71
NH_4OAC Extractable Mg (cmol/kg)	2.24 ± 0.19	2.54 ± 0.30
NH_4OAC Extractable K (cmol/kg)	0.46 ± 0.10	0.71 ± 0.14
NH_4OAC Extractable Na (cmol/kg)	0.37 ± 0.14	0.26 ± 0.06
Total bases (cmol/kg)	10.19 ± 0.25	11.50 ± 0.30
Sand %	47 ± 2	49 ± 3
Clay %	29 ± 2	26 ± 2
Silt %	24 ± 2	25 ± 3
Textural class	Sandy clay loam	Sandy clay loam

N = 25; SOM = Soil organic matter; ± 95% confidence interval

Table 3. Soil Standards and Rating for Crop Production in Uganda (13)

Soil property/parameter	Deficient level	Low level	High level
pH (2.5:1 water)	4.5	5.2	6.2
SOM (g/kg)	17.2	30	60
Total N (g/kg)	1	NA	NA
Available P (mg/kg) Bray 1	5	5	20
Exchangeable K (cmol/kg)	0.2	0.4	1.3
Exchangeable Ca (cmol/kg)	2	2	10
Exchangeable Mg (cmol/kg)	0.5	NA	NA

NA = Not available; Deficient level implies can not support crop growth

Immediately after the soil samples were taken from Ntanzi village, 69 farmers were invited for a one-day seminar to discuss the issue of gender and soil fertility. Out of the 69 farmers, 20 were women. A simple survey was carried out. The participating farmers were asked if they thought that there was a gender bias in soil fertility in their village, in the sense that husbands allocated to their wives agricultural plots that were inferior in soil fertility. 68% of the women felt that there was no gender bias vs. 48% of the men. The survey revealed that gender in soil fertility was not considered an issue in Ntanzi village, supporting actual soil laboratory data discussed earlier.

The soil data from Kagulube village are shown in Tables 4A, 4B, and 5. The profile was classified as Ferralic Arenosols, according to FAO-UNESCO (5). The USDA and the local classifications are also indicated in Table 4B. Under the high rainfall and aided by the coarse texture of the parent material, the soil from Kagulube village has been thoroughly leached of bases. The increase in base concentration at the 120 cm depth is an indication of leaching of bases from upper horizons. A similar trend is also observed for the increase in clay content to a depth of 120 cm. Data presented in Table 4B, clearly show that the soil is highly acidic and deficient in SOM, total N, exchangeable Ca, Mg, and K. With the exception of available P, the topsoil from all agricultural plots is chemically poor (compare Tables 3 and 5). The low nutrient values in wives' and husbands' plots suggest that they have been under comparable management practices. As was observed for Ntanzi village, there was no significant difference in soil fertility indicator values between soil samples taken from wives' and husbands' agricultural plots at Kagulube village (Table 5).

Table 4A. Description of a Selected Pedon from Kagulube Village,
Kalangala District, Ssese Islands
Profile: Pit-PK2-Kagulube

Location:	On Mr. Simeo Gyagenda's plot of land in Kagulube village, Kalangala District. The pit is about 30 m east of Gyagenda's residence..
Vegetation:	Underground nuts, cassava, sweet potatoes and corn.
Parent Material:	Sedentary material derived from coarse texture acid rocks
Geomorphology:	The profile is located on a crest of a broad ridge.
Elevation:	1170 m
Drainage:	Well drained.
Moisture:	Moist throughout
Rock out crops:	None
Erosion:	No evidence

Diagnostic characteristics
A profile of a thin brown ochric A-horizon over a deep subsoil which shows the beginning of horizon differentiation that is taxonomically insignificant.

Profile Description:

Soil depth (cm)	Horizon description
0 - 20	Dark brown 7.5 YR 3/3 moist, sandy loam; weak crumbs to loose, many coarse and fine roots; many channels and medium pores; clear smooth boundary (sample number7) .
20 - 33	Dark brown 7.5 YR 4/3 moist, sandy loam; weak crumbs to loose, many coarse and fine roots; many channels and medium pores; some pieces of charcoal; gradual smooth boundary (sample number 35)
33 - 70	Reddish brown 5 YR 4/4 moist, sandy clay loam; weak coarse angular blocky; friable, slightly sticky, slightly plastic; few coarse roots, few fine roots; many channels and fine to medium pores; diffuse boundary (sample number 40)
70 - 120	Reddish brown 5 YR 5/4 moist, sandy clay; strong coarse sub-angular blocky, firm, sticky, plastic; few coarse roots, few fine roots; many channels and fine pores; diffuse boundary (sample number 62)
120 - 140+	Reddish brown 5 YR 5/4 moist, sandy loam; weak coarse sub-angular blocky; friable, slightly sticky, slightly plastic; few fine roots, many fine and medium pores (sample number 29).

Table 4B: Soil Characterization Laboratory, Makerere University
Kampala, Uganda
Profile: Pit-PK2-Kagulube

Classification:
FAO-UNESCO: Ferralic Arenosols (5)
USDA: Typic Kandhapludults; fine –loamy, Siliceous, isothermic (10)
LOCAL: Bugoma series: (11)

Values of laboratory data for soil samples from Pit-PK2-Kagulube village

Fertility indicator (Soil parameter)	Depth (cm) 0 - 20	Depth (cm) 20 - 33	Depth (cm) 33 - 70	Depth (cm) 70 - 120	Depth (cm) 120 -140+
Lab NO	7	35	40	62	29
pH (H_2O)	4.6	4.8	4.6	5.0	5.3
SOM (g/kg)	18.0	14.0	10.5	6.0	26.5
Total N (g/kg)	1.20	0.70	0.90	0.70	1.70
Available P (mg/kg)	66.0	56.0	77.0	344.4	61.6
NH_4OAC Extractable Ca (cmol/kg)	0.95	0.60	0.71	0.96	3.60
NH_4OAC Extractable Mg (cmol/kg)	0.36	0.20	0.37	1.02	1.29
NH_4OAC Extractable K (cmol/kg)	0.18	0.14	0.17	0.17	0.55
NH_4OAC Extractable Na (cmol/kg)	0.30	0.05	0.05	0.08	0.29
Total bases (cmol/kg)	1.79	0.99	1.30	2.23	5.73
Sand %	74	70	53	49	65
Clay %	11	17	34	39	19
Silt %	15	13	13	12	16
Textural class	Sandy loam	Sandy loam	Sandy clay loam	Sandy clay	Sandy loam

Table 5. Mean values of laboratory data for composite topsoil samples from female and male owned agricultural plots from Kagulube village, Kalangala District, Ssese Islands

Fertility indicator (Soil parameter)	All Wives	All Husbands
pH (H_2O)	5.43 ± 0.19	5.25 ± 0.23
SOM (g/kg)	15.10 ± 3.10	15.10 ± 3.50
Total N (g/kg)	1.40 ± 0.20	1.40 ± 0.20
Available P (mg/kg)	202.73 ± 66.91	133.24 ± 53.08
NH_4OAC Extractable Ca (cmol/kg)	5.02 ± 1.39	2.97 ± 0.71
NH_4OAC Extractable Mg (cmol/kg)	1.28 ± 0.32	0.92 ± 0.21
NH_4OAC Extractable K (cmol/kg)	0.64 ± 0.18	0.53 ± 0.10
NH_4OAC Extractable Na (cmol/kg)	0.24 ± 0.06	0.24 ± 0.05
Total bases (cmol/kg)	7.18 ± 0.49	4.66 ± 0.27
Sand %	72 ± 2	69 ± 5
Clay %	11 ± 1	14 ± 2
Silt %	17 ± 2	17 ± 3
Textural class	Sandy loam	Sandy loam

N = 20; SOM = Soil organic matter; ± 95% confidence interval

The data for Kanyogoga village are shown in Tables 6A, 6B and 7. Like soils of Kagulube village, the Kanyogoga soils are classified as Ferralic Arenosols. The soil from the pedon is deficient in total N, and exchangeable bases (compare Tables 3 and 6B). The soil has extremely high amounts of available P as was observed for the soil from Kagulube village. The leaching of bases and clay from upper horizons to lower horizons is also evident (Table 6B). As was observed for Ntanzi and Kagulube villages, there was no significant difference in values of soil fertility indicators between soil samples taken from female and male agricultural plots (Table 7). Similarities between data obtained from woman- and man- owned agricultural plots are an indication that the plots have been under similar farming systems and management practices.

Table 6A. Description of a Selected Pedon from Kanyogoga Village, Kalangala District, Ssese Islands

Profile: Pit-PKG1-Kanyogoga

Location:	About 1 km east of Kalangala town in Kanyogoga village
Vegetation:	Mature cassava
Parent Material:	Colluvium and possibly lake alluvium
Geomorphology:	The profile is located in the middle of a long gentle slope
Elevation:	1150 m
Drainage:	Well drained.
Moisture:	Moist throughout
Rock out crops:	None within the pit but many located 100 m from the pit
Erosion:	No evidence

Profile Description:

Soil depth (cm)	Horizon description
0 - 46	Dark reddish brown 5 YR 3/2 moist, sandy loam; weak crumb; friable, non-sticky, non-plastic, many coarse and fine roots; many termite channels, many fine and medium pores, clear, smooth boundary (sample number 83)
46 - 60	Reddish brown 5 YR 4/4 moist, sandy loam; weak crumb; friable non-sticky, non-plastic; few coarse roots; many termite channels, many medium and fine pores; clear smooth boundary (sample number 3)
60 - 76	Yellowish red 5 YR 5/6 moist, sandy clay loam; weak coarse sub-angular blocky; friable, few coarse and many fine roots; many termite channels, many medium and fine pores; abrupt boundary to sandstone layer (sample number 17).

Table 6B: Soil Characterization Laboratory, Makerere University
Kampala, Uganda
Profile: Pit-PKG1-Kanyogoga

Classification:
FAO-UNESCO: Ferralic Arenosols (5)
USDA: Typic Kandhapludults; fine-loamy, Siliceous, isothermic (10)
LOCAL: Kikwayu series: (11)

Values of laboratory data for soil samples from Pit-PKG1-Kanyogoga village

Fertility indicator (Soil parameter)	Depth (cm) 0 - 46	Depth (cm) 46 - 60	Depth (cm) 60 - 76
Lab NO	83	3	17
pH (H_2O)	4.8	4.9	5.1
SOM (g/kg)	31.0	25.0	23.0
Total N (g/kg)	2.40	1.50	1.70
Available P (mg/kg)	93.80	260.0	180.0
NH_4OAC Extractable Ca (cmol/kg)	1.80	1.03	1.14
NH_4OAC Extractable Mg (cmol/kg)	0.26	0.29	0.30
NH_4OAC Extractable K (cmol/kg)	0.21	0.17	0.14
NH_4OAC Extractable Na (cmol/kg)	0.08	0.13	0.05
Total bases (cmol/kg)	2.35	1.62	1.63
Sand %	74	70	53
Clay %	11	17	34
Silt %	15	13	13
Textural class	Sandy loam	Sandy loam	Sandy clay loam

Table 7. Mean values of laboratory data for composite topsoil samples from female and male owned agricultural plots from Kanyogoga village, Ssese Islands

Fertility indicator (Soil parameter)	All Wives	All Husbands
pH (H_2O)	4.49 ± 0.20	4.16 ± 0.23
SOM (g/kg)	32.40 ± 4.40	39.80 ± 5.40
Total N (g/kg)	2.60 ± 0.20	3.40 ± 0.30
Available P (mg/kg)	144.48 ± 31.73	130.08 ± 25.64
NH_4OAC Extractable Ca (cmol/kg)	1.25 ± 0.40	1.50 ± 0.62
NH_4OAC Extractable Mg (cmol/kg)	0.39 ± 0.11	0.45 ± 0.15
NH_4OAC Extractable K (cmol/kg)	0.52 ± 0.12	0.33 ± 0.17
NH_4OAC Extractable Na (cmol/kg)	0.24 ± 0.07	0.23 ± 0.07
Total bases (cmol/kg)	2.40 ± 0.18	2.51 ± 0.25
Sand %	69 ± 6	69 ± 7
Clay %	6 ± 1	6 ± 1
Silt %	25 ± 5	25 ± 7
Textural class	Sandy loam	Sandy loam

N = 20; SOM = Soil organic matter; ± 95% confidence interval

The fertilizer recommendations for the banana-based cropping system in Uganda are 100 kg N and 100 kg K ha-1 yr-1, respectively. The recommended input rates for coffee are 100kg N ha-1 yr-1 and mulching. These soil management recommendations are rarely practiced neither by women nor men farmers. The cost of fertilizers is too high, and in some rural locations, fertilizers are not readily available (2).

Interviews with some household farmers by Aniku et al., (2001) revealed that most farmers are aware of the decline in soil fertility. These farmers would like to increase the productivity of their soils, but they are afraid to use fertilizers because they have been told that fertilizers destroy soil productivity. Including N-fixing legumes in crop rotations can increase soil fertility, but farmers would not include soybean in their cropping rotations because they believe soybean exhausts soil fertility. Most farmers in Ntazi, Kagulube, and Kanyogoga villages have had some elementary schooling. They would therefore be willing to adopt improved land management methods when the benefits can be clearly demonstrated to them.

Conclusions

Gladwin et al., (1997) have proposed a toolbox of solutions to overcome constraints faced by female farmers when trying to improve the productivity of their farmlands. The suggested solutions include: fertilizer vouchers, small bags of fertilizers sold in local shops and markets, microcredit for fertilizers, grants or free bags of fertilizers, as well as organic-source option and techniques such as nitrogen-fixing agroforestry innovations and rotations of legumes. Because the farmers need to be convinced on the benefits of fertilizer inputs, there is a need to demonstrate these benefits in on-farm experiments.

The solutions suggested by Gladwin et al. (1997), are targeted towards assisting women farmers to improve their land management practices.[6] This study has shown that for male-headed households, there is no difference in soil fertility indicators measured in agricultural plots owned by husbands or wives. This implies that husbands do not allocate soils of inferior fertility to their wives to farm. If there are lowered yields and less productivity on women's fields, therefore, the differences might be due to other (socioeconomic) factors, such as women's lack of cash or credit for fertilizers, and women's lack of extension information about new soil-fertility technologies.

Vosti and Readon (1995) have suggested that the adoption of land management technologies need to be widespread. They pointed out that "unsustainable practices on non-adopting farms could harm neighbors and degrade the shared resource base". [7] We are suggesting that in Uganda the solutions proposed by Gladwin et al. be reconsidered to target both poor women and men farmers.

In this study we found no significant difference in soil fertility indicators between men- and weman-owned agricultural plots. This should not be surprising because soil-forming factors (such as parent material, climate, vegetation, topography, and time) have nothing to do with gender issues. However, this study clearly shows that the soils in the two regions of Uganda are deficient (have low levels) on most soil fertility indicators. In addition, both male and female farmers are not convinced of the benefits of fertilizers as agricultural inputs. On-farm demonstrations on the various soil management technologies are recommended to convince both men and women farmers of the benefits of the technologies.

Notes

1. Harrop 1970, 43.
2. Aniku , Kataama, Nkedi-Kizza and Ssesanga 1999, 65.
3. Aniku , Kataama, Nkedi-Kizza and Ssesanga 1999, 65.
4. Gladwin 1991 191, Gladwin 1991, 141
5. For more information see, FAO-UNESCO 1988, USDA-Agricultural Handbook 436 1999, and Radwanski 1960
6. Gladwin 1997
7. Vosti and Readon 1995

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Reference Style: The following is the suggested format for referencing this article: Nkedi-Kizza, Peter, Jacob Aniku, and Christina Gladwin. "Gender And Soil Fertility In Uganda: A Comparison Of Soil Fertility Indicators For Women And Men's Agricultural Plots." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a2.htm