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Farmer participation in soil management research process: The case of Matugga farmers of Uganda

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Abstract

With the high rate of soil degradation in Uganda, research to address soil fertility problems has to involve farmers at all stages of the process as active participants. Farmers' participation is very important in identification of agricultural problems, their causes as well as potential solutions as farmers are knowledgeable of their farming systems. Experiments designed together with farmers to alleviate these problems are likely to be well based in reality and meaningful to farmers with high subsequent adoption rates. Therefore, farmer participation in research is important for the integration of farmers' knowledge, perceptions and skills with those of researchers, and is a learning process for both farmers and researchers which in the long run is hoped will enhance agricultural technology adoption. In case of Matugga village, farmers' perception of their soils, soil related problems and possible solutions to the problems were observed by the researchers. Indigenous technical knowledge of farmers in regard to their soils was a base for future research work on soil fertility management in the area.

Key words: Farmer participatory research, indigenous technical knowledge, soil fertility, soil types.

Introduction

Agricultural activities should aim at exploiting the environment for efficient production in a sustainable manner. If not properly planned, these activities can lead to soil degradation. While inadequate soil nutrient availability constrains crop productivity, soil fertility continues to decline due to erosion and net removal of nutrients. Research in soil management is needed to maintain and improve soil productivity.

A starting point of research on soil management would be to understand the farmers' present management practices, identify problems together with farmers, understand the causes and solutions of these problems, and set priorities for future research to solve the problems. Ravnborg (1990) showed the need to involve farmers in prioritizing for soil management research work in Tanzania. Tripp and Woolley (1989) suggested a six-step format in identifying factors for experimentation and Lightfoot et al. (1987) proposed a three-step approach in identifying problems affecting farmers. This paper reports findings of a study carried out in Matugga village (Mpigi District, Uganda) following the format suggested by Tripp and Woolley (1989).

The objective of this study was to identify together with the farmers the major agricultural production problems in the village, identify possible causes and solutions to the problems and possible interventions that researchers could evaluate with farmers to solve these problems, especially the soil related problems. Apart from this main objective, the researchers were also interested in documenting farmers' perceptions, knowledge and practices relating to soil fertility in the area.

Materials and methods

This study was conducted in 1992 in a small village of Matugga, 18 kilometers from Kampala (latitude 0.44 N, longitude 35.5 E and an altitude of 1200 meters above sea level) with a total of 28 farm units selected randomly. These were mostly small scale (peasant) farmers with average farm size holdings of 2.4 hectares. The selected farmers were interviewed in an open-ended manner for general information of their households and farming systems and specially on soil related information. Farmers were encouraged to relate soil to suitability of particular crops, and discuss soil fertility management.

The farms were later revisited for formal interviews on soil related problems and for researchers and farmers together to make observations on the soils. During the process, composite soil samples were collected and soil depth was determined from the various soil types as identified by farmers. The pH of the top soil (water saturation method), wet soil color (using Munsell color chart), and texture (by feel) were determined for all soil samples. In addition to above, complete analysis including organic matter determination (organic carbon x 1.7, Walkley and Black (1934) oxidation, available P, K and Ca (Ammonium lactate extraction, pH 3.8; Foster, 1971) were determined for the problem soils, *Lunyu* and *Zibugo*, as well as for the productive *Lidugavu* soils. Participating farmers were subsequently invited for a series of meetings to further identify agricultural problems, and perform other activities like mapping their areas and drawing the predominant catena of the area. The identified problems were ranked according to the order of importance by open-voting. Farmers participated in identifying the causes to the priority problems as well as potential solutions to these problems. A research plan was then prepared together with the farmers for experimentation.

Results and discussion

General information

Of the farmers interviewed, 69% were women and, in 4% of the cases, the husband and wife were jointly interviewed. The majority of the farmers interviewed (69%) were the head of the households. The average farm size was 2.4 hectares ranging from 0.4 to 7.1 hectares. Regarding land ownership, 58% of the farmers reported having no land title whereas 39% had land titles. Lease of land was reported only in one case. Only 38% of the farmers had livestock ranging from 1 to 7 head of cattle and 2 to 9 sheep or goats (this has implication on the use of farm yard manure in the area as the animals are few). On average, there were 2.6 cattle and 3.1 goats or sheep per farm having livestock.

Farmers' perception of their soils

Soil types

Fifteen soil types were identified by the farmers interviewed (Table 1). On a single farm, up to 5 different soil types were identified. On average, there were 2.3 soil types per farm. The criteria used by farmers for soil classification were soil color (5 colors), texture (5 classes), fertility status (3 levels), vegetation (1 type) and consistency (1 type). The criteria were very similar to those found by Fujisaka (1989) who listed slope, color, fertility, texture, acidity and friability as the criteria for soil classification in the Philippines. The predominant soil types were *Lidugavu*, *Luyinjayinja*, *Limyufu*, and *Lunyu* which together accounted for 67% of the fields surveyed. *Lunyu* and *Zibugo* accounted for 16% of the fields and were classified as 'problem' soils associated with low soil fertility.

Soil catena

The typical soil catena for the village as described by farmers indicated that the hilltops were generally stony and shallow with a high infiltration rate but a low water-holding capacity. Most of the hilltops were being used as homesteads and were confirmed as generally rocky through transect walk. Other soil types frequently occurring are *Luyinjayinja* and *Kiwugankofu*. Soils on the hillslope were described as being deeper than on the hilltop with better soil moisture. Generally, all soil types except the clayey *Bumba,* type were found on the hillslope with the more fertile soils such as *Lidugavu* and *Gimu* being on the lower slopes (foothill). The valley soils generally have a dark top soil, a clay subsoil and are underlain with sand. The valley soils were described as difficult to till when wet. This catena description is similar to Buganda soil catena described by Harrop (1970).

When farmers were asked to enumerate good or bad soil characteristics they usually indicated high or low crop yield as the good or bad soil feature, respectively. Further probing ('What soil characteristics are responsible for the good or bad crop yield ?') was necessary to get the farmers' perception of the characteristics related to the soil itself and not the crop. The most frequently mentioned soil characteristic was nutrient supply followed by water holding capacity (Table 2).

Other important soil characteristics cited were soil depth, infiltration rate, erodibility, compaction and gravel/stones. Tables 3 and 4 list cited soil characteristics for different soil types which were mentioned at least three times. Apart from *Gimu* (fertile) soil, 85% of the *Lidugavu* and 80% of the *Lukusikusi* soils, but none of the *Lunyu* and *Zibugo* soils, were classified as soils having good nutrient supply.

Table 1. Characteristics of soil types as classified by farmers in Matugga village

Soil type (vernacular)	Translation	Occurrence		Soil depth (cm)		Top soil pH Range
		Total	%of farms	Top soil	Sub soil	
Lidigavu	black/dark	13	50	20 - 55	31 - >90	5.1 - 6.7
Luyinjayinja	gravelly	12	46	8 - 45	25 - >90	4.2 - 6.4
Limyufu	red(dish)	8	31	15 - 35	>90	5.0 - 6.4
Lunyu	salty/infertile	7	27	17 - 35	40->90	4.8 - 5.9
Lukusikusi	brownish	5	19	25 - 53	>90	5.3 - 6.0
Lusenyusenyu	sandy	3	12	28 - 40	45 - 85	4.7 - 5.5
Zibugo	dead/kills crop	3	12	17 - 40	40 - >90	5.0 - 5.6
Gimu	fertile	2	8	25 - 28	>90	5.4 - 5.5
Bumba (tosi)	clay/muddy	2	8	30 - 35	>90	4.0 - 4.8
Lwazi	rocky	1	4	30	>90	5.4
Lyakibira	forest soil	1	4	20	>90	5.4
Kikofu	dark grey	1	4	30	80	5.0
Kakumeme	black/red compact	1	4	27	>90	5.6
Ligonvu	soft	1	4	30	>90	5.6
Kiwugankofu	sandy loam, silty, dusty	1	4	45	>90	6.0

The latter two were most frequently considered to be soil types with low nutrient supply.

A majority of the farmers indicated a low water holding capacity for *Lunyu*, *Luyinjayinja*, *Lukusikusi* and *Lusenyusenyu* soils. Soil depth was not a criteria used by farmers for soil classification, but is was mentioned as a positive characteristic for 23% of the *Lidugavu* soils and a negative characteristic for 17% of the stony *Luyinjayinja* soils. For 42% of the *Luyinjayinja* soils, the occurrence of gravel and stones was mentioned as a negative feature.

Table 2. Positive and negative soil characteristics cited on one or more soils by 26 farmers interviewed in Matugga village

Soil characteristics	% of farmers	
	Positive	Negative
Nutrient supply	69	62
Water holding capacity	27	46
Erodibility	12	23
Soil depth	23	12
Infiltration rate	15	8
Compaction	4	19
Gravel/stones	—	11

Soil types and associated crops

The farmers easily listed the crops which were well-adapted for the different soil types. Generally all crops were well-adapted on the *Lidugavu* soils which were classified as soils having a good nutrient supply (Table 5). Most crops were unadapted on *Lunyu* and *Zibugo* soils whereas none of the crops were cited to be unadapted on the sandy *Lusenyusenyu* soils (Table 6). Cooking banana was judged to be well-adapted on 39% of the *Lidugavu* and 40% of the *Lukusikusi* soils but never on *Lunyu*, *Zibugo* and *Lusenyusenyu* soils. Banana was cited as unadapted on 71% of the *Lunyu* and 67% of *Zibugo* soils. These findings underline the fact that cooking banana, the preferred staple food, has a high priority on the more fertile soils such as *Lidugavu* and *Lukusikusi*.

Cassava was thought to be well-adapted on all soil types except *Lukusikusi* although the reason for this exception was not determined (Table 5). It was cited as unadapted on some of the *Luyinjayinja*, *Lunyu* and *Zibugo* soils (Table 6). Cassava grows relatively well on acid and highly infertile soils (Howeler, 1981). Therefore, it does not have a high priority to be grown on the most fertile soils.

Maize and sweet potato were well-adapted crops on all the soil types except *Lunyu* and *Zibugo* (Table 5). All farmers having *Zibugo* considered sweet potato as unadapted crop for this soil type. Bean was well-adapted crop on 54% of the *Lidugavu* soil type but was never cited

Table 3. Positive soil characteristics for major soil types mentioned by farmers interviewed in Matugga village

Soil type	Number of times mentioned	Positive soil characteristics mentioned (Frequency (%) of mention)				
		Nutrient supply	Water holding capacity	Soil depth	infiltration rate	Erodibility
Lidugavu	13	85	23	23	0	8
Luyinjayinja	12	25	17	0	0	0
Limyufu	8	38	13	0	38	25
Lunyu	7	0	0	14	0	0
Lukusikusi	5	80	20	0	0	0
Lusenyusenyu	3	33	33	0	0	0
Zibugo	3	0	0	33	0	0

Table 4. Negative soil characteristics for major soil types mentioned by the farmers interviewed in Matugga

Soil type	Number of times mentioned	Negative soil characteristics mentioned (Frequency (%) of mention)					
		Nutrient supply	WHC[1]	Soil depth	IR[2]	Erodibility	Gravel/ stones
Lidugavu	13	15	8	0	8	0	0
Luyinjayinja	12	33	58	17	0	25	42
Limyufu	8	50	38	0	0	13	0
Lunyu	7	57	43	0	29	14	0
Lukusikusi	5	0	60	0	0	0	20
Lusenyusenyu	3	33	67	0	0	0	0
Zibugo	67	0	0	0	0	0	0

[1]WHC - water holding capacity.
[2]IR - infiltration rate

as well-adapted crop on *Lukusikusi* and *Lusenyusenyu* (Table 5). Groundnut was cited as well-adapted crop on only 17% of the *Luyinjayinja* soils but as an unadapted crop on all the *Zibugo* soils.

Soil chemical and physical characteristics

Soil color was determined using HUE 5YR Munsell color chart for 95% of the soils. The predominant soil color was dark reddish brown accounting for 70% of the soils surveyed (Table 1). Other soil colors found were very dark grey (13%), reddish brown (10%), black (3%), yellowish red (2%) and dusky red (2%). The soil color generally corresponded with the soil color for which farmers named the soils. The surface soil texture of the surveyed fields was sandy clay loam, sandy loam and clay loam in 54%, 33% and 13% of the cases, respectively. All *Lukusikusi*, 54% of the *Lidugavu*, and 50% of the *Limyufu* soils were sandy clay loams whereas 59% of the *Luyinjayinja* were sandy loams. All soils were well-drained except the clayey *Bumba* soil located in the valley which had a moderate to poor drainage.

The topsoil depth ranged from 8 cm for *Luyinjayinja* to 55 cm for *Lidugavu*. On the average, topsoil depth was 24 to 32 cm. The range of the subsoil depth was from 25 cm for *Luyinjayinja* to over 90 cm for the majority of the soils. However, as there was a wide range in both top and sub soil depth for each soil type identified, soil depth did not explain farmers classification of soils. In respect to the topographic position, 83% of the fields studied were located on a hillside, 10% on the hilltop and 7% in the valley. The slope of the fields on the hillsides ranged from 7% to 19%.

The pH of the top soil was generally below 6.0. Only *Lidugavu*, *Luyinjayinja* and *Limyufu* occasionally reached near neutral pH values. The most acidic soil was the *Bumba* valley soil having pH as low as 4.0 to 4.8. The soil analysis of the *Lunyu* and *Zibugo* soils showed low levels of P, K and Ca (Table 7). Compared with the *Lidugavu* soil, the differences were significant. These results strongly confirm the farmers perception of *Lunyu* and *Zibugo* being soils of low nutrient availability with low crop yields.

Soil fertility management and cropping system

Hand hoe tillage, often combined with deep tillage, was mentioned by 92% of the farmers as their current land preparation practice (Table 8).

Thus only 8% of the farmers were using a tractor or oxen-drawn plow. Mulching was practiced by 50% of the farmers interviewed, primarily on the banana crop. Manure use was mentioned by 27% of the farmers but only 50% of the livestock owners said they used manure. Generally, manure is applied to banana plantations which are located near the homesteads (problem of transport and importance attached to banana crop). Only 4% of the farmers said they used inorganic fertilizers (used on vegetables only).

Table 5. Frequency (%) of crops being well-adapted on the major soil types as mentioned by farmers interviewed in Matugga village

Soil type	Number of times soil type was mentioned	Crop is well-adapted (% of times mentioned)					
		Cooking banana	Cassava	Maize	Sweet potato	Beans	Ground-nuts
Lidugavu	13	39	54	46	39	54	0
Luyinjayinja	12	17	50	42	25	33	7
Limyufu	8	25	63	13	25	38	0
Lunyu	7	0	57	0	0	29	0
Lukusikusi	5	40	0	20	20	0	0
Lusenyusenyu	3	0	33	67	33	0	0
Zibugo	3	0	33	0	0	33	0

Table 6. Un adapted crops on major soil types as mentioned by farmers interviewed in Matugga village

Soil type	Number of times mentioned	Unadapted crops (% of times mentioned)					
		Cooking banana	Cassava	Maize	Sweet potato	Beans	Groundnuts
Lidugavu	13	15	0	0	23	0	8
Luyinjayinja	12	17	17	8	17	0	0
Limyufu	8	25	0	0	0	0	13
Lunyu	7	71	14	28	43	14	0
Lukusikusi	5	0	0	20	0	20	20
Lusenyusenyu	3	0	0	0	0	0	0
Zibugo	3	67	67	33	100	33	100

Table 7. Mean values for soil characters of *Lunyu, Zibugo and Lidugavu* soils at Matugga village

Soil type	pH	Organic matter (%)	Phosphorus (ppm)	Potassium (Me/100g)	Calcium (me/100g)
Lunyu	5.0	2.5	7.0	0.20	2.50
Zibugo	5.2	3.7	14.0	0.41	3.84
Lidugavu	6.2	3.8	50.0	1.61	6.99
Recommendation[1]	5.2	3.0	5.0	0.34	1.75
Mean	5.5	3.3	24.0	0.74	4.44
LSD (P<0.05)	0.9	ns	17.9	0.56	2.45

[1] Recommended critical values for Ugandan soils (Foster, 1971).

Burning and incorporation of crop residues were each cited by 12% of the farmers. Incorporation refers to the practice where the crop residues of the previous crop are left in the field and incorporated during land preparation for the following crop. Difficulty in incorporating the crop residues was the most frequently mentioned reason for burning residues. Fallow as a current management practice was indicated by 68% of the farmers. It is the main practice to restore soil fertility. The most frequently mentioned preferred, but not necessarily practiced management practices were deep tillage (35%), fertilizer application (35%) and use of farmyard manure (27%). Lack of funds, labor, transport and manure were the main limitations to use of the practices.

Intercropping is practiced by 77% of the farmers on one or several fields. The banana-based systems accounted for 59% of the fields intercropped. The most frequently mentioned crops in the banana intercrop were cassava (27%), beans (21%), both cassava and beans (26%) and coffee (26%). Other intercropping systems indicated were cassava and beans (8%), cassava and maize (8%), sweet potato and beans (4%), and sweet potato and groundnut (4%). No particular system of crop rotation prevailed.

Identification of factors for experimentation

At meetings with farmers, problems related to soils were identified and ranked by open vote method. The most important problems mentioned in order of importance were soil erosion, low soil water holding capacity, low soil fertility, weeds, termites and ants, high sand percentage, high gravel level, steep slope, soil stickiness, water infiltration, poor internal drainage, shallow soils, poor root growth and soil compaction. The importance of the first three problems corresponds with the results from the individual interviews where the same problems were also most frequently mentioned. Particular emphasis was given to low soil fertility (LSF) and erosion. Soil erosion is a problem in itself but also a cause for LSF. The causes of LSF as perceived by farmers were identified as: failure to use better soil management practices, i.e. crop rotation, use of fertilizer and/or farmyard manure, planting of leguminous crops; lack of knowledge about soil conservation methods; and nutrient losses due to leaching, burning, erosion, or removal of crop residues.

Table 8. Current and preferred management practices as mentioned by farmers interviewed in Matugga village

Management practice	Current (%)	Preferred (%)
Hand hoe tillage	92	0
Mulching	50	8
Deep tillage	46	35
Manure use	27	27
Fallow	23	19
Grass strips/pasture	15	12
Incorporation of residues	12	12
Burning of residues	12	0
Conservation bands	12	12
Ash application	8	4
Minimum tillage	8	0
Plow	8	4
Fertilizer application	4	35

The following solutions were proposed and are listed in order of importance as perceived by the farmers.

(a) Planting of grass strips and/or hedgerows as soil conservation bands, e.g. elephant grass (*Pennisetum purpureum*) or *Paspalum* sp and planting of hedgerows of *Calliandra* sp, *Sesbania* sp, *Laucaena* sp, although procuring planting material was a concern and not all farmers understood the importance of grass strips. Grass strips are effective in erosion control and in addition provide fodder for livestock The legumes act to fix nitrogen and add organic matter to the soil apart from providing firewood and fodder for livestock.

(b) Use of green manure crops, especially leguminous crops, e.g. *Crotalaria* sp,. On-farm trials with *Crotalaria ochroleuca* grown as green manure crop have shown that it can be easily established by farmers either in sole crop or intercropped with maize or beans (Wortmann and Musa, 1992). Preliminary results indicated a substantial yield increase for maize planted after a crop of *Crotalaria* sp.

(c) More efficient use of farmyard manure. Provided farmyard manure is available, it is cheaper than inorganic fertilizer and in addition, it contributes towards the maintenance/improvement of soil organic matter. The farmers already using farmyard manure wished to know more about storage techniques, time and mode of application of farmyard manure.

(d) Planting of nutrient use efficient crops/cultivars. While research on nutrient use efficient crops and cultivars is underway, farmers were advised to take into consideration the soil fertility when the crop is chosen.

Conclusion

The need for farmer participation in identifying factors for experimentation has long been acknowledged. A variety of approaches for assessing farmer circumstances and problems exist. The method of individual interviews combined with farmer group meetings for exploring farmers' knowledge of their soils has been successfully applied in this study. Several conclusions can be drawn from the results obtained:

(a) Farmers have considerable knowledge about their soils. Farmers' perception of specific soil characteristics exists but soil problems are rather described by crop response than by the responsible soil characteristics themselves. Therefore, specific questions and further probing was necessary to get the farmers' perception of the soil itself.

(b) Farmers are generally aware of the causes of low soil fertility. In some cases, the possible solutions are known but application is limited by various types of constraints. Thus priority has to be given to solutions with low capital requirements.

(c) The chosen approach was a learning process for both farmers and researchers. Through discussions with individual farmers on the spot as well as at the meetings, a collaborative relationship could be established which is crucial for fruitful research work. The field visits allowed discussions of specific problems on the spot and to compare farmers' perception of their soils with our own observations.

Suggestions and current research activities

Based on the results of this study (1992 study), several topics were suggested for future research work and some are currently (1998) being implemented in the area under farmer supervised trials.

(a) Hedgerows: In collaboration with AFRENA (Agroforestry Network for Africa), on-farm trials were established to evaluate tree species such as *Sesbania* sp, *Calliandra* sp and *Leucaena* sp for adaptation on the *Lunyu* and *Zibugo* soils. Currently, leaves from *Calliandra* sp are being used as mulch. Feasibility of hedgerows are currently being evaluated on more productive soils as well. The long-term objective is the establishment of hedgerows on all farms where interest is shown. Other mulching materials are also being identified together with farmers for use in soil fertility improvement.

(b) Green manure crops: On-farm trials with green manure crops e.g. *Crotalaria* sp are being carried out on soils of moderately low to low fertility.

(c) Study of nutrient fluxes: Major nutrient fluxes within and to and from representative farms are to be evaluated.

(d) Research in cropping systems (intercropping options) and evaluation of bush and climbing beans under a number of cropping systems are currently being implemented in the area.

As the approach followed in this study proved to be valuable, a similar approach may be useful for other areas. Further discussions with the farmers are necessary to answer certain questions which arose from the analysis of the interviews e.g. why are beans mentioned to be unadapted on the *Lukusikusi* soils which were mostly cited to be fertile?. Combined with the nutrient flux study, a complete picture of nutrient movement to and from the farms can be established. A variety of research options are currently being evaluated together with farmers in the village.

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