



Guidelines and Recommendations for the Coordinated Support of Improved Soil Productivity in the Teso and Lango Farming systems

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EXECUTIVE SUMMARY

Introduction

The NARO/DFID Client-Oriented Agricultural Research and Dissemination (COARD) Project is supporting demand-driven agricultural research and technology dissemination in the Teso and Lango farming systems of Eastern Uganda through the development of competitive agricultural technology funding systems.

Participatory needs assessment studies have identified soil fertility as a concern in the Teso and Lango regions. However, a comprehensive understanding of these concerns and what interventions might be appropriate to address them was lacking. This study was carried out during 2001 to review existing information and undertake selected field studies in order to develop guidelines and recommendations for co-ordinated support to improved soil productivity in the Teso and Lango farming systems.

The purpose of the study was to provide recommendations and guidelines for the development of improved soil management practices in E & N Uganda, informed by a review of current Government and non-Government interventions, and a field study of the farmers' current soil management practices and constraints, and how institutions influence these.

A recent agro-ecological zonation classed the majority of the study area as Zone 3 (Northern Moist Farmlands), with a well-distributed rainfall (MAR 1260 mm) and MAT of 24° C. The two farming systems concerned are the Teso (annual cropping and cattle system) and Lango (a sub-system of the annual cropping and cattle Northern system).

Activities

As a foundation for the study a range of representative stakeholders were consulted regarding soil management practices and soil fertility in the region. Current and previous Governmental and non-Governmental soil management interventions were identified and assessed.

Needs assessments co-ordinated by NARO in 1999 identified specific areas in the region where farmers had particular concerns over soil fertility. These assessments were used to select three villages in Kumi (Adokar Katakwi (Aterai) and Lira (Baralegi) Districts for detailed study.

In each selected village the elected Local Council representatives were asked to classify the residents into three groups according to their perception of relative "wealth". This wealth ranking was important to capture within-village differences in access to resources and influences in order to improve targeting of strategies.

For each wealth rank three farming systems based participatory assessments were undertaken, facilitated by a multidisciplinary team, they included:

- Institutional influence mapping, which identified and prioritised institutions influencing natural resource management practices.
- Resource flow diagrams of a representative farm, to record the quantity and quality of resources available and the flows.

- Land characterisation, including site and soil characterisation supported by soil analysis. The stakeholder consultations and field studies were used to develop guidelines for potential applicant for COARD funding. These were presented and reviewed at a workshop held at SAARI. The findings of the study were assessed in relation to other projects supported by COARD, NARO, NAADS and others.

Results

In the course of the study a considerable amount of detailed information was collected, analysed, presented and discussed at various fora. The details are available in the main report and appendices. The following section highlights the main findings of the study:

- There is a wide range of understanding and articulation of soil fertility concepts in Uganda.
- Concern over soil fertility decline in Uganda is relatively recent. Until the mid 90's both politicians and NARO considered Uganda's soils "fertile". Consequently, the debate and consensus on the way forward is still in flux.
- Soil fertility is often assumed to be the cause of productivity declines. In some cases productivity declines could result from the complex interaction of a variety of factors (including soil fertility).
- Comparatively little recent or current soil fertility research has been/is undertaken in the Teso / Lango area.
- NARO's regional (Teso/Lango) capability to carry out soil fertility research is currently extremely limited and national capability is stretched. It is important that steps are taken to reverse this situation, as the demand for soil fertility expertise will increase in the future.
- Historic, but useful information on soil properties and distribution in Teso / Lango area exists but it is not readily available. Efforts should be made to improve availability.
- In comparison with the soil resources of the majority of the African continent, the soils of Teso / Lango cannot be considered to have major soil fertility problems. Nevertheless, if current practices continue without interventions the trend will be one of production decline because there are larger losses from the systems than there are gains. This trend is more apparent in some areas than in others.
- The subdued relief of much of the area, combined with vegetative cover reduces the occurrence and risk of significant accelerated soil erosion.
- The fertility status of the soils of Teso/Lango can be attributed to the individual effects and interactions of:
 - a Climatic influence, principally rainfall distribution and temperature that permit plant growth, (both crop and re-growth) throughout the year. These conditions

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livestock as well as having better access to information sources. Farmers in the wealthier categories also often had non-farm income sources. Information and options available to wealthier farmers are not available to the poorer neighbours who make up the majority of the communities studied.

- Knowledge of sustainable land husbandry practices is well established at community level and generally common to all types of farmers. However, the translation of this knowledge into practice is constrained. Consequently initiatives that aim to increase farmer knowledge of soil management without examining the constraints to using the knowledge are likely to have limited impact.
- Where individual holdings are small, due to relatively high population density, the opportunity for fallows and crop rotations decline, continuous cassava tends to dominate the cropping cycle. When this situation occurs on coarser textured soils the loss of organic matter is more rapid.
- The problems of soil fertility decline are exacerbated by, limited smallholding size; coarse soil textures; and very limited affordable opportunities for increasing soil nutrient status.
- Opportunities also exist to develop new ways of working with different types of farmers. These should aim to identify different soil management strategies appropriate to farmer circumstances, which will contribute to the productivity and sustainability of the farming systems.
- Possible soil management interventions appropriate for Teso and Lango include those identified by the National Soil Fertility Initiative Team. These interventions include: conservation tillage; organic mulch management; retention and incorporation of crop residues; accelerated and tree fallows and the promotion of the use of locally available low cost organic materials. Promotion of the use of low-level mineral fertilizer applications integrated with appropriate organic matter management particularly for cash crops where the economic benefits are clear is recommended.
- Farmer support for improvement of soil management could be effectively delivered through the NAADS framework. The NAADS emphasis on de-centralised, farmer-demand led services provides the mechanism to ensure that the support will deliver what farmers want to address their perceived problems and hence increase and sustain impact.
- At the Workshop held at SAARI in Oct 2001 to obtain feedback on the soils study the following key issues were endorsed by a range of stakeholders:
 - a. Resource endowments must be taken into account when designing interventions (and priority given to technologies for poorer groups).
 - b. Gender labour implications must be taken into account when designing interventions.
 - c. Financial cost & availability of technologies must be taken into account when designing interventions.
 - d. COARD should promote projects on:
 - Testing & disseminating technical information/ guidelines in a variety of media.

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provide a source of organic materials, which maintain the organic matter status of the soil surface at relatively high levels.

- b The wide range of relatively undemanding crops grown, including legumes that are rotated and interplanted (intentionally or unintentionally) in both Teso and Lango farming systems. Conversely, there is limited mono cropping of gross-feeding crops such as maize.
- c The relatively low population pressure and consequently relatively large individual holdings, which permit fallowing to be practised. The fallows are generally effective in providing a net contribution to levels of organic matter because a good cover of vegetation re-growth is established.
- d Relatively limited burning of crop residues and limited use of burning in land preparation.
- e Parent materials that give rise to soils with predominantly medium to fine textures.

Changes in soil fertility are likely to occur as factors (b), (c) and (d) above change. Any reduction in rotation and or fallow and or increase in burning will inevitably contribute to a trajectory of declining productivity.

- Important differences exist within communities with respect to access to resources, particularly area of land and livestock. Such differences need to be taken into account when designing soil management intervention strategies.
- The resource flow analysis showed differences between the study areas and between the wealth ranked groups within the villages. Farm sizes are smallest in Kumi and largest in Lira. The least wealthy group in Kumi have insufficient land to fallow, which limits their options for fertility management. The poorer groups have few or limited livestock, which again limits their options. Some households may have access to manure but do not apply it to crops, indicating that there are opportunities to improve resource use. All wealth groups practice crop rotation to a greater or all farmers and maize grow lesser extent in all areas and. Cassava, millet and sorghum by nearly all. Sweet potato is important in the Teso sample but not Lango, while pigeon pea is important in Lango and also some simsim and cotton.
- Study findings reveal that across all study sites and all farmer categories; Familial, communal and governance institutions are the most important type of institutions influencing the way farmers manage their soils. Parents and other family members are the key familial institutions while elders are the key communal institution influencing the soil management practices of farmers of all wealth categories. Extension featured as the most influential governance institution across all districts, with the exception of the better off farmers in Katakwi and the least well off farmers in Lira. Results show that NGOs and radio were more important to the wealthier group than to the others in influencing their soil management practices. Radio was not cited by the least well off farmers in any of the districts.
- The wealthier categories of farmers in all areas had access to the largest areas of land,

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- Procedures/methods for helping farmers learn.
- Community mobilisation for soil/ land management.
- e. NARO & COARD have important role in promoting awareness of "new" soil/land management technologies, through farmer-managed technologies.
- f. Project teams must demonstrate their capacity to carry out interventions.

Institutional Influences on Soil Fertility Management

Familial, communal and governance institutions (especially village elders, family and front-line extension workers) were of considerable importance to all farmer categories, and tended to reinforce similar management practices (observation of boundaries; time of planting; crop rotations; discouraging burning, etc.).

Commercial institutions (traders, middlemen, markets) were of low importance for all categories. The study suggests somewhat less importance attached by poorer farmers to radio, schools and NGOs, and greater importance to churches and health clinics in terms of influence. This may have implications for communications strategies for poverty-alleviation focused soil management projects, both in considering ways to disseminate information and who to include in project implementation. In light of these findings the following points should be considered in the design of interventions:

- Inclusion of village elders in project design, problem and solution analyses, project reviews and dissemination activities; Emphasise and facilitate farmer-farmer dissemination;
- Critical consideration of use of radio for announcing meetings and disseminating agricultural information, to ensure that information is appropriate to, and gets to the intended audience;
- Actively seek novel ways to get information to poorer groups, such as health clinics;
- Carefully consider criteria for inclusion in farmer groups when discussing these with rural communities, to ensure that they do not repeat the mistakes of some NGO-led efforts

Table 1.1 Comparison of institutional influence across farmer categories

Resource Flows
Although the actual resource flow diagrams best illustrate the individual circumstances, the following summary gives the range of circumstances and differing access to resources encountered during the field studies. Attention is drawn to the range of holding sizes as given by the farmers. Although the farm sizes were unverified the information can be used for comparative purposes. Areas ranged from over 20 acres in Baralegi, Group A to less than 2 acres in Adokar Group C. The presence and absence of livestock and the use of fallows are also important differentiating characteristics. Table 1.2 shows the main differences.

Soil fertility management in both Teso and Lango is integrated into general farming practices. It is perhaps an artificial and academic distinction to consider it as a separate activity. For example crop rotations, which include legumes, can make a significant contribution to soil fertility, but this is not the primary reason legumes are grown. The primary justification is likely to be the production of a crop, but there are other advantages to rotations such as pest and weed control as well as land preparation for a more valuable following crop.

Crop rotation and natural fallows are the main means of fertility management. As can be seen from Table 1.2 and from the resource flow diagrams individual farmers studied grew a

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minimum of five and up to ten crops, which are rotated in different plots from season to

Wealth rank	Well off (A)	Middle (B)	Poor (C)
Extension	H	H	H
Parents/family members	M	H	H
Elders	H	H	M
School	M	H	M
NGOs	H	M	M
Local Council 1	M	H	M
Research	M	M	H
Radio	H	M	L
Chiefs/civic leaders	M	M	M
Friends/neighbours	M	M	M
Church	L	L	M
Farmer groups	L	L	M
Health	L	L	M
Forestry	L	L	L
Markets/Traders	L	L	L
Drinking groups/ social gatherings	L	L	L
Cooperative Society	L	L	L
Adult Literacy Campaigns	L	L	L
Clan	L	L	L
District Farm Institutes	L	L	L
Parish Credit Committees	L	L	L
Politicians	L	L	L

season. Rice being the exception. Fallowing is generally practiced, apart from Kumi District where individual holdings are too small amongst the poorest group to allow fallowing. Although the concept of rotation and fallowing are well established there is not necessarily strict adherence to a particular sequence for individual plots. "Typical" rotations were cited, but within the general pattern of cereal, legume, root crop there appeared to be individual variation.

Incorporation of crop residues and ploughing in of grass fallows is the main means of active fertility management. Farmers were aware of the theoretical benefits of incorporating organic materials as opposed to burning, but further investigation would be required to establish actual practice. Where farmers have livestock and a source of manure in some cases but not all this was applied to plots. In some cases animals were tethered in fallow plots or encouraged to consume crop residues in harvested fields where their manure was consequently deposited. This practice would appear to be more strongly motivated by the feeding requirements of the animals than soil fertility, although the benefit was generally recognised. In some cases farmers did not apply manure to their fields, where they had a plentiful supply. Reasons for non-application

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included lack of knowledge and the difficulty of transporting the material. Livestock manure was valued for its contribution to soil fertility, but not sufficiently to justify its application at all costs. Lack of transport was most frequently cited as a reason why manure was not applied to fields. Household waste, chicken and goat manure were generally returned to the plots immediately around the homestead, but not in a systematic manner. Such applications can make a considerable impact on soil fertility and crop productivity locally (the soil fertility analysis from Aterai C is a good example of this). Minimal use of mineral fertilizers occurred in the sample farms, although most farmers had some familiarity with them.

With respect to regional variation, the main differences relate to the crops grown. Groundnut is the main legume in Teso, while pigeon pea is generally absent. Pigeon pea is important in Lango. Sweet potato is widely grown in Teso, increasingly as a cash crop while it is less frequent in Lango. Cassava was the only crop that was grown on every farm studied. Although the range of crops grown is wide, there is further potential to extend the cultivation of a wider range of crops throughout the region, particularly the legumes. The range of crops grown and the consequent rotation options in general is a positive contribution to the maintenance of soil fertility. The Plan for the Modernisation of Agriculture advocates crop specialisation with an inevitable reduction in rotation options as an important modernisation strategy. The soil fertility maintenance implications of specialisation should be carefully examined to ensure sustainability.

Soil Characterisations

The following section gives a brief summary of the main characteristics of the soils at each village site.

Adokar

Site observations indicated reasonably consistent soil characteristics, with the exception of unpredictable depth to a laterite layer or weathering rock. Depths varied from 120cm + to 40cm, but were generally less than 70cm and independent of slope position. Surface textures were generally sands and loamy sands with sandy clay loam at depth. Upper slope positions were well drained with poorly drained conditions in the lower slopes and bottomlands. The profiles were stone free above the laterite.

Soil analysis showed the majority of samples to have a pH at or slightly above the critical limit of 5.2. Organic matter was typically only 25% of the critical level of 3%. Phosphorus was typically 40% of the critical level and calcium 50% of critical levels. Potassium was generally at or slightly above the critical level.

The Adokar soils are the least "fertile" of the three villages in the study, the combination of sandy surface textures, low organic matter and phosphorus being the main limitations. The depth limitation could influence rooting depth and have consequences for moisture availability, but this could not be verified in this study. The low relief reduces the effects of accelerated soil erosion, however any reduction in depth in such shallow profiles is a major threat to productivity. The loss of a significant amount of soil and exposure of the laterite layer although unlikely would result in a complete and irreversible degradation of the soils productivity.

Aterai

The site observations indicated reasonably consistent soil characteristics. Laterite was encountered occasionally but generally the soils were deeper than 90cm over laterite, with

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Table 1.2 Selected Characteristics from resource flow diagrams

Sample Farm	Area (farmer est.)	Livestock	Main Crops	Land Fallowed ?	Organic Material Recycled ?	Produce Marketed ?
Adokar A	5 acres	7 cows, 2 pigs, 3 goats	Cowpea, cassava millet, g-nuts sorghum, s-pots, maize, beans banana	yes	Livestock manure	yes
Adokar B	6 acres	2 oxen, 1 pig with 5 piglets, 1 goat, 3 ducks	Cassava, sweet potatoes, groundnuts, cowpeas, bambara nuts, maize, rice	yes	Livestock manure	yes
Adokar C	2 acres	1 chicken	Cassava, g-nuts, s-pots, millet, cowpeas, green gram	no	No	occasional
Aterai A	14 acres	6 cattle, pigs, goats, chickens	Cassava, g-nuts, maize, sorghum, millet, s-pot, erudurde peas.	yes	Only chicken manure not cattle	yes
Aterai B	15 acres	Chicken	Sorghum, millet, g-nut, maize, cassava	yes	Chicken droppings	yes
Aterai C	7 acres	None	Cassava, g-nuts, millet, maize, s-pots, sorghum	yes	Household waste only	no, food deficit most years
Baralegi A	20 acres	2 oxen, 5 goats, 7 chicken	Cassava, maize, g-nut, sorghum, beans, p-pea, simsim, cotton, rice	yes	Livestock manure	Yes
Baralegi B	11 acres	2 oxen, 8 chicken	Cassava, sunflower, millet, sorghum, simsim, p-pea, cotton	yes	Household waste	Yes
Baralegi C	10 acres	2 pigs, 4 chicken	Maize, g-nut, millet, rice, cowpea, cassava, sorghum, simsim, p-pea, cotton	yes	Household waste	Yes

the majority of samples over 120cm+. Surface textures were generally sands with sandy clay loam and sandy clay at depth. Upper slope positions were well drained with poorly drained conditions in the lower slopes and bottomlands. The profiles were stone free above the laterite.

Soil analysis showed the majority of samples to have a pH well above the critical limit of 5.2. Organic matter was typically 50% of the critical level of 3%. Phosphorus, potassium and calcium were typically above the critical levels.

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The main soil limitation at Aterai is the sandy surface textures and the organic matter levels. Increasing organic matter in soils with sandy textures is known to be difficult, as a higher clay fraction tends to protect the organic fraction.

Baralegi

Soil depths at Baralegi were similar to Aterai and again occasionally limited by laterite. Crest and upper slope sites can be shallower with one profile having a depth of 38cm. Baralegi had the highest clay content of all the soils sampled, with surface textures consistently sandy clay loam over sandy clay sub-soils. Upper slope positions were again well drained with poorly drained conditions in the lower slopes and bottomlands. The profiles were stone free above the laterite.

Soil analysis for Baralegi showed surface pH at or slightly above the critical limit of 5.2. Organic matter levels were the higher than Adokar or Aterai mainly at or near the critical limit of 3%. This is probably correlated with the higher clay content of the soils. Phosphorus was 50% below the critical limit in half of the samples. Calcium was well above the critical limit and potassium limiting in a few samples. Apart from phosphorus, the Baralegi soils are probably the most "fertile" of the three villages and consequently the most suited to intensive production.

Farmer perceptions of soil fertility

Findings on farmer perceptions reveal that all farmer categories in both Lango and Teso concur that soil fertility has been on the decline over the past decade or so. The farmers in Lango cited low yields to be the indicator of reduced soil fertility while increased prevalence of striga was attributed to declining soil fertility in Teso.

Perceived causes of fertility decline

Several factors were reported to have contributed to the decline in soil fertility and these include: reduced fallow periods; reduction in number of animals, continuous cultivation of same piece of land; Karimjong invasions, prolonged dry spells, increased pest prevalence and increased intensity of burning.

- Reduced fallow periods. All farmer categories in Lango and Teso noted that the fallow periods have reduced. Differences exist by District and wealth category, with Lira farmers reporting that they can still fallow land for at least 2-3 years while only well off farmers in Katakwi can fallow land, fallowing has almost lost meaning in Kumi where fallow periods range between one season to one year. The implication is that land is no longer rested for long enough for it to regain fertility through natural process.
- Reduction in the number of animals was cited by both the well off and middle category farmers in Lango and Teso regions but not the least well off farmers. These categories of farmers noted that due to reduced livestock numbers, the amounts of animal manure available have also greatly reduced, they no longer have kraals where they could collect the manure and change locations in order to spread manure on their land. Also reduction in cattle numbers meant loss of oxen, which used to incorporate grass and crop residues has stopped and negatively impacted on nutrient recycling.
- Closely linked to the above to issues is continuous cultivation of the same piece of land,

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which was cited by all farmer categories in Lango and Teso. Farmers note that due to lack of oxen, land opening has become difficult. In addition the land available to these farming households was also reported to have decreased, as land is continually subdivided among the offspring as population grows. Continuous cultivation of land has intensified nutrient mining from these fields hence the decline in soil fertility.

d. *Karamojong* invasions were cited to have compounded the problem of land fertility especially in Katakwi district in a number of ways:

- The large herds of cattle which break/loosen the topsoil, exposing it to soil erosion.
- The influx of people running away from *Karamojong* invaded areas increase pressure on land
- Increased bush burning as farmers destroy the natural pastures on in an effort to discourage *Karimonjong*.

Increased pest prevalence and prolonged dry spells were both noted to result wide spread burning as farmers try to eliminate the crop residue in order to check pests. The outcome is that land is often left bare with no vegetation cover exposing it to wind or water erosion

Suggested solutions

Farmers cited some interventions which could help check the reduction in soil fertility these include:- crop rotations; fallowing land; applying manure; burning grass/crop residues in the process of ploughing, and changing the direction of ploughing.

All farmer categories in both Lango and Teso acknowledged that crop rotation could be used to help soils regain fertility. Among the possible rotations cited in Lango were pigeon peas / sorghum / groundnuts / pigeon peas / cassava. In Teso groundnuts / millet / sorghum / sweet potatoes /cassava/ fallow. Both rotations include legumes, with a higher percentage in Lango than Teso. It was reported that men make decisions regarding crop sequencing.

Applying manure featured most in Teso compared to Lango, with the well-off farmers in Lango noting that the work is difficult and they have no time for it. Least well-off farmers in Lira and all farmer categories in Katakwi reported applying manure especially household waste; goats and poultry waste as an option. The responsibility of moving manure to the fields rests with women and children to a lesser extent.

Farmers in Lira noted that planting trees could help check soil erosion in addition the leaves which fall and decompose to add manure to the soil while Katakwi farmers highlighted burying crop residues or spreading them in small heaps over the field.