



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

EPTD WORKSHOP SUMMARY PAPER NO. 10

**POLICIES FOR IMPROVED LAND
MANAGEMENT IN UGANDA**

edited by

Pamela Jagger and John Pender

Summary of Papers and Proceedings of a Workshop
Held At Hotel Africana
Kampala, Uganda
25 and 27 June 2001

Environment and Production Technology Division

**International Food Policy Research Institute
2033 K Street, N.W.
Washington, D.C. 20006 U.S.A.**

September 2001

EPTD Workshop Summary Papers provide an overview of the discussions and findings of workshops and conferences that the division has helped organize and sponsor. It is generally expected that a proceedings volume of papers will be published at a later date

CONTENTS

1. Welcome and Introduction.....	i
2. Opening of the Workshop.....	iv
3. Policies for Improved Land Management in Uganda: Project Objectives, Activities, and Organization.....	1
4. Summary of Workshop Papers and Discussions	4
5. The Evolution and Characteristics of Farming Systems in Uganda	24
6. Policies and Institutions Affecting Land Management.....	27
7. Hypotheses About Causes of Land Management Problems and Strategies for Improvement	32
8. Agricultural Input Marketing in Uganda	37
9. Problems and Constraints in the Multiplication of Seed and Planting Materials In Uganda: Some Preliminary Findings	43
10. Evolving Roles for Programs and Organizations: Promoting Sustainable Land Management in Uganda	47
11. Coping With the Problem of Low and Declining Agricultural Productivity in the Banana-Coffee Lakeshore System.....	52
12. Soil Conservation By-Laws: Perceptions and Enforcement Among Communities in Uganda	58
13. Development Pathways and Land Management in Uganda: Causes and Implications	62
14. Modeling Program-Induced Development Pathways: A Case Study for Eastern Uganda	67
15. Soil Potentials and Constraints in Uganda.....	71
16. Strategies for Soil Fertility Replenishment – The Potential of Velvet Bean (<i>Mucuna pruriens</i>) and Azolla as Compared to Inorganic Fertilizers for Improving Maize and Rice Productivity.....	76
17. Stratification and Resource Mapping Methodology for Community Based Analysis of Soil Degradation in Uganda.....	80
Appendix A: Workshop Agenda.....	82
Appendix B: List of Participants.....	86

1. WELCOME AND INTRODUCTION

Welcoming remarks by Dr. Sam Kyamaywa
Head of Department of Crop Science, Makerere University
for Professor E.N Sabiiti, Dean of Makerere University Faculty of Agriculture
and Chairman of the Project Advisory Committee

WELCOME TO:

- Representative for The Minister of Agriculture, Animal Industries and Fisheries (MAAIF), Hon. Dr. Kisamba Mugerwa - Hon. Fabius Byaruhanga Minister of State for Agriculture;
- Honorable Ministers and Members of Parliament;
- The visiting delegation from the International Food Policy Research Institute (IFPRI) and other international institutions;
- Participants; and
- Ladies and Gentlemen.

It is my pleasure to welcome you all to this first national workshop on *Policies for Improved Land Management in Uganda*. We at Makerere University, and the faculty of agriculture in particular, are proud to co-sponsor this workshop because it is a very significant step towards eradicating poverty in Uganda, through improved land management and agricultural productivity. I wish to congratulate our partners IFPRI, the National Agricultural Research Organization (NARO), the Agricultural Policy Secretariat (APSEC) and the Center for Development Research, University of Bonn (ZEF) for this significant achievement.

Two and a half years ago, we gathered in this same place to plan for policy research aimed at helping policy makers identify and assess policy, institutional and technological strategies for improving land management and reducing poverty without jeopardizing the natural resource base. To date, most of the field activities that the project

planned to undertake have been completed (such as the characterization survey, community survey, and market surveys), or are about to be completed (household and plot surveys). I am glad to report to you that we are gathered here today to receive and discuss the preliminary findings of the completed surveys. I must emphasize that these are preliminary findings and should not be interpreted as conclusive final findings, but rather are intended to stimulate discussion and pave the way forward for the remaining period of this project. I, therefore, call upon you to listen attentively and actively participate in the discussions.

In addition to the completed field activities, the project has made significant progress in capacity strengthening by involving local collaborators in research design, implementation and analysis; and two Ugandan scholars are receiving Ph.D. training at the Center for Development Research, University of Bonn (ZEF) through the project. Increased awareness of the project and its objectives has been achieved among policy makers through the project advisory committee, to which Professor Sabiiti is the Chairman. This is a very significant achievement and although it is still early for the project to impact on policy making, it certainly has the attention of key policy makers, and the foundation has been laid upon which future impact will be achieved.

There is still more to be done in terms of data collection, analysis and report writing. Your input is critical in identifying key areas for the project to contribute to informing policy making on the best approach for addressing the problems of land degradation, low agricultural productivity, and poverty in Uganda. I wish you fruitful deliberations during this workshop. Thank you very much.

I now take this opportunity to call upon the Honorable Minister to open this Workshop.

2. OPENING OF THE WORKSHOP

Opening remarks by Hon. Fabius Byaruhanga
Minister of State for Agriculture, Animal Industries and Fisheries, Uganda
for Hon. Dr. Wilberforce Kisamba-Mugerwa
Minister of Agriculture, Animal Industry and Fisheries, Uganda

WELCOME TO UGANDA

- Distinguished chairman and members of the Advisory Committee for the research project *Policies for Improved Land Management in Uganda*;
- The project lead scientist, Dr. John Pender from IFPRI headquarters in Washington D.C.;
- Development partners and other international research and development organizations representatives; and
- Other fellow participants.

It is a great honor and pleasure to be invited to give opening remarks at this workshop, taking place in Kampala, Uganda. The need for policy oriented-research cannot be over-emphasized. As many of you are aware, the Government of Uganda is deeply committed to the modernization of agriculture in Uganda, as documented in the Plan for Modernization of Agriculture (PMA).

The PMA is a strategic framework for the implementation of programs and policies the Government of Uganda intends to introduce in the process of modernizing agriculture in Uganda. As such there are several policy areas in which we need answers, but these can only be obtained through research. Looking through your workshop program and other materials sent to me prior to the workshop, I am particularly happy to note that the research priority areas are very relevant to the research needs of the PMA and the policies we intend to adopt. The land degradation problem in Uganda is critical,

including problems of soil fertility mining, soil erosion and others. Research is needed to understand the nature and extent of the problem, its causes, and to identify appropriate policy responses.

I should therefore say at this juncture that the initiation of this research project on policies for improved land management could not have come at a more opportune time. Uganda is grappling with the need to build capacity for policy-oriented research needed to guide policy makers to plan our long-term strategy for developing agriculture in Uganda.

I understand that the main objectives of the research project *Policies for Improved Land Management in Uganda* are to:

- Identify the main factors affecting land management in Uganda;
- Identify major current and potential development pathways, their causes and implications;
- Identify and assess policy, institutional and technological strategies to promote more productive, sustainable, and poverty-reducing pathways of development and improved land management;
- To strengthen the capacity of collaborators in Uganda to develop and implement such strategies; and
- To increase awareness of the underlying causes of land degradation problems in Uganda, and promising strategies for solving the problems.

These are very important objectives, which I believe, if the project is able to achieve will help in meeting the PMA's requirements for information on how to increase smallholder productivity and to reduce poverty in a sustainable manner. I can confirm MAAIF's commitment to this noble cause and challenge. We look forward to reading the reports and papers derived from your research activities in Uganda.

With these few remarks, MAY I DECLARE THIS WORKSHOP OPENED

May you have a fruitful deliberation, and May God Bless You All and have a safe trip back home after the workshop.

3. POLICIES FOR IMPROVED LAND MANAGEMENT IN UGANDA: PROJECT OBJECTIVES, ACTIVITIES, AND ORGANIZATION

John Pender
International Food Policy Research Institute

BACKGROUND OF THE PROJECT

The project began in January 1999 with a planning workshop in Uganda sponsored by the International Food Policy Research Institute (IFPRI), Makerere University, and the National Agricultural Research Organization (NARO). The planning workshop included participants from the University of Bonn, Center for Development Research (ZEF); the Agricultural Policy Secretariat (APSEC); the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF); Makerere Institute for Social Research (MISR); the National Environmental Management Authority (NEMA); and various international research organizations. The project itself is a collaborative effort of IFPRI, Makerere University Faculty of Agriculture (MUFA), NARO, APSEC and ZEF, with financial support from the governments of Germany, Norway and the United States. The focus of the project is most of Uganda, excluding insecure, lowland and dryland areas. Seven of nine major farming systems in Uganda are represented within the framework of the project.

PROJECT GOAL, PURPOSE, AND OBJECTIVES

The long-term goal of the project is to contribute to improved land management in Uganda, in order to increase agricultural productivity, reduce poverty, and to ensure the sustainable use of natural resources. The immediate purpose of the project is to help

policy makers identify and assess policy, institutional, and technological strategies to improve land management in Uganda.

SPECIFIC OBJECTIVES

The project has several specific objectives:

- To identify the main factors affecting land management and its linkages to agricultural productivity, poverty, and sustainability;
- To identify the major current and potential pathways of development in Uganda, as well as their causes and implications;
- To identify and assess strategies to promote more productive, sustainable, and poverty-reducing pathways of development and improved land management;
- To strengthen the capacity of collaborators in Uganda to develop and implement such strategies, based upon policy research; and
- To increase awareness of the underlying causes of land degradation problems in Uganda, along with promising strategies for solving the problems.

ACTIVITIES

To achieve the specific objectives listed above a series of research activities are being undertaken including:

- Characterization of the land degradation problem and development of hypotheses using secondary information;
- Market surveys to identify market structure and responses to structural adjustment policies;
- Community surveys and resource mapping to identify pathways of development, their causes, and implications for land management;
- Household surveys to assess impacts of policies and other factors on land management and implications;

- Farm level soils characterization and experimental work to better understand farmers' options and implications of alternative land management practices; and
- Household and market models to explore the potential impact of alternative policy, institutional and technological strategies.

PROGRESS

A great deal of progress has been made so far:

- Characterization work has been completed and the results presented to the National Advisory Committee in January, 2000;
- Market and community level surveys are completed and initial analysis done;
- Household surveys are nearly completed;
- Soils and experimental work is ongoing; and
- Modeling work is ongoing.

WORKSHOP OBJECTIVES

The main purpose of this two-day workshop is to review results of the first three activities and seek stakeholder input to help guide the remaining activities.

The specific objectives of the workshop are:

- To familiarize policy makers and other stakeholders with the project;
- To review preliminary findings of the research so far, and obtain feedback from stakeholders;
- To consider key policy issues affecting the prospects for improved land management in Uganda.

4. SUMMARY OF WORKSHOP PAPERS AND DISCUSSIONS

Pamela Jagger and John Pender
International Food Policy Research Institute

OVERVIEW OF PAPERS

Papers focusing on characterizing land management, the development of input markets, development pathways and their relationship to land management, and assessing the impact of land management practices were presented at the policy workshop.

Characterizing Land Management – Problems and Possible Responses

In order to formulate hypotheses about development pathways and to understand the conditions under which pathways may evolve (or fail to evolve) it is necessary to characterize the current state of land management and the policies and programs influencing it (Bashaasha; Gashumba). Evaluating changes in farming systems and characterizing the policies and institutions that affect land management can help to formulate hypotheses about potential development pathways for regions of the country with varying agricultural potential, access to markets and population densities (Sserunkuuma et al.; Ruecker et al.).

Farming systems and land management are inextricably linked, and changes in farming systems or land management are likely to have a significant impact on the extent of land degradation. Since 1986, major changes in Uganda's farming systems include the adoption of non-traditional crops; abandonment or shifting of traditional crops (such as cotton and cooking banana); new off-farm activities such as charcoal burning, trading and

providing motorcycle transportation in rural areas; and the adoption of new soil and water conservation technologies such as zero-grazing and composting.

Changes in farming systems are driven by underlying biophysical, socioeconomic and political influences. Biophysical factors include changes in the condition and fertility of soils, climate change, and the presence of pests and diseases. Socioeconomic factors hypothesized to affect changes in farming systems include price incentives and disincentives, changes in regional comparative advantage and factor markets (i.e. land and labor), non-farm labor opportunities, decreasing farm size, access to credit, the availability of infrastructure, the availability of agricultural or natural resource management technologies, and availability and access to agricultural extension and training. Political factors such as privatization of government services, market liberalization (particularly with respect to agricultural inputs), decentralization, land tenure, and civil strife also affect changes in farming systems. Cattle rustling was identified as a serious and unique problem having a profound impact on farming systems in some regions of the country.

Based on information about changes in farming systems since 1986, and the biophysical, socioeconomic and political factors that have influenced that change – several key issues were identified. A process of farm level diversification and commercialization of agricultural production is taking place throughout the country, and appears to be motivated by market opportunities and soil fertility constraints. While commercialization in crops is taking place, intensification with respect to use of external inputs (both inorganic and organic) remains very limited. This may be due to credit constraints, lack of agricultural extension and training, limited availability of marketed

inputs, and poor information on net returns to inputs. Diversification is likely assisting farmers with managing risk – but may be contributing to soil degradation in some areas. It is unclear whether the general trend toward commercialization is having a positive affect on food security. Though household incomes appear to be increasing, there is no guarantee that new sources of income will be used to purchase food. There are also concerns that commercialization is leading to nutrient mining in some areas. For example, the transport of bananas to Kampala from the western region of the country means that plant nutrients are not recycled to the soil in the region where the bananas are produced.

To fully understand changes in farming systems and land management it is necessary to carefully consider the policies and institutions that affect land use and management, including market liberalization, privatization, decentralization, land policies, agricultural research and extension, credit policies, infrastructure development, and others (Gashumba). An overview of the macroeconomic policy framework, as well as sectoral and institutional policies (including agriculture, social, gender, environment, land, energy, and infrastructure policies) leads to several conclusions. First, reforms to policies and institutions related to land are difficult to implement for a variety of reasons. Particularly in the context of decentralization, there is a need to clarify the role of local leaders (e.g. traditional leaders vs. politically elected leaders) in implementing and enforcing policies related to land management. Policies should also be tailored according to resources available at the local level, implying that local participation in the formulation of land policies is needed. Sociopolitical circumstances at the local level and

conflicts between policies and local resource endowments are often the downfall of policy implementation.

The second key finding is that there is a need to put into place a legal and regulatory framework that will ensure transparency, accountability, efficiency and effectiveness in the development of policies that affect land management. Policies should be evaluated for their relevance at both national and local levels and should be continually revised in accordance with local level resource conditions. The dynamic nature of social, economic, political, and environmental factors suggests a need to allow for flexible policies that can be revised at the local level according to current conditions.

Drawing on information about changes in farming systems, land management, and policies and institutions that affect land management, key hypotheses about the causes of land management problems and strategies for improvement were identified (Sserunkuuma et al.). The major processes of land degradation are soil erosion, soil nutrient mining, and deterioration of the physical properties of the soil. The causes of land degradation can be divided into three categories, the proximate causes, the underlying causes, and the policy and institutional factors that contribute to land degradation. The proximate causes of land degradation are relatively well understood and include natural factors such as soil type, topography and climate fluctuation; and human impacts such as deforestation and unsustainable farming practices. The underlying causes of land degradation are less well understood, but may include population pressure, poverty, low-input subsistence farming, limited commercialization, lack of infrastructure and services, lack of credit, land tenure insecurity, and lack of farmer awareness of appropriate technologies for land management. Policy and institutional factors that affect

these underlying causes include structural adjustment and market liberalization policies, decentralization, infrastructure development, market development, agricultural research and technical assistance programs. Such factors may affect land management in very complex and site-specific ways.

The complex and site-specific nature of factors influencing land management implies that no “one-size-fits-all” strategy is likely to be effective in promoting sustainable development in all of the diverse situations of Uganda. Strategies need to be targeted to different areas based upon comparative advantages of different livelihood strategies. The development of different livelihood strategies in a particular location, which we call “development pathways”, is influenced by many factors, such as agricultural potential, access to markets, population density, and presence of government programs and organizations. Such factors can be used to define different “development domains” in which particular development strategies may be pursued. Several development domains have been identified in Uganda and hypotheses put forward regarding the development pathways that may be suited to different domains (e.g. expansion of subsistence perennial food production, intensification of livestock production, increased non-farm development, etc.), and the strategies to achieve the potential of such pathways.

Spatial analysis based upon the use of geographic information systems (GIS) is a powerful tool for facilitating research on Uganda’s wide range of agroecological conditions, varying degrees of market access, and population density. (Ruecker). Due to the spatial complexity of factors influencing agricultural productivity including, variability of soils, topography, rainfall, population density, and market conditions, it is

difficult for policy makers to assess soil degradation problems and target strategies for improved land management in specific areas. Combining spatial data on agricultural potential, market access and population density with community surveys reveals information about the site-specific nature of land degradation. This stratification and resource mapping strategy was applied to Uganda and resulted in the identification of 20 different strata comprising different combinations of agro-climatic potential, population density, market access and altitude. The communities surveyed (upon which much of the data and analyses in this report are based) were randomly selected from within the stratified project region.

Development of Input Markets

With the movement towards commercialization, privatization of input supply, and the devolution of key services including agricultural extension and training, the development of markets is critical to the success of agriculture in Uganda. Examining current trends in input markets and the multiplication of seeds, as well as the role that input traders and seed multipliers play in facilitating sustainable land management practices, is important (Nkonya et al.; Gruhn and Rashid).

Relative to other countries in East Africa, the use of purchased inputs (particularly fertilizer) by Ugandan smallholders is uncommon. Further, where smallholders are using purchased inputs the amounts used are often very small. Poor development of input markets is one of the major reasons for this. However, since the mid-1990s there has been an increase in agricultural input traders and seed multiplication farmers, increasing the availability of improved seed, agrochemicals and fertilizers.

Though the Uganda Seed Project (USP) still produces and distributes the majority of improved seed, input traders are involved in the distribution of agrochemicals, fertilizer and to a lesser extent seed (Nkonya et al.). Input trading appears to be a profitable business, particularly for importers and wholesalers, whereas due to greater competition, input retailers are experiencing lower profits. Due to a lack of credit availability it may be difficult for small traders to enter the input trading market, though some non-governmental organizations (NGOs) and community-based organizations (CBOs) are offering loans for the start-up of input trading businesses. Input retailers offer credit to their customers more commonly than wholesalers and importers, perhaps due to greater social interactions between smallholders and village level retailers.

Mechanisms for information exchange regarding prices and the appropriate use of inputs include the use of telecommunications and extension services. The proliferation of mobile phones in Uganda's rural areas is improving the efficiency of input marketing – though most input suppliers are still getting market information from customers, suppliers and other traders. Having input traders act as extension agents has been proposed as a possible mechanism for dealing with the decentralization and privatization of government extension services. Though some input traders are receiving extension training, the quality and content of the training is not uniform, and the ability or incentive of input traders to impart complete and unbiased information on input use to their customers is questionable.

Similar considerations relate to input supply. The participation of private firms in seed supply may be inhibited by the dominance of the USP, though the ability of private firms to profit from sales of open-pollinated or self-pollinating varieties is doubtful.

Continued government provision of these seeds, or subsidization of distribution by private firms or NGOs may be necessary.

Identifying the constraints hindering the efficient functioning of the distribution system for modern seed varieties (including maize, beans, coffee and cassava) and other inputs provides insight into the development of better marketing and distribution networks for seed and planting materials (Gruhn and Rashid). The majority of farmers currently involved in seed multiplication are under some form of contractual arrangement with the USP, Uganda Cotton Development Authority (UCDA), National Agricultural Research Organization (NARO) or a non-governmental organization. These organizations seek out the best farmers and provide them with technical assistance. Although it was expected that there would be higher rates of input use, agricultural extension training and access to credit among these farmers, survey results did not validate this. In general, multiplication farmers were found to apply very little fertilizer and pesticides in the management of their crops.

There are several possible reasons for the lack of adoption of modern agricultural technologies that would lead to improved yields and decrease land degradation. Seed multiplication facilitators are primarily focused on the provision of improved seed and planting materials rather than promoting a holistic package of modern agricultural technologies that would include fertilizers and other inputs. This is an important finding as there is a general perception that farmers using improved seeds are more likely to use other purchased inputs. Second, extension training is limited and lacks an integrated approach. There is very little training given on the specific benefits and use of various inputs, and thus there is little evidence of higher rates of input use. Third, almost 100% of

purchased inputs other than fertilizer were purchased with cash rather than credit. The lack of credit availability for the purchase of inputs, and resistance to selling inputs on credit may be the result of low demand for credit or high transactions costs, and is likely seriously undermining the ability of farmers to purchase inputs. Finally, some multiplication farmers are using seed from the previous year's harvest, which may lead to deterioration of the seed and make seed multipliers less competitive with other locally produced or imported seed. This has implications for the privatization of the USP.

Research on the development of input markets indicates that the Ugandan government should carefully evaluate the privatization of input markets and the devolution of extension services. In particular, the issues of whether or not agricultural extension should be considered a public or private good is an important question for Uganda. Rates of input use lag far behind those in neighboring Kenya, and there is evidence to suggest that failure to provide adequate agricultural extension and information on the benefits of inputs to farmers may have long-term implications for sustainable land management.

Development Pathways and Land Management

Examining development pathways and their relationship to land management allows potential development strategies to be identified within and across regions of differing agricultural potential, market access and population density (Pender et al.). The development pathways framework also allows for the identification of areas where no development is occurring or where human welfare and natural resource conditions are worsening. Case studies provide further understanding of specific development pathways. The problem of reduced soil fertility in the banana-coffee lakeshore system is examined

(Sserunkuuma et al.). Mechanisms and institutions for addressing land management and soil fertility problems are also considered. The role of bylaws and regulations in the enforcement of soil and water conservation technologies and other natural resource management mechanisms are evaluated at the community level (Nkonya et al.), the role of programs and organizations in promoting sustainable land management are considered (Jagger), and bioeconomic modeling is planned to evaluate the role of non-governmental organizations in motivating land management innovations in two specific villages (Woelcke).

Analysis of 107 communities and villages indicates six dominant development pathways emerging in Uganda. Pathways include expansion of cereals production, expansion of banana-coffee production, non-farm development, expansion of horticulture, expansion of cotton, and stable coffee production (Pender et al.). The banana-coffee expansion pathway was most strongly associated with the adoption of soil and water conservation practices and improvements in resource conditions, agricultural productivity (of bananas), and human welfare. This development pathway is characterized as a possible “win-win-win” strategy benefiting the environment as well as promoting economic growth and poverty reduction.

There are however traditional banana-coffee areas that are experiencing deteriorating soil conditions as well as declines in banana productivity. Reduced soil fertility in parts of the lakeshore banana-coffee farming system is leading to decreased *matooke* yields (Sserunkuuma et al.). There is reluctance in many communities that have traditionally relied on *matooke* to change cropping patterns as *matooke* plays a very strong role in the dietary preferences and culture of the region; this has implications for

human welfare as well as sustainability of the resource base. Some farmers are taking up maize and livestock production as alternative investments to banana and coffee.

Increased crop and livestock production provides an opportunity to increase and sustain agricultural production as well as sustaining the natural resource base.

There may also be social implications of declining yields in *matooke*. The production of beer banana, which is more tolerant than *matooke* to poor soil conditions, is increasing in the lakeshore region. Increases in the supply of beer may be leading to increased beer consumption– which may lead to increased poverty (due to a higher proportion of household income being spent on beer), as well as increases in alcoholism and its associated social problems.

In addition to the six emerging development pathways identified by Pender et al., road development and the development of transportation services appear to be critical to improving most natural resource conditions (except forest and woodland availability), as well as human welfare conditions. The trade-offs associated with road development and potential declines in forest and woodland area need to be carefully considered in the context of potential gains in human welfare. Irrigation also appears to have a positive impact on land management. Irrigation reduces pressure to expand cultivated area by increasing the productivity of land already under cultivation. The impact of irrigation on welfare indicators is less clear.

Government programs and non-governmental organizations appear to be contributing to improvements in productivity, resource and welfare conditions; though they are also associated with some negative outcomes including declines in millet and banana yields, and declining availability of energy sources. It may be that by promoting

development of some crops, farmers decide to devote less effort to managing other traditional crops such as bananas and millet: while the environmental focus of many such programs may be reducing the availability of energy sources (by opposing charcoal production or cutting trees).

The current decentralization of government services and associated increasing reliance upon non-government organizations and community-based organizations (CBOs) to provide services such as agricultural extension and training on land management related issues might impact human welfare and natural resource conditions in the future (Jagger).

Government programs, NGOs and CBOs have varying characteristics that may contribute to their ability to address issues associated with land degradation. In general NGOs are better represented than government programs and community-based organizations. NGOs are concentrated in high potential areas with relatively good market access, whereas government programs are represented throughout the country. Community-based programs are very common in the southwest highlands.

Government programs, NGOs and CBOs also have a variety of focus areas that directly or indirectly address land degradation. Some programs and organizations focus on agriculture or environment – indicating that they deal with some of the proximate causes of land degradation. Others focus on issues such as population pressure, poverty, low-input subsistence farming and the associated lack of commercialization, lack of infrastructure and services, or providing general community services; and may have indirect impacts on land management. Programs and organizations focusing on agriculture and the environment are concentrated in the high potential areas close to Lake

Victoria; there are very few of these types of programs and organizations in the highland areas. Infrastructure programs and organizations are well represented across all zones of agricultural potential, while those focusing on poverty alleviation and community services are most common in the southwest highlands. Some LC1s (i.e. a group of a few villages) have no programs or organizations. Most of these LC1's are located in the eastern highlands and medium rainfall areas in the central or western part of Uganda (generally where access to roads and markets is limited).

Though most community-based organizations are focused on poverty alleviation and community services rather than agriculture and the environment, CBOs have some characteristics that suggest they might be the most effective forum for implementing agriculture and environment related initiatives. CBOs maintain high levels of organizational membership, and increased membership levels over time. CBOs are generally initiated, organized and financed at the LC1 level, or by LC1 members. Community autonomy over decision-making may be one of the major factors contributing to their success.

A case study of potential opportunities for NGOs is being conducted using bio-economic modeling in Mayuge District (Woelcke). Organizations such as the International Center for Tropical Agriculture (CIAT) and the Africa 2000 Network (A2N) are being called upon to fulfill roles that government extension agents have traditionally filled – particularly with respect to the diffusion of technologies that lead to the sustainable intensification of land. Bio-economic models combine the socioeconomic factors that influence farmer's objectives and constraints with biophysical factors that affect production possibilities and the impacts of land management practices.

Some general results emerge from a survey of two villages in Mayuge district. When considering the adoption of a mosaic resistant variety of cassava, social and personal networks seemed to be very important. Wealthier households that were not as tied in to village social networks (and also that may produce less cassava) did not have high rates of technology adoption. Market orientation and factor endowments were also central to the behavior of farmers with respect to technology adoption.

By-laws and restrictions represent another opportunity to influence land management (Nkonya et al.). By-laws and restrictions on private land – including no slash and burn, no cutting of trees, and no charcoal production – are common. The successful enforcement of by-laws and restrictions appears to be linked to who enforces the by-law or restriction; enforcement at the local level may lead to a higher degree of enforcement. However, if by-laws or restrictions are unpopular, there is a disincentive for elected officials to enforce them. The immediate needs of the community and the economic incentives associated with failing to observe by-laws and restrictions also influence how many people observe the restrictions and how well they are enforced. Secure land tenure, the presence of agriculture and environment related programs, and wealth influence household compliance with bylaws and restrictions.

Emerging development pathways and the institutions that exist to facilitate their evolution offer insights into how communities improve their livelihoods. Areas where development pathways have failed to emerge, or where institutions and governance have not led to improvements in land management face challenges for the future. Understanding the impact of land management practices provides important information regarding how successful communities can sustain their successes, and offers insight into

options for those communities struggling to discover their comparative advantage given the agricultural potential of their lands, their proximity to markets, and the pressures that growing populations place on the land.

Assessing the Impact of Land Management Practices

Data on the physical impact of various land management practices on soils in Uganda is scarce. Thus, to better understand the extent, causes and possible options for addressing soil fertility and land degradation issues, information and research on various land management practices and their impact on soils is necessary (Ssali; Kaizzi).

Although there has not been a recent comprehensive countrywide study to assess soil fertility status in Uganda, several indicators suggest that soil fertility is declining. Declines in rotations of leguminous crops and fallows, and continued low input use are likely contributing to and reducing soil fertility. Fertilizer use in particular is very low. However, after reaching very low rates of use in the early 1980s, fertilizer use is on the increase. Farm trials have demonstrated the benefits of using fertilizer – though farmer training and input market development remain key constraints to significantly increasing the amount of fertilizer used by smallholders. Farmers have clear preferences regarding desirable characteristics for natural resource and land management technologies. Simple technologies that require little labor and material inputs, and that rely on locally available resources are likely to be the most widely accepted by smallholders.

Integrated plant nutrient management is one approach that may offer considerable benefit to smallholders (Kaizzi). Combining nutrient recycling with soil conservation technologies and fertilizers is likely to improve soil fertility. The best strategy for improving soil fertility may be using some combination of organic and inorganic

fertilizers, improved crop husbandry practices, and biological nitrogen fixation. Evidence from representative sites in eastern Uganda indicates that in some areas intercropping with *Mucuna pruriens* significantly increases maize yields. However, there are significant differences among sites, and in some cases use of *mucuna* results in decreased yields in the near term. However, *mucuna* also contributes a significant amount of atmospheric nitrogen – indicating that it may be an important technology for addressing soil fertility problems over the longer term.

OVERVIEW OF DISCUSSION

Several themes emerged over the course of the two-day workshop. Most of the discussion was centered on the implications of market liberalization, commercialization, privatization, decentralization, and institutional reform for sustainable land management.

The impacts of agricultural commercialization were a recurring theme throughout the workshop. Incomes in general, along with access to consumer goods seem to be increasing in most areas of the country as a result of increased commercialization; while food security indicators are declining. This suggests a need for further study on the relationship between income and food security in the context of the Plan for the Modernization of Agriculture. Presuming that as incomes increase, food security will also increase may be an incorrect assumption. The possibility that commercialization is also contributing to soil fertility depletion was also discussed. There was general agreement that more information is needed on the impacts of commercialization on food security and soil fertility, and strategies identified to ameliorate negative impacts of the modernization policy.

Another recurring issue was the low rate of adoption for fertilizer, improved seeds, and other land management technologies, and the need for improved technical assistance programs for farmers. Uganda's very low rates of input use led to the discussion of several issues including the need for information on returns to input use; the appropriateness of privatizing Uganda's agricultural extension service; and the roles that input traders, seed multipliers, NGOs and CBOs can play in the dissemination of information on appropriate input use. In general there is a lack of information on returns to purchased inputs in Uganda. Though information is available from neighboring countries, the diversity of Uganda's soils and variation in agricultural productivity across the country make it difficult to draw general conclusions. Beyond that – farmers in areas that would benefit from increased use of various inputs need to be informed of the benefits of input use.

There was a great deal of discussion on the implications of privatizing the agricultural extension system and the options for alternative methods of service provision. The question of whether or not agricultural extension should be a public or private good was raised. Relative to other countries in East Africa, Uganda's expenditure on agricultural extension is very low (and declining). This fact combined with very low rates of input use suggest that this may not be an opportune time for the privatization of extension services.

There are, however, alternative service providers emerging. Input traders and seed multipliers have significant contact with farmers and opportunities to discuss input use. However, their ability to provide farmers with complete and unbiased information on input use is questionable. Similarly, as non-governmental organizations and community-

based organizations take over the delivery of agricultural extension and environment programs as well as programs that indirectly influence land management, there are also questions about the ability of these organizations to provide unbiased and consistent information. Furthermore, NGOs and CBOs did not adequately serve many areas of the country, particularly those far from roads and markets. The empirical findings emphasized the importance of market access in affecting farmers' land management decisions and resource and welfare outcomes; thus investments in infrastructure and market development may be a prerequisite for (or at least a complement to) more effective technical assistance.

The assumption that farmers involved with input traders, seed multipliers, and non-governmental organizations use a wider variety of inputs and greater quantities of inputs was not supported by the research findings. Lack of input adoption suggests that alternative methods of extension service delivery should be considered.

The centralized nature of land policy was discussed throughout the workshop. While the Ugandan government is using the Plan for the Modernization of Agriculture as a tool for decentralizing and privatizing institutions that deal with land management – the development of by-laws, regulations and policies affecting land management are taking place centrally. The need for a more grassroots approach to policy formulation – or at least more input from the district level in the formulation of policies - was debated. As it stands, many by-laws and regulations dictated by central government agencies are not followed at the local level. This has to do with a variety of factors including the inappropriateness of blanket policies for various regions of the country, reluctance of

elected officials to enforce unpopular regulations, and lack of information on what the rules and regulations surrounding land management are.

Emerging development pathways were discussed. Potential for banana-coffee expansion was acknowledged as a promising development pathway. However, the need to identify alternative development pathways, particularly those suitable for less-favored areas, was emphasized. There was also discussion of the finding that expansion of cereals is taking place in conjunction with increased livestock production. The development of mixed-crop livestock systems and the implications of these systems for sustainable land management in Uganda were discussed. In the context of identifying and understanding the processes behind the evolution of development pathways, several participants raised questions about the potential for incorporating the impacts of land tenure security, gender, labor productivity, peace and security, and the impact of HIV/AIDS on land management into the study. It was noted that these issues would be considered where there is a direct link to land management.

Several other issues were discussed in the context of the papers presented at the workshop including the negative impacts of rapid population growth on food security and resources in Uganda; the impact that pests and diseases have on crop productivity and food security; the lack of credit for agriculture and the impact of that on the adoption of improved technologies; the negative impact of cattle rustling on livelihoods in some areas of the country, and the need for an examination of this issue and policy recommendations that will bring some relief; and how Uganda fulfills its commitments to international agreements related to land management. The preliminary research findings presented at the policy workshop will be further explored and validated by household and plot level

survey data currently being collected. Several of the issues raised during discussion of the research findings will be investigated and may form the basis for further research in a second phase of the project.

5. THE EVOLUTION AND CHARACTERISTICS OF FARMING SYSTEMS IN UGANDA

Bernard Bashaasha
Faculty of Agriculture, Makerere University

To begin to understand the complex problems of land management and land degradation, it is necessary to provide a detailed characterization of the major farming systems in Uganda. The specific objectives of this study were to document the major changes in farming systems and the factors that have influenced the farming systems since 1985; to identify the main problems of land management in different farming systems; to assess the response of farmers, communities and policy makers to land management problems; and to hypothesize possible technological or policy approaches that can be utilized to address land management problems.

To undertake the objectives a combination of secondary and primary data were collected. Nine districts thought to be representative of most of Uganda's farming systems were selected from throughout the country. Districts were also selected on the basis of the severity of land degradation problems.

In the 1960s, the arable land in Uganda was divided into seven major farming systems. Since that classification, there have been several other classifications. The most recent classification is that of the National Environmental Management Authority (NEMA) undertaken in 1998. NEMA's classification recognizes nine different farming systems including the intensive banana-coffee lakeshore system, medium altitude intensive banana-coffee system, western banana-coffee cattle system, banana-millet-cotton system, annual cropping and cattle Teso system, annual cropping and cattle West

Nile system, annual cropping and cattle northern system, montane system, and the pastoral and some annual crops system.

There have been several major changes in farming systems in recent years. In general, traditional crops are declining or shifting into new areas. The shifting of cooking banana (*matooke*) production from central to southwest Uganda, and declining cotton production are examples of such changes. While traditional crops are declining, a wide variety of new crops are being tried. Some are being retained and others abandoned. Dairy production is expanding in some areas. New farming methods are being developed perhaps in response to new types of crops being planted, and also possibly in response to declining soil fertility. Technologies of potential benefit to soil management such as zero grazing and composting are becoming more common. Finally, off-farm or non-farm activities are becoming increasingly important sources of income for rural households. Activities such as roadside trade, providing motorcycle transport, and charcoal production are increasingly common.

Changes in farming systems since 1985 are motivated by biophysical, socio-economic, and political factors. Biophysical factors include changes in the condition and fertility of soils, climate change, and the presence of pests and disease. Socioeconomic factors hypothesized to affect changes in farming systems include price incentives and disincentives, changes in regional comparative advantage and factor markets (i.e. land and labor), non-farm labor opportunities, decreasing farm size, access to credit, the availability of infrastructure, the availability of agricultural or natural resource management technologies, and the ability and access to agricultural extension and training. Political factors such as privatization of government services, market

liberalization (particularly with respect to agricultural inputs), decentralization, land tenure, and civil strife also affect changes in farming systems. Cattle's rustling was identified as a serious and unique problem having a profound impact on farming systems in some regions of the country.

Based on information about changes in farming systems since 1986, and the biophysical, socioeconomic and political factors that have influenced that change – several key issues were identified. A process of farm level diversification and commercialization of agricultural production is taking place throughout the country, and appears to be motivated by market opportunities and soil fertility constraints. While commercialization in crops is taking place, intensification with respect to use of external inputs (both inorganic and organic) remains very limited. This may be due to credit constraints, lack of agricultural extension and training, limited availability of marketed inputs, and poor information on net returns to inputs. Diversification is likely assisting farmers with managing risk – but may be contributing to soil degradation in some areas. It is unclear whether the general trend toward commercialization is having a positive affect on food security. Though household incomes appear to be increasing, there is no guarantee that new sources of income will be used to purchase food. There are also concerns that commercialization is leading to soil nutrient mining in some areas. For example, the transport of bananas to Kampala from the western region of the country means that plant nutrients are not recycled to the soil in the region where the bananas are produced.

6. POLICIES AND INSTITUTIONS AFFECTING LAND MANAGEMENT

Charles Gashumba
Agricultural Policy Secretariat

Characterizing the policies and institutions that affect land management in Uganda is important to understanding the forces that are affecting land degradation throughout the country and possible responses to it. This study characterizes the policies and institutions affecting land management, focusing on market liberalization, decentralization, land policies (including land tenure), agricultural research and extension, credit policies, infrastructure development, and other relevant institutions and policies. The paper reviews policy and institutional changes that have taken place since the 1980s, and considers the likely effects of these changes on land management.

Information and data for this study were gathered using a variety of methods including literature reviews, interviews with relevant government and private sector institutions and officials, and a rural rapid appraisal that covered nine districts throughout the country selected to represent the main agroecological and farming systems of the country (the same districts studied by Bashaasha (this volume)).

Since the late 1980s, the general policy framework of the Ugandan government has emphasized promotion of peace and security; macroeconomic stability; liberalization of markets; privatization of many services; reform of legal institutions; decentralization of authority and responsibilities to district and local governments; and modernization of agriculture. The Law Reform Commission has been formed to review existing laws and harmonize and update them in keeping with the governmental goals of decentralization, liberalization, and privatization. Various laws and institutions have been created to

ensure the devolution of functions, powers, and services to the districts and lower levels of government under the Local Government Act of 1997.

In this study, specific sectoral and institutional policies were identified and their impacts on land management were assessed. Social policy covers the areas of population policy (for which the Population Secretariat has been established), human settlement, housing, urbanization, migration, education, employment, and labor policies. These policies affect Uganda's future demographic trends and will influence the number of poor people and how they live in the future. The National Gender Policy was developed to mainstream gender issues in the national development process, and to improve the overall socio-economic, cultural, and political conditions of Ugandan women. Sensitization is the primary policy mechanism for improving the status of women. The infrastructure sector has also been assessed. The government's medium-term policy on transportation and communication infrastructure is to promote cheaper, more efficient and reliable services to support increased agricultural, industrial, trade, tourism, social and administrative services, and growth in general. The new approach to road development (which is a program priority area for government) is to incorporate environmental and social criteria in road development plans. This takes into consideration the impact of roads on land management.

Several sectors deal with issues that affect land management, including agricultural policy, environmental policy, land policy, and energy policy. Major reforms in the agricultural sector were introduced in the areas of research, extension, input supply, credit, and commodity markets. Some of these sectors, including credit and input supply and marketing, were passed over to the private sector. With respect to environmental

policy, the National Environmental Management Authority (NEMA) was formed in 1995. The methods of environmental management are based upon principles that promote community participation in the management of natural resources and sharing the benefits of improved natural resource management. Accordingly, various committees and departments have been formed at the national and district levels to implement environmental policy according to guidelines defined by the framework of decentralization.

The Land Act of 1998 is the major land policy reform and provides for security of tenure and ownership of land. Four types of land tenure are recognized under the Act, namely customary, *mailo*, leasehold and freehold. The Act also provides for the establishment of the Uganda Land Commission, District Land Tribunals, Parish Land Committees and Sub-County Land Tribunals. The implementation of the Act has posed problems in some areas. The new institutions developed under the Act have not adequately created a fluid system that facilitates the modernization of agriculture. Issues related to spouses and dependant children with respect to the management and transfer of land are not adequately addressed in the Act, and the cost of implementing the provisions of the Land Act have exceeded available resources.

With respect to the energy sector, the overall policy of the government has been to improve the level of energy supplies at the least cost to the national economy, by promoting efficient use and conservation of energy resources. However, several problems have persisted and continue to threaten woodland and forest resources. Demand for biomass is very high and growing, with wood representing 98% of the fuel used for cooking. There has been a slow rate of adoption of more efficient technologies such as

solar cookers, there is insufficient electrical power to serve both rural and urban communities, and the expansion of rural electrification has been very slow. Further, the cost of petroleum products is high.

Having identified the key policy and institutional reforms that relate to land management, observations, conclusions, and recommendations have been made in the study. First, reforms to policies and institutions related to land are difficult to implement for a variety of reasons. Although the reforms have been designed to address land degradation concerns, they cannot be wholly implemented due to some inadvertent contradictions with the immediate needs of the people. For example, the immediate need for energy (fuelwood) cannot be met without infringing on the government's objectives of maintaining sustainable forest resources and preventing land degradation. In the context of decentralization, where policies are being implemented at the district level or below there is a need to clarify the roles of local leaders (local chiefs and political elected leaders) in implementing and enforcing policies related to land management. Another constraint identified is the lack of adequate resources to implement various activities outlined in some legislation.

The second key finding is that there is a need to put into place a legal and regulatory framework that will ensure transparency, accountability, efficiency and effectiveness in the development of policies that affect land management. Programs with a direct impact on land management should be of particular interest. Impact studies that have been conducted have not adequately focused on land management. Policies should be continuously reviewed and evaluated for their relevance both at national and local levels given the dynamic nature of social, economic, political and environmental factors.

The continual assessment of land related programs, sensitization of local communities about land management related by-laws, clear identification of roles for leaders at the district level, and the rationalization of certain issues in the Land Act should be undertaken to facilitate implementation of reforms.

7. HYPOTHESES ABOUT CAUSES OF LAND MANAGEMENT PROBLEMS AND STRATEGIES FOR IMPROVEMENT

Dick Sserunkuuma,^A John Pender^B and Ephraim Nkonya^B

^AFaculty of Agriculture, Makerere University

^BInternational Food Policy Research Institute

Land degradation is contributing to low agricultural productivity, unsustainable land use, and poverty in Uganda. Research is needed to identify the causes of land degradation (as well as improvement) and appropriate strategies to address the problem. The objectives of this paper are to review the available evidence about the extent of land degradation problems in Uganda, to develop hypotheses about the causes of such problems, and to begin to identify appropriate strategies to promote sustainable development and improved land management.

The major processes of land degradation in Uganda are soil erosion, soil nutrient mining, and deterioration of the physical properties of soil. The causes of land degradation can be divided into three categories: the proximate causes of land degradation, the underlying causes of land degradation, and the policy and institutional factors that contribute to land degradation. The proximate causes of land degradation are relatively well understood, and include natural factors such as fragile soils and climate fluctuation, as well as human-caused factors such as deforestation, overgrazing of livestock and unsustainable farming practices such as decreased fallow periods, limited application of plant nutrients (through inorganic or organic sources), and cultivation of fragile lands with limited use of soil and water conservation measures. The underlying causes of land degradation are less well understood, but are hypothesized to include the

effects of population pressure, poverty, low-input subsistence farming and associated limited commercialization, lack of infrastructure and services, lack of credit, land tenure insecurity, and lack of farmer awareness of appropriate technologies. Many policies and institutional factors may affect these underlying causal factors, including structural adjustment and market liberalization, decentralization, infrastructure development, land policies, credit policies, and research and technical assistance programs. Such factors may affect land management in very complex and site-specific ways, posing a major challenge for policy research seeking to identify policies to facilitate improved land management.

This paper proposes a conceptual framework and approach to help sort through these linkages and to identify the impacts of policies and programs on land management. The complex and site-specific nature of the factors influencing land management imply that no “one-size-fits-all” strategy is likely to be effective in promoting sustainable development in all of the diverse situations of Uganda. In order to identify effective development strategies, it is useful to consider which livelihood strategies and land management practices have comparative advantage in different types of situations. The development of different livelihood strategies in a particular location, which we call “development pathways”, is influenced by many village level factors, such as agricultural potential, access to markets, population density, and presence of government programs and organizations. These factors largely determine the comparative advantage of a location by determining the costs and risks of producing different commodities, the costs and constraints to marketing, and the opportunities and returns to alternative activities, such as farming vs. non-farm employment. Household level factors such as endowments

of physical assets, human capital, and social capital may also determine the development pathway pursued by particular households.

Hypotheses about potential development pathways in rural Uganda are identified in the paper according to factors expected to determine the comparative advantage in various development domains (defined by agricultural potential, market access and population density). Possible development strategies – i.e., the set and sequence of policies, institutions and technologies to facilitate certain development pathways and land management practices in particular development domains – are then considered.

Twenty possible development pathways have been classified. Six of these involve expanding crop production (annuals for subsistence, storable annuals for cash, perishable annuals for cash, perennials for subsistence, storable perennials for cash, and perishable perennials for cash) without significant intensification in the use of labor and other inputs. Six of these involve intensification of crop or mixed crop livestock production. One is expansion of extensive livestock production (cattle or small ruminants), while two involve intensive livestock production (dairy and other livestock – pigs, poultry, and fish farming). Two involve increased production of forestry products (high or low value). Two involved rural industry (linked or not linked to agriculture), and the final pathway is increased employment in urban areas.

The extensive crop and livestock strategies are expected to have comparative advantage mainly in low population density areas, while intensive strategies are appropriate to high-density areas. Perishable crop and livestock products must be produced close to markets, while storable crops may be produced in areas of either high or low access. Perennial crops are expected to be suited more to the bimodal rainfall

regions while longer duration annuals (such as maize) are suited to all regions except the bimodal low rainfall region (though having higher potential in the areas classified as high than those classified as medium). Forestry activities are expected to have comparative advantage mainly in low population density areas of at least medium rainfall, with low value products requiring good market access (if production is for cash purposes) while high value products may be produced in areas of either high or low access. Rural industry (whether or not linked to agriculture) will be most common in more densely populated areas close to markets and towns, while urban employment is likely common close to Kampala. More development pathways are possible in areas of high or medium agricultural potential than in areas of low potential, and in areas of high market access than in areas of low market access. Differences in population density are expected to determine mainly the labor intensity of the pathways pursued.

Generally the development strategies for areas of high potential and good market access need to focus on research and extension approaches that improve profitability and land management without reliance on overly labor-intensive methods. Improvement and maintenance of rural feeder roads, increased availability of improved seeds and livestock breeds, and development in the capacity of rural financial systems will also facilitate development in these areas. In areas of moderate potential for annuals and good market access, many of these same priorities will be important, though less emphasis should be given to perishable crops and more to storable products like cotton, cereals, pulses and oilseeds. In areas of moderate potential but poor market access (which are generally of low population density), possible priorities include investments in infrastructure (especially in roads and water sources for animals); addressing potential conflicts over

access to land, water and forests; increasing the responsibility of local governments for sustainable management of common resources; and promoting sustainable land management practices that are not highly labor intensive.

It is important to emphasize that these are only hypotheses, based upon theoretical considerations and a limited amount of empirical evidence. Furthermore, there is substantial variation within the broad types of situations discussed, and across households having access to different resource endowments. Addressing problems of poverty, low agricultural productivity and resource degradation will therefore require strategies to address the needs of poorer as well as wealthier smallholders. Nevertheless, identifying the broad strategies of development that are feasible can help to identify and recommend targeted strategies for specific situations. Making recommendations about specific strategies will require more detailed information about the costs and benefits of alternative strategies in different situations, the priorities and concerns of key stakeholders, and other factors that will determine the likely success or failure of such recommendations.

8. AGRICULTURAL INPUT MARKETING IN UGANDA

Ephraim Nkonya and Edward Kato
International Food Policy Research Institute, Kampala

Declining soil fertility in Uganda is the major issue that motivated this study. One of the primary reasons for declining soil fertility is the low use of fertilizers and other off-farm inputs. It has been estimated that smallholder farmers use less than 1 kilogram per hectare of inorganic fertilizers, with only 10% applying pesticides, and less than 10% using improved seeds. The poor input marketing system is one of the major reasons contributing to low use of external inputs throughout the country. This study analyzes input market constraints that are contributing to low rates of external input use, and identifies and analyzes input marketing opportunities in Uganda. A purposive sample of 148 input traders located in 17 districts throughout the country was selected. Input traders were divided into three major categories: importers, wholesalers, and retailers.

During the past five years there has been a marked increase in the number of agricultural input traders in Uganda. This increase may be a result of marketing reforms that the government of Uganda has been implementing since the late 1980's. Also, growing demand for improved agricultural production technologies has fueled the rapid growth of the agricultural input sector. The number of agricultural input businesses has increased, as has the availability of inputs. Consequently farmers have better access to inputs than was the case before input market liberalization. In our study we observed that more than 70% of smallholder farmers were purchasing inputs from input traders who

were within a 20 km radius of their households. However, the government Uganda Seed Project (USP) remains the largest wholesale supplier of seeds for Uganda's major crops.

The most commonly traded inputs are seeds (maize, bean and vegetable seeds), agrochemicals (pesticides and herbicides), and fertilizers. Importers are mainly involved in agrochemicals, possibly due to the active involvement of the government in seed production and marketing through the USP. In the neighboring countries of Kenya and Tanzania, seed marketing is fully liberalized. Well-known importers like Cargill Hybrid Seed, Pioneer, and others are actively involved in seed production and marketing in those countries. If the Ugandan government were to expedite the privatization of the Uganda Seed Project competitive services might be available to farmers.

The Uganda Seed Project plays a crucial role in producing and distributing the most preferred maize seed type – open pollinated varieties (OPVs) and self-pollinated seeds. Studies in Tanzania and Uganda show that private seed companies may not be interested in producing and marketing maize OPVs and self-pollinated seeds. OPVs may be recycled for more than three years without substantial yield loss. Self-pollinated seeds keep their genetic composition much longer than maize OPV's, implying that they may be recycled for a much longer time. Hence they are much less desirable to profit-motivated private seed companies. Further research is needed to determine the feasibility and profitability of producing and marketing maize OPVs and self-pollinated seeds by the informal sector. A study of the role of non-government organizations (NGOs) and community-based organizations (CBOs) in promoting the production of maize OPVs and self-pollinated seeds at the community level would be of interest.

Input trading in fertilizer is becoming increasingly common. More than half of the input traders interviewed in our study traded fertilizer. In the northern region in particular, there has been a pronounced promotion of fertilizer use by several non-governmental organizations including Sasakawa – Global 2000, Uganda's Investment in Developing Export Agriculture project (IDEA), and Appropriate Technology Uganda (AT). In part due to the efforts of these organizations, the majority of input traders in northern Uganda carry fertilizer. However, a fundamental problem in fertilizer marketing in Uganda is that more than 90% of fertilizer imports are for specialized large-scale export crop farmers. These farmers import specialized fertilizers that are expensive and in many cases not suitable for small-scale agriculture.

Our study indicates that input trading is a profitable business, especially for importers and wholesalers. For each shilling invested, the importer receives a marginal rate of return of Ush 0.20 compared to Ush 0.17 for wholesalers and 0.04 for retailers. High marginal rates of return for importers and wholesalers imply that competition among them is still low due to limited participation of large input traders. However, for retailers, low marginal rates of return imply high levels of competition.

The majority of input traders started their businesses using their own funds. Credit is limited, and credit constraints may be restricting entrepreneurs wishing to enter the input market. A number of non-government organizations (NGOs) and community-based organizations (CBOs) have been offering credit to small entrepreneurs in Uganda. This has improved credit availability in less developed regions of the country, including northern Uganda. The proportion of retailers offering loans to their customers is higher than for wholesalers and importers. This may be a result of higher social interactions

between farmers and retailers in small towns and villages. The government, in collaboration with NGOs and CBOs, may facilitate and encourage input retailers to give credit to smallholder farmers. Such efforts need to be spearheaded by NGOs, which have already been successful in administering small loans to resource poor farmers and entrepreneurs.

There has been a tremendous increase in the ownership of telephones due to private sector participation in the telecommunications industry. The advent of mobile phones, e-mail and the Internet has enormous potential to improve the efficiency of input marketing in Uganda by improving the availability of information. However, limited data collection and dissemination remain major problems in the input marketing system. Most respondents in our study get their price and other market information from regular customers, other suppliers, and other traders. Market information made available through published data and the media was available to very few respondents. Improving access to public data would allow input traders to make better-informed decisions.

Training retailers to be extension agents is an interesting opportunity that may help to reduce the current problem of poor extension services in Uganda. Over 70% of traders in our survey offered informal extension training. Informal training is common because it is relatively easy and inexpensive to conduct. Neither the trainer nor the trainee may have the time and money to get involved in formal training, which often consists of theoretical lectures, or is conducted by trainers who do not have adequate field experience. Consequently, only a few respondents offered formal training to their customers. Research needs to be conducted to assess the impartiality of input traders in offering training to farmers on input use and handling. The input traders may tend to

emphasize or exaggerate the efficacy of the products they sell, and play down the attributes of those they do not distribute.

In Uganda there is relatively little participation of private companies in producing and marketing improved seeds. This is probably partially due to presence of the government funded Uganda Seed Project (USP), which poses a barrier to entry of private seed companies. This underscores the need to speedily privatize USP to pave way for entry of new private seed companies. However, there is a potential market failure in producing and marketing maize OPV's and self-pollinated seeds by private companies. This is because the private seed dealers may not be interested in producing and marketing maize OPV's and self-pollinated seeds because of their competition with farmers' recycled seeds. This suggests a need for the government to subsidize private seed companies and/or support informal seed multipliers to produce and market OPV's and self-pollinated seeds.

In general the active promotion of fertilizer by NGOs operating in northern Uganda has had led to an increase in the number of input traders carrying fertilizer. However, fertilizers imported by large-scale farmers are generally not suitable for use on small-scale farms. This calls for a special effort by the government to encourage private input traders to import fertilizers that are suitable for small-scale agricultural production.

Our study also observed the potential for using input traders as sources of credit. A high proportion of the input traders responding to the survey reported to have offered very short-term loans to farmers. There is a need for the government to facilitate and support credit mediation institutions in order to help farmers and input traders to secure relatively longer-term credit services. Lack of market information is another problem

that calls for the government to increase its human and financial resources for market data collection and dissemination.

Finally, our study indicates that a significant amount of technical information is exchanged between traders - mainly between retailers and farmers on the topic of input use. There is need strengthen the input trader-farmer linkages as a way of complementing government and other formal extension services that are often constrained by financial and human resources.

9. PROBLEMS AND CONSTRAINTS IN THE MULTIPLICATION OF SEED AND PLANTING MATERIALS IN UGANDA:

SOME PRELIMINARY FINDINGS

Peter Gruhn and Shahidur Rashid
International Food Policy Research Institute

In this paper, we present the preliminary results of a survey of seed and planting material multiplication farmers in Uganda. It is one of four surveys that have been carried out under the project, *Policies for Improved Land Management in Uganda*, to analyze the marketing of agricultural inputs and outputs in the country. The survey focuses exclusively on multiplication farming of maize, beans, coffee, and cassava. One of the main objectives of this survey has been to identify the constraints that hinder the efficient functioning of the distribution system of modern seed varieties and other inputs. A purposive sample of 202 farmers was selected, of which 60 were involved in the multiplication of maize seed, 38 in bean multiplication, 55 in coffee tree propagation, and 49 in cassava multiplication. All maize and bean seed farmers were randomly sampled from the districts of Masindi and Kasese, where the Uganda Seed Project (USP) undertakes its seed multiplication activities. By contrast, coffee nurseries and cassava multiplication farmers were randomly selected based in part on the estimated total production of these crops in different districts, and on lists of coffee nurseries and cassava farmers provided by the Uganda Coffee Development Authorities (UCDA) and Namulonge Agricultural Research Institute (NAARI), respectively.

The majority of multiplication farmers interviewed for this study operate under some form of contractual arrangement with the USP, UCDA, the National Agricultural Research Organization (NARO), or some non-government organizations (NGOs). In

addition to selecting the best farmers, these facilitating organizations are also responsible for providing farmers with technical assistance in terms of proper input use and other farming practices. Therefore, there is a general perception that the level of agricultural extension training, access to credit, and modern input use should be significantly higher for the selected sample of multiplication farmers. However, our preliminary results do not support this. Although generalized conclusions have not been drawn, the following interesting findings come out of our analyses.

First, despite their likely better access to modern inputs, information, and extension services through or with the assistance of the facilitating organizations, multiplication farmers are found to have applied very little fertilizer or pesticides in the management of their crops. Only 24 percent of maize farmers, 31 percent of coffee farmers, two percent of bean farmers, and none of the cassava farmers reported applying fertilizer to their plots during the previous year. The proportion of farmers' applying agro-chemicals for pest management is also found to be very small, ranging usually from 3 to 8 percent. The only exception is coffee tree propagators, about 64 percent of who applied pesticides.

Second, the roles of the USP, the UCDA, and other facilitators seem to be primarily limited to the provision of improved seed and planting materials to the multiplication farmers, not a whole package of modern agricultural technologies. This finding speaks against the general perception that farmers who use improved seed are also likely to use other modern inputs (such as fertilizer and pesticides), leading to technology diffusion and ultimately better land management.

Third, although the majority of farmers received some type of extension training during the previous year, the delivery mechanism of such training seems to lack an integrated approach. Only a small fraction of the multiplication farmers, generally 15-30 percent, reported receiving specific training related to the adoption of modern varieties, the application of fertilizers and other agro-chemicals, or land and soil fertility management. While some of the farmers may have received such training previously, it does not appear to have translated into higher application of modern inputs.

Fourth, credit for modern inputs is found to be virtually non-existent. Almost 100 percent of the pesticides and other agro-chemicals used by the multiplication farmers were purchased in cash. For fertilizer, only maize farmers reported to have received about 61 percent of total use from the facilitators. Coffee and bean farmers purchased all fertilizer in cash. There may be any number of reasons why a farmer decides not to purchase inputs or sell output on credit. For instance, in addition to the lack of a local credit market, the limited use of credit may be the result of low demand for credit or high transaction costs. Additional analyses will be undertaken as part of this study to examine the ability or desire of farmers to obtain credit.

Finally, a few of the multiplication farmers reported using seed from the previous year's harvest rather than registered seed obtained from the USP. If such practices continue, the quality and reputation of USP seed could deteriorate. This could in turn affect the ability of USP seed to compete with other locally produced or imported seed, and make it more difficult to privatize USP.

These results hold important policy implications for Uganda, particularly in the context of public expenditure on agricultural extension services, which is commonly

considered to be a *public good* and a critical determinant of technology diffusion and agricultural growth. The Plan for the Modernization of Agriculture (PMA) has correctly placed heavy emphasis on reforming the country's extension services through restructuring and decentralization. However, successful implementation of this policy agenda will critically depend on the allocation of public resources to agricultural extension, which continues to be very limited in the country. According to available estimates, both actual and projected expenditure on agricultural extension fall far short of the international benchmark of one percent of agricultural GDP. Although further studies will be necessary to determine optimal allocation, the main findings of this study clearly suggest that the government needs to increase extension expenditure in order to accelerate technology diffusion and achieve desired agricultural growth.

10. EVOLVING ROLES FOR PROGRAMS AND ORGANIZATIONS: PROMOTING SUSTAINABLE LAND MANAGEMENT IN UGANDA

Pamela Jagger
International Food Policy Research Institute

The government of Uganda is currently decentralizing many of its services, including those that are directly related to agriculture and the environment. Given this shift in institutional support to rural areas, it is expected that sustainable land management will take on an increasingly important role in the agendas of non-governmental organizations (NGOs) and local communities. At the same time as government services in areas related to agriculture and land management are decreasing, land degradation in Uganda's rural areas is increasing. Whether organizations are evolving in key areas, how they are organizing themselves, and what impacts they are having with respect to improving land management and rural livelihoods are questions that policy makers should be interested in as the provision of traditional government services decreases. This objective of this paper is to characterize programs and organizations and their impacts on land management in Uganda based upon a community level survey conducted in 107 Local Councils (LC1s) (i.e. a group of a few villages) in 1999/2000.

For the purposes of this paper, programs and organizations include the range of institutions that may influence natural resource management and rural livelihoods in general. We define *programs* as institutions associated with the government of Uganda. Programs are unique in their ability to evoke the authority of the state to enforce decisions, levy taxes, and prohibit certain behaviors by implementing and enforcing laws. *Organizations* are divided into two categories, non-government organizations and

community-based organizations (CBOs). The category of NGOs includes international and indigenous non-government organizations, and religious organizations. Community based organizations are administrated, financed and managed at the local level, and are not part of a branch of a larger organization. Although NGOs and CBOs may not have the same degree of legal power as governments, they may have stronger linkages to communities allowing them to affect change.

In general NGOs are better represented than government programs or CBOs in our study of 107 LC1s. Government programs and NGOs are most common in the high potential bimodal rainfall areas (in the Lake Victoria crescent), and under represented in the southwest and eastern highland regions. NGOs and CBOs are less common in some less-favored areas including parts of the medium potential bimodal rainfall areas (covering much of central and western Uganda), and the eastern highlands. In both of these regions approximately half of the LC1s in our study had no programs or organizations. NGOs and CBOs are more common in areas with good market access and high population densities. This raises the question of whether government should provide incentives for NGOs and CBOs to operate in less-favored areas where government services may be devolving from in the near future.

Programs and organizations dealing with agriculture and the environment are concentrated in the high potential bimodal rainfall areas. In the southwest and eastern highlands where land degradation is very serious, there are relatively few programs and organizations focusing on agriculture and the environment. The unimodal (northern and eastern parts of Uganda) and medium potential bimodal rainfall areas also have very few of these types of programs. Agriculture and environment programs are more common in

areas with good market access or high population density. Infrastructure programs are well represented across all zones of agricultural potential. Programs dealing with poverty alleviation are most common in the southwest highlands and bimodal high potential areas. Programs and organizations providing community services are most common in the southwest highlands, whereas there are very few programs and organizations dealing with poverty, and none focused on community services in the eastern highlands.

Throughout the country there is a general absence of programs and organizations dealing with population pressure and access to credit – two of the major underlying causes of land degradation.

Government programs focus on three major areas: infrastructure, poverty alleviation, and agriculture and the environment. On average, government programs that operated in LC1s between 1990 and 1999 were started in 1996. The highest levels of community involvement for government programs were for those focusing on infrastructure. Programs focusing on agriculture, environment or poverty had fewer community members involved – though the number of community members in agriculture or environment programs was maintained over time. Few government programs are initiated at the LC1 level or below. Communities are expected to raise revenue for a significant portion of infrastructure-related programs. In general the impact of government agriculture and environment programs is perceived by communities to be positive in terms of land management (including crop and livestock production), average incomes, and welfare. Government programs dealing with the underlying causes of land degradation were perceived to have a small affect on agricultural production but a larger positive impact on general welfare.

The three main focus areas of NGOs are infrastructure and service development, agriculture and the environment, and poverty alleviation. Most NGOs started operating between 1995 and 1997. Though community participation was higher for NGOs focusing on infrastructure and poverty, the number of community members involved in agriculture and environment organizations remained relatively constant over time. This is an encouraging finding as suggests the potential sustainability of these organizations. Local communities are more involved in initiating NGOs than in initiating government programs. Most financing for NGOs does not come from the local community. Community involvement in decision making for NGOs is mixed – though generally communities seem to have a slightly higher degree of autonomy in decision-making for NGOs than they do for government programs. NGOs focused on agriculture and the environment, population and to a lesser degree poverty are all perceived to have a general positive impact on land management, incomes and welfare.

Community based organizations are almost exclusively focused on poverty alleviation and the provision of community services. Most CBOs have been operating for much longer than NGOs or government programs, starting in 1983 on average. Closer examination of the characteristics that allow these organizations to succeed over long time periods may have important implications for sustainable organizational development and land management. Community based organizations focused on poverty maintained levels of organization membership, while organizations focused on community services had considerably increased membership over time. The majority of CBOs are initiated, organized and financed by the LC1 officials or LC1 members. CBOs are perceived by community members to have positive impacts on average incomes and welfare.

Community autonomy in decision-making is very high for CBOs and may be one of the major factors contributing to their longevity and relative success.

As Uganda's plans for decentralization of government services move forward there are several questions policy makers might consider. The first is whether or not there should be incentives for NGOs and CBOs to locate or operate in less-favored areas. The reasons for absence of programs and organizations in the medium potential bimodal areas and the eastern highlands should be explored. For sustainable land management it will also be important for policy makers to consider those areas where very few organizations are focusing on agriculture and the environment. Areas of the country where land degradation is particularly serious might be considered as priority areas for promoting the evolution of NGOs and CBOs that deal directly with the proximate causes of land degradation. Also, the potential impacts of programs and organizations that focus on the underlying causes of land degradation (such as population pressure or lack of credit) should be further explored. Finally, whether or not the characteristics that CBOs exhibit (i.e. longevity, high and increasing rates of community member involvement, community initiation and financing, and community autonomy in decision making) can be used to promote sustainable land management should be explored. There may be enormous untapped potential to involve CBOs in promoting sustainable land management in Uganda.

11. COPING WITH THE PROBLEM OF LOW AND DECLINING AGRICULTURAL PRODUCTIVITY IN THE BANANA-COFFEE LAKESHORE SYSTEM

Dick Sserunkuuma^A, Ronnie Babigumira^B and Betty Abang^B

^AFaculty of Agriculture, Makerere University

^BInternational Food Policy Research Institute

Though in recent years Uganda's agricultural sector has grown at an average rate of four percent per annum, growth has come primarily from increased area under annual crops rather than increased productivity. In fact, the yield for many crops has stagnated or declined throughout much of the 1990s. As a result, poverty remains severe in rural areas where over 85% of Ugandans live. This paper uses the sustainable livelihoods framework to examine the changes in livelihood strategies and activities of farm households in the banana-coffee lakeshore farming system. A key question addressed is: how are rural households coping with the problem of declining agricultural productivity, as they continue to pursue higher income and improved food security? The intensive banana-coffee farming system includes 10 districts in the Lake Victoria crescent. In general, the lakeshore area is population dense, has good agricultural potential, and has favorable access to markets and infrastructure relative to other regions of Uganda. This makes the intensification of *matooke* (and other perennial crops) production a viable development pathway for the lakeshore region.

Matooke has traditionally been the staple food crop in most of the lakeshore system. However, in recent years commercial *matooke* production has been shifting from the Lake Victoria crescent (areas close to the urban market in Kampala) to southwestern

Uganda, and is being replaced by annuals such as maize. This is reportedly largely due to pest problems (especially banana weevils and nematodes) and declining soil fertility. These changes pose the threat of a downward spiral of decreasing soil fertility and perennial crop production in the Lake Victoria crescent due to the resultant increase in exposure of the soil to erosive forces. This has serious implications for poverty and food security in the region. As crop yields have stagnated or declined over the past decade, it is likely that this decline has strained the livelihoods of farm households. In reaction, households have had to make changes, including changing their livelihood strategies (for example, off-farm vs. farming activities), product mix (for example, livestock vs. crops or cash crops vs. food crops), cropping intensity, use of yield-enhancing inputs, adoption of soil and water conservation measures and other changes in farming practices.

Survey data for twelve communities in the banana-coffee lakeshore system were analyzed for changes in activities pursued by farm households during the past ten years. All twelve communities reported a decline in soil fertility, with the decline being major in eleven of these communities. However, reduced soil fertility is perceived to be secondary to the problem of diseases and pests, which was the most frequently cited reason for declining yields of major crops. In addition, eight out of the twelve communities reported an increase in the proportion of households without adequate food throughout the year. These communities ranked reduced soil fertility and unreliable weather as second most important causes of food insecurity, while pests and diseases were the most frequently cited reason. Pests and diseases were also reported as the leading cause of decreased ability to cope with drought during the past ten years in communities where this was viewed as a problem. Increased use of fertility replenishing inputs and soil conservation

practices was due to increased training and sensitization, rather than the need to improve soil fertility. This emphasizes the need for more effective extension service delivery to increase awareness of the land degradation problems.

Although a large proportion of communities reported a decline in the yields of major crops, the proportion of households continuing to grow these crops in most communities has either not changed or increased over the past 10 years. The importance attached to major crops (in terms of time allocated to their production) hasn't changed much as a result of declines in productivity.

Traditional food crops such as *matooke* continue to be important in the study region. However, the proportion of *matooke* produced that is being sold has decreased, while the proportion of maize sold has increased. Maize is increasingly becoming a commercial crop in the banana-coffee lakeshore system, while *matooke* is receding to a subsistence level. Nonetheless, *matooke* still occupies a large portion of land in the lakeshore region, even though *matooke* plantations are generally characterized by emaciated plants with low productivity. As more and more households stop depending on *matooke* for their cash needs, it is very likely that their banana plantations will continue to be poorly managed as resources are diverted to more lucrative commercial crops.

The shift from *matooke* to maize as a commercial crop may be contributing to land degradation. Maize does not provide good soil cover and thus exposes land to the forces of erosion. Further, because it is a commercial crop often "exported" to urban markets, the export of nutrients from the farm leads to nutrient mining when nutrients are not replaced through the use of external inputs. The combination of continued poor

management of banana plantations, nutrient loss associated with maize production, and nutrient export from the farm implies increased land degradation unless improved land management practices are adopted.

Other activities that seem to be gaining importance in the lakeshore region include livestock keeping and beer brewing. The reasons cited for increased livestock keeping include income generation and increased use of livestock as an asset or store of wealth. In the past, coffee plantations were the primary asset and income source held by farm households in the region. However, because of the coffee wilt disease epidemic, farmers are increasingly investing in livestock (particularly cattle) as an alternative asset. This creates an opportunity for integrating crop and livestock production to exploit the synergistic interactions between the two enterprises in order to achieve sustainable agricultural growth and natural resource use.

Beer brewing is gaining importance as an income source in the lakeshore region, largely as a result of increased production of beer banana, which performs better in areas with low soil fertility. Out of the twelve communities studied, eleven grew beer bananas and seven of these reported an increase or no change in production during the past ten years. While there is nothing wrong with increased reliance of farm households on beer brewing as an income source, the resultant increase in beer consumption in rural areas that has likely accompanied increased production may be cause for concern. It may increase poverty in rural areas, not just because of increased expenditure on beer, but more importantly, because of reduced productivity due to over consumption of beer. However, more research is needed on this issue to guide policy making.

Although the contribution of reduced soil fertility to low agricultural productivity is perceived to be secondary to that of pests and diseases, its importance is increasingly recognized, and an increasing number of farm households are beginning to take action to address the problem. Farmers are attributing this to increased training and sensitization more than anything else, which justifies the need for a stronger and more effective extension service delivery system to ensure that sufficient action is taken to reverse the trend of declining soil fertility in Uganda. The importance attached to pests and diseases as a cause of declining agricultural productivity suggests that the extension system needs to focus more on pest and disease management as well.

It has been seen that the production of *matooke* as a cash crop has greatly declined in the lakeshore region, although farmers are reluctant to replace it with other crops. The desire of farm households to continue producing *matooke* despite declining yields should be exploited to reverse the trend and take advantage of the region's access to markets in major urban areas. Given the perishable nature of *matooke*, the high cost of fuel and truck services, the long distances over which *matooke* is currently transported from western Uganda to urban markets, and the persistence of lakeshore farmers to continue producing *matooke*, it is difficult to accept the status quo, where the largest share of the *matooke* consumed in major urban markets comes from western Uganda.

Policy makers and researchers should consider supporting the revival of commercial production of *matooke* in central Uganda. The contribution of research, particularly in plant breeding to develop high-yielding, pest and disease-resistant, poor soil and drought-tolerant varieties of *matooke* is critical, and so is increased funding for such research. Maize has gained importance as a cash crop but will need to be

accompanied by increased use of external inputs and soil conservation measures to avoid further land degradation through erosion and soil nutrient mining.

12. SOIL CONSERVATION BY-LAWS: PERCEPTIONS AND ENFORCEMENT AMONG COMMUNITIES IN UGANDA

Ephraim Nkonya, Ronnie Babigumira, and Rhona Walusimbi
International Food Policy Research Institute

Regulation is one of several strategies that are available to policy makers to address land and water degradation problems. The regulation of soil and water conservation technologies involves by-laws and restrictions that regulate the activities of farmers in a given community. The main objective of this study is to identify the factors that influence the level of compliance with by-laws and restrictions related to land management. Identification of these factors will be helpful in identifying methods or policies that will increase compliance. The data from this analysis are drawn from a community level survey conducted in 107 LC1s in 1999/2000.

In Uganda, the most common by-laws and restrictions related to the management of private land are *no slash and burn*, *no cutting trees*, and *no charcoal making*. The majority of communities reported that authorities enforcing the *no slash and burn* restriction are LC1 officials and/or community members. The enforcement of by-laws and restrictions by authorities at the grassroots level may lead to higher compliance. Grassroots authorities and the participation of local people makes both responsive and responsible for the by-laws and restrictions that are put in place. Local people and authorities also have better information about the community's needs and the potential impacts of restrictions on land use. However, grassroots initiatives may fail if by-laws and restrictions are not popular. For example, elected local authorities like the LC1 chairman may fail to effectively enforce restrictions for fear of losing in the next election.

Over 64% of communities reported that the *no slash and burn* restriction is enforced fairly well with the majority complying. However, the *no cutting trees* and *no charcoal burning* restrictions are poorly enforced. This may be partially due to the fact that 96% of cooking energy is derived from woody biomass. In most regions of the country, smallholders have no alternative but to cut trees for fuelwood. Also the economic incentive to cut trees or burn charcoal is probably greater than the incentive to slash and burn land. Further, the *no cutting trees* restriction demands farmers to plant trees to replace the ones cut. In order to encourage communities to comply with this restriction, it could be useful to provide incentives to farmers to plant trees, or to tax the charcoal makers and use the tax revenue for tree nursery establishment and tree planting campaigns. Poverty alleviation is also critical as poor smallholders may have a short-term perspective, precluding them from making long-term investments in land. Our results also show that there is poor compliance with restrictions that require farmers to construct and maintain soil and water conservation (SWC) structures.

Our empirical results indicate that the major factors influencing level of compliance with by-laws and restrictions related to land management are land tenure, presence of agriculture and environmental-related programs, and wealth status (as indicated by proportion of households with metal roof). Households owning land under customary land tenure are more likely to comply with by-laws and restrictions than those owning land under freehold. Recent empirical studies have shown that customary land tenure systems are flexible, equitable and more secure. Under customary tenure, land is required to remain in the hands of the family or lineage. The transition of land ownership from one generation to another is 'smooth' and stable, giving owners a sense of security

and attachment to the land. It is also possible that landholders under customary tenure accept the principle of restricted land use rights more readily since this is a long-established principle. As such, landholders under this system are more likely to comply with bylaws that may eventually increase the sustainability of the land.

To offer the same feeling of security under the freehold system (in which titles are issued), titles are required to be enforceable and supported by an adequate legal system. If the formal land code is ambiguous in its definition of rights, or the government lacks the will or the means to enforce those rights, landholders may not perceive greater security with land title. Further, the Land Act of 1998 fails to address ambiguity in the enforcement of land rights. Estimates of the cost for implementation of the Land Act of 1998 suggest that they may be unaffordable. The Land Act assumes that there is sufficient manpower in the land tribunals to handle land disputes, but this is not true. There is a general sense of ambiguity and a lack of resources for enforcing rights. This may lead to tenure insecurity under the freehold and leasehold tenure systems. This may act as a disincentive to sustainably manage land as well as to comply with regulations.

As expected, the presence of agriculture or environment related programs in the community increased the level of compliance. This implies that programs probably increase awareness about the adverse effects of land degradation and possible responses to it. The presence of wealthier households is also associated with a higher level of compliance. This suggests that the government's efforts to reduce poverty may increase the level of compliance in the long run.

Our research points to several policy issues. First, there is a need to investigate tax collection methods from charcoal makers and those who harvest woody biomass from

community and public lands. The revenue obtained from such taxes could be used to establish community tree nurseries and other reforestation efforts. Second, there is a need to review the Land Act of 1998 with the aim of increasing the security and stability of existing land tenure systems. Existing institutions are in some cases inadequate for enforcement of the Act. Third, the presence of programs and organizations dealing with agriculture and the environment in a community is found to increase compliance to restrictions on land use. Thus, the government should consider creating more conducive institutional and economic environments to encourage and foster such programs and organizations. Finally, our study suggests that the government's poverty alleviation policies are likely to increase compliance to soil conservation-related restrictions. This is an additional justification for the government to increase its efforts in this area.

13. DEVELOPMENT PATHWAYS AND LAND MANAGEMENT IN UGANDA: CAUSES AND IMPLICATIONS

John Pender^A, Pamela Jagger^A, Ephraim Nkonya^A and Dick Sserunkuuma^B

^AInternational Food Policy Research Institute

^BMakerere University

This study investigates the development pathways, changes in land use and land management practices occurring in Uganda since 1990, their causes and implications; based upon a community level survey conducted in 107 LC1's and villages.

Development pathways are defined as common patterns of change in livelihood strategies. The concept is similar to the concepts of farming systems or livelihood strategies, but is more general than farming systems in that it incorporates non-farm activities, and unlike livelihood strategies is dynamic since it refers to changes in livelihood strategies over time.

The general picture of development in Uganda between 1990 and 1999 is of increasing specialization and commercialization of economic activities based upon differences in local comparative advantages. This development pattern is associated with changes in land use, including expansion of cultivated area, settlements, and woodlots; and declining use of land for fallow, grazing land, forest, and wetlands. Ownership of cattle has increased but use of most other livestock has declined. Use of purchased inputs has increased, though use is still low by international standards (especially of fertilizer). Adoption of some soil and water conservation practices has increased, though rates of use are still generally low. Despite increased adoption of inputs and some conservation practices, crop yields and natural resource conditions are perceived to have degraded

throughout most of Uganda. At the same time, many aspects of human welfare have improved, stimulated by improved access to roads, transportation, health, education and other services; various government and non-government programs; and other factors. Nevertheless, food security appears to be worsening in many areas. The rate of population growth is very high and may be one of the main underlying causes of land degradation and food insecurity in Uganda.

There have been many changes in livelihood strategies in different parts of Uganda. Cereal crop production is increasing in importance, especially in bimodal low and medium rainfall areas (in the western and central parts of the country) and in the eastern highlands. Production of horticultural crops is also increasing in importance in some parts of these zones. Production of other storable annual crops such as pulses and oilseeds has increased, especially in the southwest highlands and the bimodal low rainfall areas. Banana production has increased in the bimodal high rainfall areas (in the Lake Victoria crescent), and to a lesser extent in the southwest highlands and bimodal low rainfall areas. Both banana and coffee production have declined in importance in the bimodal medium rainfall areas, while coffee production is more stable in other areas. Cattle production has increased in several zones, especially the eastern highlands and the bimodal medium and high rainfall zones. Ownership of crossbred cattle has increased, especially in areas having better market access and higher population density in the bimodal high rainfall zone and the eastern highlands, indicating development of dairy production in these areas. Trading and other non-farm employment activities have become more important, particularly in the southwest highlands, the northern unimodal rainfall areas, and areas of high population density and good access to urban centers.

With respect to land management there have been increases in purchased input use and the adoption of some soil and water conservation technologies. High market access areas are benefiting from privatization and market liberalization that make inputs easier to obtain. However, use of most purchased inputs, particularly fertilizer, is still low, and average yields are reported to be stagnant or declining in most places. Declining soil fertility, soil erosion and other aspects of land degradation are perceived to be worsening problems in most of the country, but these problems are particularly severe in the high potential bimodal rainfall areas and in the eastern highlands. The proportion of households adopting new soil and water conservation technologies is generally low, and suggests the need for programs and organizations to provide extension support that might act as a catalyst for the adoption of these technologies.

Improved access to roads, transportation, health, education, water and other services are contributing to perceived improvements in many welfare indicators. Nevertheless, poverty remains severe in much of rural Uganda, and food security is perceived to be worsening in many areas. The impacts of market liberalization, privatization, decentralization and other aspects of the modernization strategy thus appear to be generally positive for welfare of people in rural Uganda, though significant problems still remain to be adequately addressed; particularly land degradation and increasing food insecurity.

We have investigated the development pathways and changes in land use and land management occurring in Uganda, their determinants and implications for agricultural productivity, natural resource conditions and human welfare using factor analysis and

econometric analysis. We have identified several key tentative findings (subject to verification through analysis of ongoing household and plot surveys in the region).

Six dominant development pathways emerged, including expansion of cereals production, expansion of banana-coffee production, non-farm development, expansion of horticulture, expansion of cotton, and stable coffee production. Of these pathways, expansion of banana and coffee was most strongly associated with adoption of soil and water conservation practices, improvements in resource conditions, agricultural productivity (at least of bananas) and human welfare. Promotion of this pathway may be a potential “win-win-win” development strategy, benefiting the environment while contributing to economic growth and poverty reduction. This pathway is not suited to all parts of Uganda, however, and has been developing most in the bimodal low and high rainfall zones. One factor associated with this development pathway is increasing access to rural markets, suggesting that continued development of rural markets will be an important component of achieving such a “win-win-win” development strategy.

Road development, and associated development of transportation and other services, appears to be a critical factor contributing to improvements in many natural resource conditions (except forest and woodland availability) and human welfare indicators. In areas where natural forests and woodland are still important, there may be tradeoffs between welfare and environmental objectives in pursuing road development. In other areas, road development can be a “win-win-win” strategy.

Irrigation appears to reduce pressure to expand cultivated area at the expense of forest, wetlands and fallow strips; contributes to fertilizer adoption; and is associated with improvement in several resource and welfare indicators. However, irrigation is also

associated with less improvement in some welfare indicators, though this may be because irrigated areas were better off initially in terms of these indicators. Further research is needed on these issues, but there appears to be potential to improve both resource and welfare conditions through appropriate investments in irrigation.

Government and non-governmental programs and organizations appear to have contributed to improvements in many productivity, resource and welfare conditions; such as increased (or less decline in) yields of cassava and sweet potatoes, reduced soil erosion, increased quality of forests and grazing land, increased quality of housing and drinking water, improvement in child nutrition and reduction in infant mortality. However such programs are also associated with some negative outcomes, such as declining yields of some crops (millet and bananas), and declining availability of energy sources. It may be that by promoting development of some crops such programs cause farmers to devote less effort to the management of other crops, leading to some trade-offs in impacts on productivity. The environmental focus of many programs and organizations may be reducing the availability of energy sources (for example, by discouraging charcoal production or tree cutting), reflecting a trade-off between environmental and welfare objectives.

It should be emphasized that these results are based upon rough and qualitative measures of impacts as well as fairly crude measures of some of the causal factors (such as the number of organizations of each type). Further research using household level data is needed to validate these findings and to enable greater confidence in the explanations for the changes and impacts reported here.

14. MODELING PROGRAM-INDUCED DEVELOPMENT PATHWAYS: A CASE STUDY FOR EASTERN UGANDA

Johannes Woelcke
University of Bonn, Center for Development Research

The process of market liberalization and decentralization presents an opportunity for non-government organizations (NGOs) to reinforce their influence on the livelihood strategies of farm households in Uganda. In the recent past farm households have increasingly had to cope with the interrelated problems of land degradation, poverty, and food insecurity. Different organizations are promoting various types of technologies to overcome these problems and to contribute to the sustainable intensification of land.

Two villages in Mayuge District, Uganda (formerly Iganga District), which represent the intensive banana-coffee lakeshore system, were selected to illustrate the impact of NGOs on the social well-being and livelihood strategies of smallholder households. The villages fall within a development domain having high population density, high market access and high agricultural potential. The predominant NGOs in these villages are the International Center for Tropical Agriculture (CIAT) and the Africa 2000 Network (A2N). Both organizations have the primary objective of encouraging the adoption and diffusion of soil productivity enhancing technologies, including the use of inorganic fertilizers, organic fertilizers and soil and water conservation technologies.

The objectives of this study are to identify constraints affecting the adoption of new technologies, e.g. land and capital constraints; to identify “overlap technologies” or those technologies that simultaneously achieve economic and ecological goals; to illustrate/predict the diffusion processes of new technologies; and to identify policy interventions that could contribute to more productive and sustainable land management.

Recently, a new type of computer simulation model appropriate for addressing the research objectives cited above, the bio-economic model, has become increasingly popular. Bio-economic models combine the socio-economic factors influencing farmers' objectives and constraints with biophysical factors affecting production possibilities and the impacts of land management practices. Though this approach is still in its infancy, initial results are promising.

Conventional simulation models based on mathematical programming largely neglect feedback effects between land management practices and biophysical processes. A bio-economic model, based on a multi-agent approach, can help to overcome these weaknesses. Recursive mathematical programming models for each actor represent the individual choice of a farm household among available land and water use, consumption, investment and marketing alternatives. Inter-household linkages such as informal labor markets and communication concerning technical innovations can be captured explicitly.

In order to collect the socioeconomic data needed to develop and calibrate the bioeconomic model, two different household surveys were carried out in the study villages in Mayuge district. The main objective of the first survey was to identify representative household types with the help of principal component analysis and cluster analysis. During the second survey, representative households of each type were interviewed in detail in order to gather sufficient information to be able to calculate the technical coefficients needed for the mathematical programming approach. The sampling strategy was developed to fulfill the specific data requirement of a bio-economic multi-agent approach.

Preliminary results allow for the identification of four different groups of households: semi-subsistence farm households, subsistence farm households, commercial farm households, and innovative farm households. The main differences between the identified clusters fall into four categories: household characteristics, household assets, crop production and innovativeness. With respect to household characteristics, the highest average number of years of schooling of the household head (an indicator for human capital) was found for the commercial farm households. The group of commercial farm households also has the highest average value of household assets, followed by the group of innovative farm households.

Similar qualitative findings are observed for total value of agricultural production and value of agricultural production per acre of cultivated land. If we compare the group of semi-subsistence farm households with subsistence farm households we find that total value of agricultural production is much higher for the former, but the value of agricultural production per acre of cultivated land is nearly the same for both groups. High labor to land ratios were observed for innovative farm trial households. This could be due to the fact that some new technologies are very labor-intensive. This hypothesis will be verified in the subsequent data analysis.

Innovativeness is very important in the context of diffusion of technologies. Data were collected regarding the time of adoption of a mosaic resistant cassava variety and were compared to the social and personal network of the household. Survey results indicate that innovative farm households belong to the early adopters in the social network and have low thresholds in their personal network. Interestingly, commercial farm households are late adopters. One explanation may be that wealthier households are

not well integrated into the social system of the villages and therefore are excluded from the exchange of information and experiences about new technologies. Another explanation could be that the technology chosen for the diffusion study (a mosaic-resistant variety of cassava) is not relevant for commercial farm households since cassava is more commonly a staple food crop rather than a cash crop.

Further data analysis confirmed the importance of social and personal networks for the diffusion of innovations. Survey households stated that after NGOs like CIAT and A2N, peers, friends and relatives are the most important sources of information about new technologies. Moreover, the interviewed households mentioned that insufficient awareness is the main reason for the non-adoption of new technologies. This statement emphasizes that the dissemination of knowledge and experiences is important for the adoption of new technologies.

The preliminary results of this study need further clarification but they seem to support the hypotheses that social and personal networks, market orientation and factor endowments are central aspects to understanding and modeling the behavior and livelihood strategies of farm households in eastern Uganda. The next step in the study will be the development and calibration of bioeconomic multi-agent models. The bioeconomic multi-agent approach is most appropriate for this study because interactions between individuals can be captured explicitly, and simulations can predict the short to long run impact of promoted technologies and policy interventions on household welfare and the condition of natural resources.

15. SOIL POTENTIALS AND CONSTRAINTS IN UGANDA

Henry Ssali

Kawanda Agricultural Research Institute
National Research Organization (NARO)

The soil reconnaissance survey that was conducted in the late 1950s indicated 138 soil mapping units using a local classification based on morphological characteristics (for example, color, texture, parent material and depth), and related to landscape features that can be easily identified in the field. The units were recently translated into 20 groups based on the FAO-UNESCO Soil Map of the world legend.

The results of these mapping exercises indicate that the majority of Uganda's soils are highly weathered with few mineral reserves. In general soil nutrients are found mainly in the top 30 centimeters of the soil and hence are susceptible to loss through erosion. Soil erosion is most likely to occur in the northeast region of Karamoja and in areas with steep slopes. In terms of soil productivity, soils with productivity ratings of better than medium cover only about 11% of the country.

The level of organic matter in soils is a good indicator of soil fertility. In general, soil organic matter, soil nutrients, and soil pH deteriorate during cultivation. Traditionally soils were cultivated until crop yields deteriorated to unacceptable levels. The "tired" pieces of land were then fallowed or rested to restore fertility. Soil mapping indicates that soil organic matter is high in heavier soils and low in lighter soils (for example, those soils around Lake Kyoga). Responses to fertilizer application were rare where soil organic matter content was greater than 3.5% - suggesting that fertilizer application may not be an appropriate solution for soils with high levels of soil organic matter. Proper soil

management requires conserving the top layers of the soil where the organic matter is found.

Studies conducted throughout the country have helped to develop recommendations for good management of soils. Using cropping systems that included a fallow period of about three years following three years of continuous cropping has been suggested. In addition, weedy fallows or improved fallows (for example, elephant grass or herbaceous/woody species such as *Crotalaria* and *Sesbania*) help to improve soil physical properties and recycle leached nutrients. Rotating crops during the cropping period is also recommended. In particular rotating cereals and legumes to exploit the nitrogen fixing capacity of legumes, and alternating shallow and deep-rooted plants to tap nutrients may enhance soil fertility. The application of inorganic and organic inputs (alone or in combination) to increase yields and lengthen the cropping period is also likely to enhance soil fertility. Better management of organic inputs will also lead to improved soil fertility. Improving the value of manure through better collection and storage, incorporating grass bedding to reduce nitrogen losses, and covering manure during storage to reduce losses through volatilization and minimize leaching by rain are suggestions of how organic fertilizer can be improved. Finally, the use of soil and water conservation technologies (for example, contour bands, trashlines, mulch, and cover crops such as *Mucuna*), to improve the ability of soils to benefit from rainfall, and prevent loss of nutrients and soil organic matter through erosion can lead to improved soil conditions.

There has been no recent systematic countrywide study to assess soil fertility status in the country. However, there are several indirect indicators pointing to declining

soil fertility status. These include decreased use of rotations that include leguminous crops, reduced fallowing due to population pressure, urbanization led increases in nutrient mining from farms due to increased exports from rural areas to urban centers, and continued low levels of input use. Estimates indicate that in high rainfall areas (58% of Uganda's total arable area), there are negative annual total nutrient balances for major nutrients. Higher depletion rates may be found in high population areas.

Although research indicates the benefits of organic and inorganic inputs, few farmers are using them. Nutrient balance studies indicate that banana fields and other fields close to homesteads have a positive nutrient balance, while fields further away from homesteads and annual crop fields have a negative balance. Often there is no deliberate effort to distribute crop residues available closer to the homestead, indicating that sensitization is a major constraint.

There are a number of non-government organizations (NGOs) promoting the use of organic residues (biomass transfers), composts, and farmyard manure to increase soil productivity. However the areas covered by NGOs and their capacity to reach a significant number of farmers is limited. Further, farmers are constrained by the availability of labor and organic materials.

Fertilizer use in the country is very low, estimated at 1 kg/ha of arable land. Fertilizer is primarily used on cash crops including sugarcane, tea and other high value crops such as flowers. Smallholders use fertilizer mainly on tobacco, vegetables in peri-urban areas, and in a few cases on cotton and coffee. Lack of availability and the high cost of fertilizer contribute to its limited use by smallholders.

Fertilizer use has fluctuated over the past thirty years. Total fertilizer use peaked shortly after Uganda gained independence in 1971-1972 at 37,000 MT countrywide. In the 1980s fertilizer use dropped to virtually nothing in the wake of years of insecurity. After liberalization of fertilizer markets in the early 1990s fertilizer use gradually increased, reaching an estimated 18,500 metric tons in 2000 (only 27% of this was used by smallholders).

Although the downward fertilizer use trend has been reversed, use is still far below the levels observed in 1971-1972, and the fertilizer sector is still developing. Fertilizer availability is increasing, though there is still confusion among many farmers, dealers and stockists as to what type of fertilizer should be used on what crop, how much should be applied, and when it should be applied.

Maize trials demonstrate that the use of inputs can lead to increased yields, and how fertilizer liberalization policies are helping to increase the use of fertilizers by smallholders. In 1998, fertilizer use was still very low and fertilizer prices relatively high compared to other countries in sub-Saharan Africa. Benefit-cost ratios for maize plots with nitrogen (N) and phosphorus (P) applied to them averaged approximately 1.7 (where 1.0 is the point at which benefits exceed costs), and N and P fertilizer application doubled average maize yields from 2400 to 4800 kg/ha. However, the Food and Agriculture Organization of the United Nations suggests that farmers are not likely to adopt fertilizer if the benefit-cost ratio is below 2.0. The average yield without fertilizer (over 2 T/ha) indicates that soils are still productive while the yield with fertilizer indicates what can be achieved.

Data collected from similar trials in 2000 indicates benefit-cost ratios of over 2.0. In addition to increases in the amount of fertilizer available (largely due to increases in dealers and stockists throughout the country), liberalization has driven fertilizer prices down. By the end of 2000, fertilizer prices were comparable to prices in Kenya after adjustments for additional transport costs. However, the total amount of fertilizer coming into the country is still relatively low and restricts fertilizer delivery and distribution throughout the country. Uganda remains an extension of the Kenya fertilizer market.

In a recent survey smallholder farmers indicated preferences for technologies that promote sustainable land management. The preferred technologies are simple, require little labor, are inexpensive, and rely on locally available resources. Technologies that require the purchase of inputs or are very labor intensive were rated as average. Longer-term investments (i.e. those that have few or no immediate benefits) such as improved fallows and agroforestry were ranked very low. Farmer's perceive their main constraints to be labor, cash and awareness/training. The goal of food security may not be enough to motivate farmers to invest in sustainable land management technologies. Better access to markets may help ensure better returns to inputs (including labor) and encourage use of inputs and proper land husbandry.

More broadly, there is a need to sensitize farmers and decision makers about the long-term benefits of sustainable land management and develop appropriate policies for land management. While liberalization of fertilizer markets has helped to increase the availability of fertilizers, the fertilizer sector should be assisted (through training of farmers, dealers and stockists) to develop at a faster pace.

16. STRATEGIES FOR SOIL FERTILITY REPLENISHMENT – THE POTENTIAL OF VELVET BEAN (*MUCUNA PRURIENS*) AND AZOLLA AS COMPARED TO INORGANIC FERTILIZERS FOR IMPROVING MAIZE AND RICE PRODUCTIVITY

Crammer Kayuki Kaizzi
Center for Development Research (ZEF), University of Bonn

Soil fertility depletion, cultivation of marginal lands, continuous cropping, poor soil and crop management practices, the export of produce to urban areas (nutrient mining), and government policies that fail to help smallholder farmers are causing declines in agricultural productivity in Uganda. Traditional low-input farming systems are no longer capable of maintaining or restoring soil fertility. Furthermore, smallholder farmers lack financial resources to purchase sufficient fertilizers. Yet restoring soil nitrogen (N) and phosphorus (P) are major priorities not only for sustained productivity but also for the rehabilitation of eroded and damaged soils. Improving soil fertility and land management is necessary for the modernization of agriculture, for poverty alleviation, and for general food security among smallholders.

There is little option but to use purchased fertilizers to balance losses of phosphorus and potassium (K) from soils. However nitrogen can be supplied through the process of biological nitrogen fixation (BNF), as well as by organic and inorganic fertilizers.

The problem of declining soil fertility can be addressed through an integrated nutrient management (INM) approach, which involves the efficient use of available resources. INM requires combining nutrient recycling and soil conservation to retain resources within the cropping system, together with the judicious and efficient use of fertilizers. Perhaps the best strategy for improving soil fertility involves the use of both

organic and inorganic fertilizers, improved crop husbandry practices, exploitation of biological nitrogen fixation, and use of soil and water conservation technologies where appropriate.

The objectives of this study are:

- To determine *mucuna* biomass production and nitrogen accumulation (alone and when intercropped with maize) in soils of contrasting production potential;
- To assess nitrogen distribution in different soil organic matter fractions following the application of *Mucuna pruriens* residues;
- To evaluate maize growth, yield and nitrogen uptake in response to the application of *Mucuna pruriens* residues under soils of contrasting production potential;
- To evaluate rice growth, yield and nitrogen uptake in response to the application of *Azolla* and *Mucuna pruriens* under soils of contrasting production potential;
- To determine the utilisation efficiency of nitrogen derived from *Mucuna pruriens* as compared to inorganic fertilizers;
- To calculate the system nitrogen balance following the application of *Mucuna pruriens* and *Azolla*;
- To determine the benefits and costs of using *Mucuna pruriens* and *Azolla* residues in soil fertility management under soils of contrasting production potential as compared to inorganic fertilizers; and
- To determine biological nitrogen fixation by *mucuna* on soils of contrasting production potential.

The research is being conducted at eight sites in six districts of eastern Uganda.

The sites are located on different soil mapping units, parent materials, on soils of varying productivity ratings, and different altitudes. Two types of trials were set up, farmer managed on-farm trials with twenty randomly selected farmers in each site; and researcher-managed trials set up at two government farms.

All sites/farmer fields were characterized by analyzing soil samples collected from 0-20 cm depth, for pH, organic matter, extractable phosphorus (P), potassium (K), Calcium (Ca), and texture using routine methods at the Kawanda Agricultural Research Institute soils and plant tissue analytical laboratory. Results from routine analysis of the soil indicated that a considerable percentage of farmers had fields with analytical values below the critical low level. It was decided that the plots be split into two, with one-half receiving potassium (K) and phosphorus (P) in addition to nitrogen (N). The other half of each plot received only nitrogen (N).

Maize (grain and stover) yield obtained for the different treatments varied among farmer-managed trials. Maize yields were significantly decreased by intercropping with *mucuna* in Bulegeni, but not in Kibale. This is attributed to differences in soil productivity as determined by different soil physicochemical characteristics. The amount of *mucuna* biomass (dry matter) produced for the farmer-managed sites/on-farm trials also indicates significant differences among sites.

The quantity of atmospheric nitrogen fixed by *mucuna* at the two researcher managed sites determined by using ^{15}N Isotope dilution techniques was found to be 42.5% and 41% of the total nitrogen in *mucuna* at Bulegeni and Kibale respectively. Considering average *mucuna* yield at the different sites and the average N content of 2.5%, the estimated amount of nitrogen added to the system ranges from approximately 28 kg/hectare in Kongta to 125 kg/hectare in Bulegeni. Considering low input smallholder agriculture, *mucuna* has the potential to contribute a significant amount of atmospheric nitrogen. This may significantly reduce negative nitrogen balances in various agro-ecosystems.

The effect of Azolla, inorganic fertilizers and their combination on the rice yield (grain & straw) at the Lubembe/Doho Rice Scheme is significant.

17. STRATIFICATION AND RESOURCE MAPPING METHODOLOGY FOR COMMUNITY BASED ANALYSIS OF SOIL DEGRADATION IN UGANDA

G. Rücker^A, H. Ssali^B, S. Park^A, J. Pender^C

^ACenter for Development Research (ZEF), Germany

^BKawanda Agricultural Research Institute (KARI), Uganda

^CInternational Food Policy Research Institute

Soil degradation problems, such as erosion and nutrient depletion are of growing concern in Uganda. Due to the spatial complexity of factors influencing agricultural production including variability of soils, topography, rainfall, population density and market conditions, it is difficult for policy-makers to assess soil degradation problems and target strategies for improved land management in specific areas. To allow researchers and policy makers to identify and understand soil degradation problems, geographic information systems (GIS), spatial statistics and community resource mapping can be integrated and used for analyzing data sets at large scale and of high spatial complexity.

Using agricultural data sets already available in digital format - spatial domains, which comprise combinations of variables that impact soil degradation, can be generated for a large region in a fast and cost-effective way. Examples of spatial domains are agricultural potential, population density and market access. Spatial correlation of domains can be used to stratify and classify complex agricultural regions such as Uganda. For example, a region of the country may have high agricultural potential but low population density and poor market access. The stratification can guide researchers and policy-makers in formulating hypotheses about possible combinations of factors that may have an impact on soil degradation.

Community surveys within each stratum are necessary to collect information about the site-specific variation of factors that determine soil degradation from one community to the next, e.g. variability in soil conditions or land management. Geo-referenced and participatory mapping of community resources, combined with soil sampling and semi-structured interviewing of farmers on land management and soil degradation problems provides GIS data at the community level which is nested to the stratification data for soil degradation assessment of regions.

The stratification and resource mapping strategy described above was applied to Uganda and implemented in the project on Policies for Improved Land Management. The correlation of spatial domains resulted in 20 different strata comprising different combinations of agro-climatic potential, population density, market access and elevation. Within the stratified project region, 108 communities were randomly selected. Participatory community surveys were carried out, including geo-referenced mapping of resources and soil degradation combined with the recording of farmers' socio-economic conditions. From each community, 10 topsoil samples were collected during transect walks and respective global positioning systems (GPS) coordinates were collected. GIS maps on changes in land use and land management as well as maps showing soil degradation problems were generated from each community. Information about land use, land management and soil degradation was linked to the GIS maps. Soil samples were analyzed for texture, pH, organic matter and bases. Spatial statistics and spatial modeling will be applied to assess land quality and factors determining soil degradation under different environmental and socio-economic settings, to target policies for improved land management to the specific problems of regions in Uganda.

APPENDIX A: WORKSHOP AGENDA

POLICIES FOR IMPROVED LAND MANAGEMENT IN UGANDA

International Food Policy Research Institute (IFPRI)
Makerere University Faculty of Agriculture (MUFA)
National Agricultural Research Organization (NARO)
Agricultural Policy Secretariat (APSEC)
Center for Development Research, University of Bonn (ZEF)

Hotel Africana, Kampala, June 25 and 27, 2001

OBJECTIVES

1. To familiarize policy makers and other stakeholders in Uganda with the objectives and activities of the project.
2. To review the preliminary findings of the research so far, and obtain feedback from stakeholders on these findings.
3. To consider key policy issues affecting the prospects for improved land management in Uganda.



AGENDA

Monday, June 25, 2001

Session 1: Opening

Chairperson: Dr. Fred Opiyo, 2020 Coordinator of the Network for East Africa, IFPRI
Rapporteur: Pamela Jagger, IFPRI

- 9:00 Welcome and introduction.....*Dr. Sam Kyamanywa, Makerere University*
 9:15 Opening of the workshop.....*Honorable Fabius Byaruhanga, MAAIF*
 9:30 Policies for improved land management in Uganda: Project objectives, activities,
 and organization..... *John Pender, IFPRI*
 9:45 Questions/clarifications

Session 2: Characterization of Land Management Problems in Uganda

Chairperson: Dr. Fred Opiyo, 2020 Coordinator of the Network for East Africa, IFPRI
Rapporteur: Pamela Jagger, IFPRI

- 10:00 The evolution and characteristics of farming systems in Uganda.....
 *Bernard Bashaasha, MUFA*
 10:20 Questions/discussion
 10:30 Coffee/tea break and photograph
 11:00 Policies and institutions affecting land management...*Charles Gashumba, APSEC*
 11:20 Questions/discussion
 11:30 Hypotheses about causes of land management problems and strategies for
 improvement.....*Dick Sserunkuuma, MUFA and John Pender, IFPRI*
 11:50 Questions/discussion of morning session
 12:15 Lunch

Session 3: Development of Input Markets

Chairperson: Mr. Charles Gashumba, APSEC

Rapporteur: Pamela Jagger, IFPRI

- 13:30 Agricultural input marketing in Uganda.....*Ephraim Nkonya, IFPRI*
 13:50 Questions/discussion
 14:00 Problems and constraints in the multiplication of seed and planting materials in
 Uganda: Some preliminary findings..... *Shahidur Rashid, IFPRI*
 14:20 Questions/discussion
 14:30 Coffee/tea break

Session 4: Development Pathways and Land Management

Chairperson: Mr. Charles Gashumba, APSEC

Rapporteur: Rhona Walusimbi, IFRPRI, Kampala

- 15:00 Evolving roles for programs and organizations: Promoting sustainable land
 management in Uganda.....*Pamela Jagger, IFPRI*
 15:20 Questions/discussion
 15:30 Coping with the problem of low and declining agricultural productivity in the
 banana-coffee lakeshore system.....*Dick Sserunkuuma, MUFA*
 15:50 Questions/discussion
 16:00 Soil conservation by-laws: perceptions and enforcement among communities in
 Uganda.....*Ephraim Nkonya, IFPRI*
 16:20 Questions/discussion
 16:30 General discussion
 17:00 Close
 17:15 Reception

Wednesday, June 27, 2001

Session 4: Development Pathways and Land Management (continued)

Chairperson: Dr. Julius Zake, MUFA

Rapporteur: Pamela Jagger, IFPRI

- 9:00 Development pathways and their relationship to land management in Uganda:
Causes and implications.....*John Pender, IFPRI*
- 9:30 Questions/discussion
- 9:45 Modeling program-induced development pathways: A case study for eastern
Uganda..... *Johannes Woelke, ZEF*
- 10:05 Questions/discussion
- 10:15 Coffee/tea break

Session 5: Assessing Impacts of Land Management Practices

Session Chair: Dr. Julius Zake, MUFA

Rapporteur: Pamela Jagger, IFPRI

- 10:45 Soil potentials and constraints in Uganda..... *Henri Ssali, NARO*
- 11:05 Questions/discussion
- 11:15 Strategies for soil fertility replenishment – The potential of velvet bean (*Mucuna pruriens*) and Azolla as compared to inorganic fertilizers for improving maize and rice productivity.....*C.K. Kaizzi, ZEF*
- 11:35 Questions/discussion
- 11:45 Stratification and resource mapping methodology for community-based analysis of soil degradation in Uganda.....*Gerd Ruecker, ZEF*
- 12:05 Questions/discussion
- 12:15 General discussion
- 12:45 Close
- 13:00 Lunch

APPENDIX B: LIST OF PARTICIPANTS

Ms. Betty ABANG
IFPRI
Plot 4, Pilkington Road Collin House
KAMPALA
Email: enkonya@africaonline.co.ug

Ms. Evelyne APILI
IFPRI
Plot 4, Pilkington Road Collin House
KAMPALA
Email:
2020network@africaonline.co.ug

Mr. Ronnie BABIGUMIRA
IFPRI
Plot 4, Pilkington Road Collin House
P. O. Box 28565
KAMPALA
Email: enkonya@africaonline.co.ug

Professor Bernard BASHASHA
Makerere University
P. O. Box 7062
KAMPALA

Dr. Simon BOLWIG
IFPRI
Plot 4, Pilkington Road Collin House
KAMPALA
Email: s.bolwig@cgiar.org

Dr. Peter BRINN
Natural Resource Institute
Medway University Campus
Central Avenue, Chatham Maritime
Kent ME4 4TB
United Kingdom
Email: P.J.Brinn@gre.ac.uk

Hon. Dr. Fabius BYARUHANGA
MAAIF
P.O. Box 102
ENTEBBE
Ms. Hanne CARIS
Danish Embassy
KAMPALA

Dr. Sonia DAVID
CIAT
P.O. Box 6247
KAMPALA
Email: ciat-uganda@cgnnet.com

Mr. Anthony ESILABA
CIAT
P. O. Box 6247
KAMPALA
Email: Ciat-uganda@cgnnet.com

Mr. Charles H. GASHUMBA
Agricultural Policy Secretariat
P. O. Box 24133
KAMPALA
Email: mpagric@starcom.co.ug

Dr. Mike HARRISON
Uganda Forest Sector Co-ordination
Secretariat, PO Box 27314
KAMPALA
Email: MikeH@ugandaforests.org

Ms. Pamela JAGGER
IFPRI
2033 K Street NW,
Washington DC 20006 USA
Email: P.Jagger@cgiar.org

Mr. C. K. KAIZZI
Kawanda Research Institute
C/O IFPRI (UGANDA)
Email: kckaizzi@hotmail.com

Mr. Edward KATO
IFPRI
Plot 4, Pilkington Road Collin House
KAMPALA
Email: enkonya@africaonline.co.ug

Mr. B.R.E. KAYAAYO
Sasakawa Global 2000
P.O. Box 6987
KAMPALA
Email: sguganda@starcom.co.ug

Mr. Andrew KIZITO
Foodnet
P. O. Box 7878
KAMPALA
Email: mis@imul.com

Ms. Hiroko KOSAKA
EC1, 5 South Parks Road
Oxford OX1 3UB
United Kingdom
Email:
hiroko.kosaka@green.oxford.ac.uk

Dr. Samuel KYAMANYWA
Faculty of Agriculture
Makerere University
P.O. Box 7062
KAMPALA

Dr. Mathias MAGUNDA
Kawanda Agricultural Research Institute
P.O. Box 6247
KAMPALA
Email: landuse@infocom.co.ug

Hon. Chebet MAIKUT
Uganda National Farmers Association
P. O. Box 6213
KAMPALA
Email: ulaa@swiftuganda.com

Mr. Lawrence MAYANJA
IFPRI
Plot 4, Pilkington Road Collin House
KAMPALA
Email: enkonya@africaonline.co.ug

Mr. Sam MUGASI
Faculty of Agriculture
Makerere University
P.O. Box 7062
KAMPALA

Mr. Charles MUSOKE
AFRICARE
P. O. Box 7655
Fax: 230266
Email: Musokec@yahoo.com

Ms. Primrose NABISUBI
Office of the Vice President
P. O. Box 7169
KAMPALA

Mr. N. NANGOTI
NARO/SAARI
SOROTI

Dr. Ephraim NKONYA
IFPRI
Plot 4, Pilkington Road, Collin House
KAMPALA
Email: e.nkonya@africaonline.co.ug

Mr. Eddie NSAMBA-GAYIYA
 Ministry of Lands and Environment
 P. O. Box 7096
 KAMPALA
 Email: mwle@mwle.go.ug

Mr. J.E.P. OBUO
 NARO/SARRI
 SOROTI

Dr. Fred OPIO
 IFPRI
 Plot 4, Pilkington Road Collin House
 P. O. Box 28565
 KAMPALA
 Email:
2020network@africaonline.co.ug

Mr. Charles OWACH
 Food Agricultural Organization
 P. O. Box 521
 KAMPALA
 Email: fao@infocom.co.ug

Dr. John PENDER
 IFPRI
 2033 K Street NW,
 Washington DC 20006 USA
 Email: j.pender@cgiar.org

Dr. Shahidur RASHID
 IFPRI
 2033 K Street NW,
 Washington DC 20006 USA
 Email: s.rashid@cgiar.org

Mr. Gerd RUECKER
 IFPRI
 Plot 4, Pilkington Road Collin House
 P. O. Box 28565
 KAMPALA
 Email: giskari@infocom.co.ug

Prof. E. N. SABIITI
 Makerere University
 P. O. Box 7062
 KAMPALA
 Email: dean@foema-ug.com

Mr. Patrick SERUYANGE
 MAAIF
 P. O. Box 102
 ENTEBBE

Mrs. Fortunate SEWANKAMBO
 NEMA
 P. O. Box 22255
 KAMPALA
 Email: nema@imul.com

Dr. Henri SSALI
 Kawanda Agricultural Research
 Institute/NARO
 P. O. Box 7065
 Email: landuse@infocom.co.ug

Dr. Dick SSERUNKUUMA
 Makerere University
 P.O. Box 7062
 KAMPALA
 Email: mukifpri@infocom.co.ug

Mr. Ron STRIKER
 USAID
 P. O. Box 7856
 KAMPALA

Dr. Ann STROUD
 AHI
 Kawanda Research Institute
 P. O. Box 6247
 KAMPALA
 Email: a.stroud@cgnet.com

Professor Moses TENYWA
Makerere University
P. O. Box 7062
KAMPALA

Dr. Clesensio TIZIKARA
NARO
P. O. Box 295
KAMPALA
Email: mukiibi@imul.com

Mrs. Rhoda TUMUSIIME
Directorate of Planning
MAAIF
P. O. Box 102
ENTEebbe
Email: Rhoda@infocom.co.ug

Ms. Astrid VAN ROOJ
GTZ/UWA
P.O. Box 10346
KAMPALA

Ms. Rhona WALUSIMBI
IFPRI
Plot 4, Pilkington Road Collin House
P. O. Box 28565
KAMPALA
Email: enkonya@africaonline.co.ug

Mr. Johannes WOELCKE
IFPRI
Plot 4, Pilkington Road Collin House
P. O. Box 28565
KAMPALA
Email: j.woelcke@uni-bonn.de

Professor Julius Y. K. ZAKE
Makerere University
P. O. Box 7062
KAMPALA

EPTD WORKSHOP SUMMARY PAPERS

LIST OF EPTD WORKSHOP SUMMARY PAPERS

- 01 *Conference on Agricultural Sustainability, Growth, and Poverty Alleviation in East and Southeast Asia*, by Julie Witcover and Mark Rosegrant, November 1995.
 - 02 *Designing Policy Research on Local Organizations in Natural Resource Management*, by Sara J. Scherr, Louise Buck, Ruth Meinzen-Dick, and Lee Ann Jackson, with Tony Bebbington, Deborah Merrill-Sands, and Gill Shepherd, November 1995.
 - 03 *Workshop on Non-Timber Tree Product (NTTP) Market Research*, by Julie Witcover and Stephen A. Vosti, November 1995.
 - 04 *Conference on Agricultural Growth, Natural Resource Sustainability, and Poverty Alleviation in Latin American Hillside Regions*, by Julie Witcover, Oscar Neidecker-Gonzales, Sara Scherr, Mario Ardón, Carlos Duarte, Guadalupe Durón, and Fernando Mendoza, July 1996.
 - 05 *Multiple Functions of Common Property Regimes*, by Brent M. Swallow, Ruth S. Meinzen-Dick, Lee Ann Jackson, Timothy O. Williams, and T. Anderson White, May 1997.
 - 06 *International Conference on Agricultural Growth, Sustainable Resource Management and Poverty Alleviation in the Low Rainfall Areas of West Asia and North Africa*, by Peter Oram, with Peter Hazell, Tom Nordblom, Nabil Chaherli, and Tidiane Ngaido, April 1998.
 - 07 *International Conference on Strategies for Poverty Alleviation and Sustainable Resource Management in the Fragile Lands of Sub-Saharan Africa*, by Anna Knox McCulloch, Suresh Babu, and Tidiane Ngaido, September 1998.
 - 08 *International Symposium on Property Rights, Risk, and Livestock Development*, by Winnie K. Luseno and Nancy McCarthy with Peter Hazell, Michael Kirk, Brent Swallow, and Ruth Meinzen-Dick, February 1999.
 - 09 *Policies for Sustainable land management in the highlands of Ethiopia*, by Mohammad A. Jabbar, John Pender, and Simeon Ehui, October 2000.
-